Solar Energy Policies in China: Trajectory, Change and Drivers of China's Energy Transition

A dissertation presented by
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to

Freie Universität Berlin
Fachbereich Politik- und Sozialwissenschaften.

In partial fulfillment of the requirements for the degree *doctor rerum politicarum (Dr. rer. pol.)* – an equivalent of a PhD in Political Science.

Submitted in Berlin on July 28, 2016

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Date of PhD Defense
February 10, 2017.

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To my loving husband, Professor Dr. med. Francisco J. Martinez Portillo, and my beautiful daughter, Neyla Alegria Martinez Liu. Your unconditional love, encouragement and endurance have made this journey possible. I also dedicate this thesis to my parents and grandparents – Kosima, John, Eleanor and Liu Guoan – for nurturing my creative potential and paving the way for this academic achievement. Dearest Rosa and Rosita – thank you for your unreserved support. To Liberto whose wisdom and unquenchable thirst for knowledge will always inspire me.

Executive Summary (in German)

China befindet sich energiepolitisch an einem historischen Scheideweg. In den letzten Jahren erzielte China, trotz seiner Rolle als weltweit größer Umweltsünder und Treibhausgasverursacher, wichtige Fortschritte im internationalen Klimaschutz. Im Rahmen der UN-Klimakonferenz in Paris (COP21) kündigte der chinesische Staatschef Xi Jinping an, dass China seine CO_2-Emissionen bis zum Jahr 2030 um 60-65% senken werde. Dies stellt eine historische Absichtserklärung dar, die eine dramatische Kehrtwende des bisherigen Wachstumsmodells erahnen lässt und insbesondere einen raschen und effektiven Ausbau von erneuerbaren Energieträgern, vorwiegend im Bereich Solarenergie, erfordert. Wissenschaftliche Studien bezweifeln jedoch, dass China zu einer nachhaltigen und erfolgreichen Solarpolitik fähig sei und attestieren der chinesischen Solarpolitik eine regelmäßige „Sprunghaftigkeit", „Inkohärenz" und „Ziellosigkeit". Als Beleg hierfür dienen der vermehrte Anstieg und die Änderung von politischen Vorgaben in den Jahren nach 2011 (beispielsweise die Zieländerungen der Kapazitäten für installierte Solarenergie der Jahre 2011, 2012 und 2013). Implizit schwingt hier die Annahme mit, dass es sich bei Chinas jüngsten Bemühungen um den raschen Ausbau von Solarenergie eher um einen kurzlebigen und ziellosen Prozess handelt, der anstelle einer grundlegenden Neuausrichtung vielmehr von opportunistischen und flüchtigen Interessen geleitet sei.

Die vorliegende Arbeit untersucht die Entwicklung und den Politikwandel der chinesischen Solarpolitik im Zeitraum 1980 bis 2013 und stellt in diesem Zusammenhang die Frage, wie sich die jüngsten und ambitionierten Gesetzesentwürfe in den historischen Verlauf von Solarpolitik in China einordnen lassen, zu welchem Zeitpunkt sich der *Policy Wandel* hin zu Solarenergie vollzogen hat und welche Auslöser hierzu beigetragen haben. Hierfür werden zwei analytische Theoriemodelle herangezogen, um den Strukturwandel und dessen Hintergründe umfassender zu verstehen. Das erste Theoriemodell (*Punctuated Equilibrium Theory* (PET)) dient dazu, Phasen der Stabilität und des Politikwandels zu unterscheiden, zu systematisieren und ermöglicht folglich eine genauere Betrachtung der Faktoren und Umstände, die den Politikwandel begünstigen bzw. auslösen: institutionelle Rahmenbedingungen, Auslöser sowie positive/negative Feedbackzyklen. Das zweite bei dieser Untersuchung benutzte Theoriemodell (*Fragmentierte Autoritätsmodel* (FA)) erweitert den analytischen Rahmen, in dem es die Besonderheiten und Strukturen von Chinas politischen Prozessen und fragmentierten Machtverhältnisse im Energiesektor hervorhebt. Eine Zusammenführung beider Theorien liefert dementsprechend Erkenntnisse, wie Chinas jüngste Solarpolitik zu interpretieren und einzuordnen ist, ob es sich hierbei um einen Paradigmenwechsel oder nur um inkrementelle Veränderungen handelt, in welchem erkennbaren Muster sich der Politikwandel vollzogen hat und welche Prozesse, Auslöser und Dynamiken dazu beigetragen haben.

Die Entwicklung der chinesischen Solarpolitik unterteilt sich in vier Phasen. In der ersten Phase (vor 1992) gab es weder spezifische Gesetzentwürfe noch Ziele bezüglich Solarenergie, jedoch vereinzelte, vage Interessensbekundungen hin zu einem verstärkten Ausbau und Nutzung von Solarenergie (beispielsweise im Umweltgesetz von 1979, namentlich im sechsten Fünfjahresplan (1981-1985) und im siebten Fünfjahresplan (1986-1990)). In der zweiten Phase der Solarpolitik (1994-2003) lieferte China zum ersten Mal einen konkreten und landesweiten Strategieplan für den Solarsektor für den Zeitraum 1996 bis 2010 („*New and Renewable Energy Development Programm*"). Der Strategieplan für den Solarsektor beruhte ausschließlich auf Chinas Vision für das 21. Jahrhundert, festgeschrieben in der Agenda 2001. Das Programm diente als politische und strategische Richtlinie, die für den genannten Zeitraum 1996 bis 2010 zunächst den Ausbau einer Solarindustrie und entsprechender Infrastruktur vorsah, um noch nicht ausgereifte Technologien gezielt zu fördern und in einem zweiten Schritt (in den Jahren 2000 bis 2010) eine gezielte

Anwendung und Verbreitung von Solartechnologien auf das Niveau von Industrieländern anzuheben. In der dritten Phase der chinesischen Solarpolitik (2003-2008) wurde mit dem das Erneuerbaren Energien Gesetz („*Renewable Energy Law*“) das bis dato wichtigste Instrument zur Förderung erneuerbarer Energien entwickelt. Mit diesem Gesetz wurden konkrete Ziele vorgegeben und wichtige Maßnahmen geregelt, wie beispielsweise der Anschluss von Solaranlagen, die vorrangige Abnahme durch die Netzbetreiber, die Übertragung und Vergütung des Stroms durch die Netzbetreiber und die landesweite Finanzierung der durch den Solarenergieausbau verursachten Mehrkosten. Dies führte in den folgenden Jahren zu einem sprunghaften und intensiven Anstieg von politischen Vorgaben, um die weiteren Maßnahmen und Instrumente zu konkretisierten und auszuarbeiten. Die vierte und letzte Phase der chinesischen Solarpolitik (2009-2013) war zum einen durch einen weiteren Anstieg an Regelungen und Maßnahmen zur Anpassung der obengenannten Vorgaben gekennzeichnet, und zum anderen erfolgte eine ambitioniertere Abstimmung der geplanten Zielvorgaben für den Ausbau der Solarenergie.

Wie durch die vorliegende Arbeit gezeigt werden konnte, bestätigt die Anwendung der *Punctuated Equilibrium Theorie*, dass Chinas Solarpolitik des letzten Jahrzehnts vor allem einem Paradigmenwechsel geschuldet ist, der sich im Zeitraum 1994 bis 1996 vollzog und eine historische Kehrwende der bis dato existierende Kernziele, Priorisierungen sowie Policy Instrumente führte. Diese historische Kehrwende (oder *Punctuation*) war das Resultat zweier neuer Denkarten (*Positive Feedbackprozesse*), nämlich die des *Environmental Paradigms* und die des *Scientific Development Paradigms*, welche das bis dahin dominante auf kohlebasierte Wachstumsmodell (*Policy Monopols*) entschieden in Frage stellte und stattdessen eine Neuausrichtung auf nachhaltige, soziale, umweltverträgliche sowie auf Innovation und Technologie-basierende Werte forderte. Die radikale Abkehr des bis dahin dominanten Denkmusters wurde letztendlich durch externe und interne Ereignisse (*Triggers*, *Window of Opportunity*) ausgelöst, allen voran wachsende energiepolitische Bedenken, ausufernde Umweltzerstörung und die Sorge um Chinas Energiesicherheit. Das Eintreten dieser zwei neuen Denkarten wurde zu den durch die schwach ausgeprägten formellen Institutionen (*Institutional Venues)* begünstigt.

Die Meilensteine in der chinesischen Solarpolitik, die in den Jahren nach 1996 folgten, insbesondere das im Jahr 2005 erlassene Erneuerbaren Energiegesetz und die darauffolgenden Regelungen und Policyänderungen, führten zwar zu einem rascheren Ausbau und der Initiierung neuer Handlungsweisen, waren aber letztendlich nur Teil eines *routinierten* und *inkrementellen* politischen Prozesses, ausgelöst und ermöglicht durch den Paradigmenwechsel im Zeitraum 1994-1996, und gelten somit als Modi eines *normalen* Policy-Zustandes (*First and Second Order Change*). Vor diesem Hintergrund ist die vermehrte Häufigkeit und Zunahme an politischen Vorgaben im Solarsektor insbesondere in den letzten Jahren nicht als „grüne Revolution“ aufzufassen, sondern vielmehr als die routinemäßige Anpassung eines relativ stabilen und schrittweisen Prozesses zu verstehen. Diese Annahme wird zusätzlich durch die Erkenntnis bekräftigt, dass sich das Thema Solarenergie bereits seit den 1970er auf der politischen Tagesordnung befand (*systematischen, institutionellen Agenda* und *Entscheidungsagenda)* und dass Solarenergie spätestens seit 1994 als nationale Priorität auf allen politischen Ebenen/Agenden wahrgenommen wurde. So lässt sich festhalten, dass die chinesische Solarenergiepolitik tief in Chinas langfristiger, allumfassender und kohärenter Energiestrategie für das 21. Jahrhundert eingebettet ist und diese damit auch in Zukunft weiterhin Priorität für politisches Handeln haben wird.

Executive Summary (in English)

China's energy sector is at critical crossroads. The country has recently committed itself to ambitious climate targets: In 2015, China's President Xi Jinping announced during the UN Climate Conference in Paris (COP21) that China would peak its carbon emissions by 2030. This constitutes a historical step for China and implies a dramatic shift away from of its heavy coal reliance towards a low-carbon path. This will require an unprecedented and highly ambitious promotion of renewable and clean energy sources particularly in the area of solar Photovoltaics.

Despite these commitments, reasonable doubts remain as to whether China's policymakers are able to develop support mechanisms and policies that are necessary for an effective and sustained deployment of solar energies in the long run. Recent studies have described China's solar policies as *not ideal*, *highly erratic* and *unfocused*. This had led to recent *flare-ups* of solar regulations and measures as well as *frequent* and *dramatic* changes in solar energy targets, especially since 2011 (these include the solar target amendments in the years 2011, 2012 and 2013). It is implicitly assumed that China's efforts towards solar energy deployment are manifestations of an *ephemeral* and *unfocused* policy process that is predominantly guided by opportunistic maneuvering and short-term interest rather than the outcome of a long-term and consistent planning process.

This study sets out to understand *how* and *why* China's solar policies have emerged in recent past and how these seemingly sporadic flare-ups of contemporary solar policies fit into the overall trajectory of solar policy development. This study applies both the *Punctuated Equilibrium Theory* (PET) and the *Fragmented Authoritarianism* (FA) Model to examine China's policy transitions for the period 1980 to 2013. The PET pays particular attention to the disruptive phases and characteristics of political processes and is therefore highly conducive to understanding and identifying a general pattern of policy change and to understand why policymakers suddenly abandon a chosen path and explore new pathways and policy directions. The FA Model is considered the most durable heuristic through which to study contemporary politics in China and allows for a better understanding of the structures, processes and mechanism behind policy choices. A combination of the PET theory and FA Model allows for an improved understanding of the trajectory and rationale behind China's solar policy development.

The trajectory of solar policies in China can be distinguished into four phases. During the first phase (prior to 1990), solar policies included mostly official declarations of intent to encourage the use and development of solar technologies but lacked specific legislations or targets. A major milestone achieved during this time was the mentioning of solar energies in China's Sixth Five-Year-Plan (1981-1985). During the second phase (1994-2002), China released two landmark policies, namely the 1994 *White Paper on China's Population, Environment and Development in the Twenty-First Century* and the 1996 *New and Renewable Energy Development Program*, which elaborated on the general strategy for solar energy development for the following decade. It proposed to develop solar energies through a two-step process, whereby the first stage (period 1996-2000) should establish an industrial base for solar technology and the second stage (period 2000-2010) should scale-up solar energy technologies to the national level. During the third phase of solar policy development (2003-2008), China released another landmark policy in 2005 titled the *Renewable Energy Law*, which for the first time elaborated on concrete support measures for solar energy technologies including (i) a mandatory grid connection and full purchase agreements; (ii) a renewable energy fund to finance solar application and research; (iii) feed-in tariffs and remuneration schemes; and (iv) the specification of solar energy targets. Although the *Renewable Energy Law* remained rather vague, it established an essential guideline for lower levels of government to draft subsequent policies. The fourth and last phase of solar energy development (2009-2014) was marked by a sudden increase of new solar policies to specify and substantiate

existing support measures and to amend solar energy targets, including the solar target amendments since 2011.

By applying the PET and FA Model, this study shows that the recent proliferation of solar policies especially in recent years is mostly attributed to a paradigm shift (*Punctuation*) that took place during the period 1994 to 1996. This punctuation (*Third Order Change)* led to (i) a complete *new set of goals and priorities* (ii) a new *environment of instruments*, and (iii) a host of new *instruments themselves*. The large-scale departure from the past was the result of two new emerging paradigms (*Positive Feedback Forces*), namely the *Environmental Paradigm* and the *Scientific Development Paradigm*, that increasingly challenged the heretofore dominant "*pollute first, control later*" and "*getting rich first, clearing up later*" way of thinking (*Policy Monopoly* and *Negative Feedback Forces*) and offered instead new perspectives and interpretations on economic growth especially in terms of *sustainable*, *inclusive* and *innovative* parameters. The radical departure from the existing paradigm was finally prompted through internal and external events (*Triggers, Window of Opportunity*), most important of which were growing energy political factors, environmental degradation and emerging energy security concerns. New paradigms were able to enter the political arena due to weak institutional venues and boundaries. The solar policies that followed the first punctuation in the years after 1996, in particular the *Renewable Energy Law* in 2005 and the numerous policy changes and amendments in solar targets since then, have constituted important milestones for solar energy policy development that lead to a burgeoning of solar policies and an accelerated growth of solar energy capacities. However, they represent the type of routinized decision-making that is associated with the *normal* and *incremental* state of policy processes (*First and Second Order Change*). This conclusion aligns with the presumption that solar energy issues have been part of China's national agenda (*agenda universe, systematic, institutional and decision agend*a) since the 1970s and since 1994 have been considered an issue of major national concern that is to be acted upon by the government body or ruling elite (*decision agenda level*). Therefore, China's recent efforts and ambitious solar energy plans are not as much a "green revolution" or *new phenomenon* but instead constituents of a *routinized*, *incremental* and relatively *stable* policy process that is part of a more entrenched policy path that China began venturing in the mid 1990s and that builds upon a coherent and long-term energy strategy for the 21 centuries. Therefore, solar policies will likely continue to be a priority for energy policymaking in China's mid- and long-term future.

Outline

Figures, Tables, Abbreviations, Acronyms, Units and Maps

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List of Abbreviations and Acronyms

AC	Alternating Current
BIPV	Building-integrated Photovoltaics
CAS	Chinese Academy of Sciences
CAE	Chinese Academy of Engineering
CDC	China Datang Corporation
CdTe	Cadmium-Telluride
CGC	China Guodian Corporation
CHDC	China Huadian Corporation
CHNG	China Huaneng Group
CIGS	Copper-indium-gallium-diselenide
CIS	Copper-Indium-Selenide
CNREC	China National Renewable Energy Centre
CO_2	Carbon Dioxide
CPC	Communist Party of China
CPIC	China Power Investment Corporation
CPP	China's Communist Party
CPV	Concentrating Photovoltaics
CREIA	Chinese Renewable Industry Association
CSG	China Southern Power Grid Cooperation
CSP	Concentrated Solar Power
CSR	Corporate Social Responsibility

DC	Direct Current
EPIA	European Photovoltaic Industry Association
ERI	Energy Research Institute
EU	European Union
FA	Fragmented Authoritarianism
FYP	Five-Year Plan
GDP	Gross Domestic Product
GHG	Greenhouse Gas
IAD	Institutional Analysis and Development
IEA	International Energy Agency
IMG	Inner Mongolian Power Grid Cooperation
INC	International Negotiating Committee
IPCC	Intergovernmental Panel on Climate Change
LCOE	Levelized Cost of Energy
MEP	Ministry of Environmental Protection
MIIT	Ministry of Industry and Information Technology
MLP	Multi-level Perspective
MLR	Ministry of Land and Resources
MOE	Ministry of Education
MOP	Ministry of Personnel
NSFC	National Natural Science Foundation of China
MOF	Ministry of Finance
MofCom	Ministry of Commerce
MoHURD	Ministry of Housing, Urban and Rural Development
MOST	Ministry of Science and Technology
MOC	Ministry of Commence
MOF	Ministry of Finance
Mtce	Metric tons of coal equivalent
NDRC	National Development and Reform Commission
NEA	National Energy Administration
NEC	National Energy Commission
NGO	Non-governmental organization
NIMBY	Not in my back yard
NIS	National innovation system
PM	Particulate Matter
PRC	People’s Republic of China
PV	Photovoltaic
R&D	Research and Development
RD&D	Research, Development and Demonstration
RE	Renewable Energy
REL	Renewable Energy Law
RES	Renewable Energy Sources
RPS	Renewable Energy Portfolio Standard
SASAC	State-owned Assets Supervision and Administration Commission
SDPC	State Development Planning Commission (since 2003 NDRC)
SETC	State Economic and Trade Commission
SGCC	State Grid Cooperation of China
SSTC	State Science and Technology Commission

STC	Standard Testing Conditions
TT	Technological Transitions
UHV	Ultra-high Voltage
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
US / USA	United States of America
USD	United States Dollar
VAT	Value Added Tax
WECD	United Nations World Commission on Environment and Development
WHO	World Health Organization

List of Units

a-Si	Amorphous
mc-Si	Multicrystalline
sc-Si	*Monocrystalline*/ single crystalline
μc-Si	Micromorphous Silicon
μm	Microns

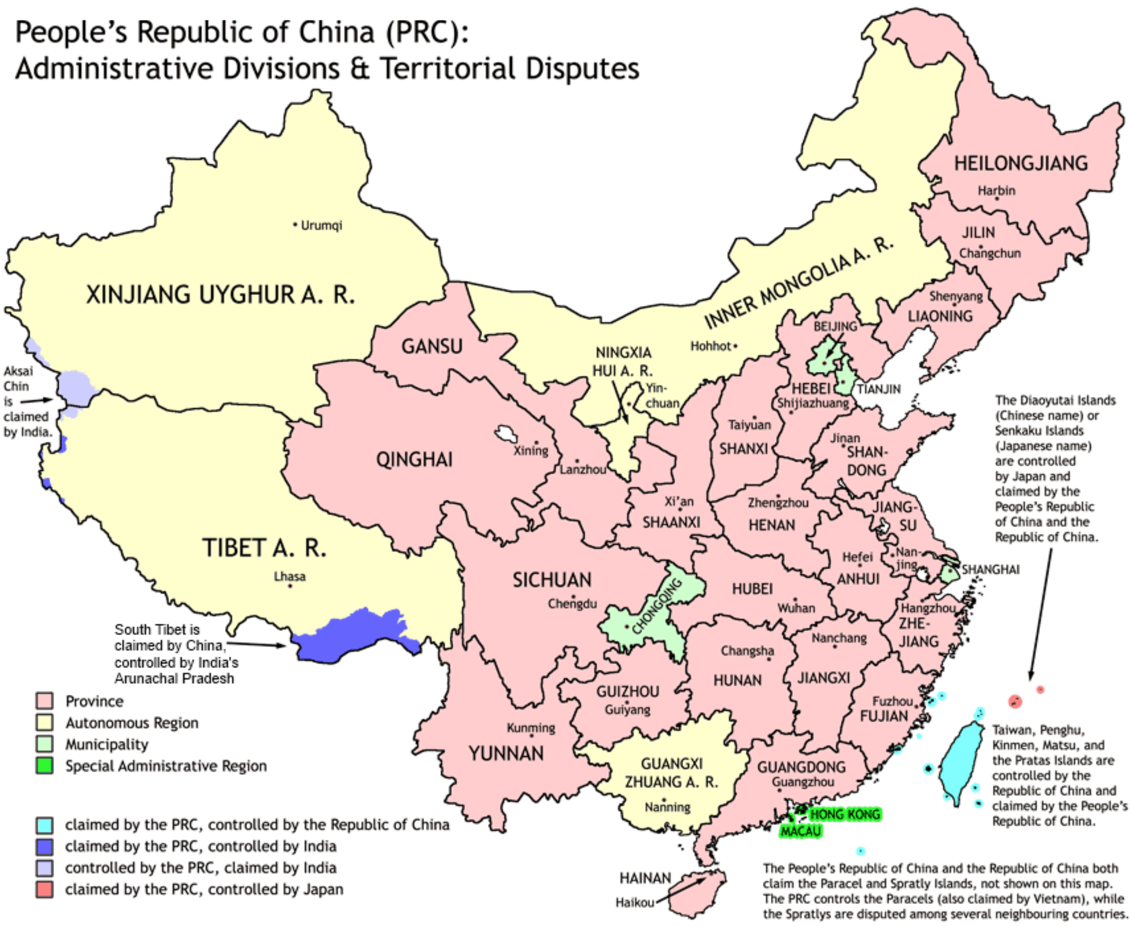
Currency Equivalents

(as of July 18, 2016)
Chinese Renminbi (CNY)
Euro (EUR)
CNY 1.00 = EUR 0.135
EUR 1.00 = CNY 7,422

Physical Units and Conversion Factors

Name	Abbreviation	Conversion Calculation
Nanometer	nm	1×10^{-9} m
Kilo	k	10^3
Mega	M	10^6
Giga	G	10^9
Tera	T	10^{12}
Peta	P	10^{15}
Watt	W	1 J x s^{-1}
Kilowatt	kW	1 000 W
Megawatt	MW	10^6 W = 1 000 kW
Gigawatt	GW	1 000 MW
Terawatt	TW	1 000 GW
Kilowatt-second	kWs	3 600 J = 3,6 kJ
Wattpeak	Wp	
Kilowatt Peak	kWp	
Megawatt Pek	MWp	
Watt-hour	Wh	3 600 J = 3,6 kJ
Kilowatt-hour	kWh	3,6 x 10^6 J = 3 600 000 J = 3 600 kJ = 3,6 MJ

Megawatt-hour	MWh	3,6 x 10^9 J = 3 600 000 kJ = 3 600 MJ = 3,6 GJ
Gigawatt-hour	GWh	3,6 x 10^{12} J = 3 600 000 MJ = 3 600 GJ = 3,6 TJ
Terawatt-hour	TWh	3,6 x 10^{15} J = 3 600 000 GJ = 3 600 TJ = 3,6 PJ
Joule	J	1 kWs
Kilojoule	KJ	
Megajoule	MJ	
Gigajoule	GJ	
Terajoule	TJ	
Petajoule	PJ	
Ton/tonne	Ton	1 000 kg
BTU		1,054.615 joules
1 barrel of crude oil		6.193 gigajoules
1 tonne oil equivalent (TOE)		41.9 GJ
1 tonne coal equivalent (TCE)		29.3 GJ



Source: Wikipedia, www.wikipedia.com

China has four levels of formal administration under the central government. The first level is officially made up of 34 provincial-level governments. This includes 23 provinces; five geographic entities that China calls “autonomous regions,” which have large ethnic minority populations (Guangxi, Inner Mongolia, Tibet, and Xinjiang); four municipalities that report directly to the central government (Beijing, Chongqing, Shanghai, and Tianjin); and the two special administrative regions of Hong Kong and Macau. The PRC’s count of 23 provinces includes Taiwan, the island of 23 million people that the PRC does not control, but over which it claims sovereignty. The second level of administration includes more than 300 prefectural-level administrative units, including prefectures and prefectural-level cities. The third level of administration includes nearly 3,000 counties and county-level cities. The lowest tier of official administration is made up of approximately 40,000 townships and towns. The first, third, and fourth levels of administration all have political structures that mirror the central government, with parallel Party and government organizations and people’s congresses. At the second administrative level, prefectural-level cities and autonomous prefectures also have government organizations and people’s congresses, but regular prefectures do not. Instead, they have administrative agencies. Villages are not considered part of the formal administrative structure, but are rather considered “mass organizations of self-management at the grass-roots level.” Their status outside the government hierarchy allowed China to introduce direct elections at the village level in the 1980s without setting a precedent for direct elections at higher levels.[1]

[1] Saich, T. (2011). Governance and Politics of China. In *Governance and Politics of China (review)* (3rd ed., pp. 1–448). New York, USA: Palgrave Macmillan.

Acknowledgements

This thesis has benefited greatly from the contributions of many interviewees, practitioners and scholars in China and Germany, who participated and generously devoted their time and efforts to make this study possible. To them, I express my sincere gratitude. A number of reviewers made constructive suggestions during the revision and writing of this thesis. Special thanks go to Annie Liu for sharing her insights into the Chinese energy sector. I also wish to thank the Tsinghua University for hosting me as visiting scholar and providing me with three memorable semesters and courses at their historical university campus. I would like to express my very great appreciation to Prof. Dr. Miranda Schreurs and Prof. Dr. Manfred Fischedick for their input and patience during this thesis. This thesis would not have existed without the financial support from the Reiner Lemoine Foundation, the German Academic Exchange Service (DAAD) and the China Scholarship Council (CSC). Last but not least, I am extremely grateful for the incredible support, encouragement and patience from my family. This is especially true for my loving husband, Professor Dr. med. Francisco J. Martinez Portillo and mother-in-law Rosa Portillo Marin, who made it possible for me to pursue and reconcile research, motherhood and a career abroad. I am indebted to my parents and grandparents, John D. Liu, Kosima Weber Liu, Guo An Liu and Eleanor Liu who have always encouraged and inspired me.

PART 1 Introduction

1.1 Problem Definition: China at Energy Crossroads

China's energy sector is at a critical crossroads. The country has recently embarked on an impressive development path to generate extensive amounts of electricity from renewable and clean energy sources. In November 2014, China's President Xi Jinping announced during a presidential visit to the United States, that China would peak its carbon emissions by 2030.[2] This constituted a historical step for China and reflects the ambitious low-carbon path that China has recently ventured: by 2030, China plans to achieve a 20% share of non-fossil and renewable energies in the primary energy supply and reduce its CO2 emissions by 60-65% per unit of GDP, as shown in Table 1.[3]. To this end, China has embarked on a fast track to expand its renewable energy capacities: The country has currently 19.81 Gigawatt (GW) of wind and 10.60 GW of installed solar energy capacity, which its plans to scale up to 200 GW and 100 GW respectively by 2020.[4] China has thus also become the world's largest investor in renewable energy, with more than US$ 89.5 billion of investments into clean technologies in 2015.[5]

Table 1 China's Energy and GHG Emission Targets

	2006-2010	2011-2015	2020	2030
Non-fossil fuel shares (%)	10	11.4	15	20
Energy intensity reduction in (%)	20 (2005)	16		
Emissions intensity reduction (in %)	17 (2010)	40-45 (2005)	60-65 (2005)	

Source: National Development and Reform Commission of China (2015). Enhanced Actions on Climate and China's Intended Nationally Determined Contributions. Beijing, China: NDRC.

Yet the narrative of China emerging as a "green giant"[6] sits uneasily with the socio-economic and political realities of China as the world's largest greenhouse gas emitter and major coal consumer. China still produces more than 68.4% of its primary energy and 70% of its electricity from coal.[7] Moreover China is responsible for approximately 70% of new CO2 emissions each year,[8] expected to emit around 32% of global GHG emissions by 2020, approximately 70% more carbon dioxide than the U.S. as the second largest GHG emitter.[9] This is not surprising as China has also

[2] The White House. (2016). U.S.- China Joint Presidential Statement on Climate Change. *Office of the Press Secretary*. Washington D.C., USA.
[3] Davidson, M. R., Zhang, D., Xiong, W., Zhang, X., & Karplus, V. J. (2016). Modelling the potential for wind energy integration on China's coal-heavy electricity grid. *Nature Energy*, *1*(7), 16086. http://doi.org/10.1038/nenergy.2016.86
[4] National Energy Administration. 2014 Nián guāngfú fādiàn tǒngjì xìnxī (2015). National Energy Administration.
[5] The Climate Group. (2015). RE 100 - China's Fast Track to A Renewable Future.
[6] Neslen, A. (2016, June). China to generate a quarter of electricity from wind power by 2030. *The Guardian*.
[7] National Bureau of Statistics of China. (2013). *China Statistical Yearbook 2013*. Beijing, China.
[8] International Renewable Energy Agency (IRENA). (2014). *Renewable Energy Prospects: China REmap 2030 analysis.* Abu Dhabi, Arab Emirates: IRENA.
[9] The Climate Group. (2015). RE 100 - China's Fast Track to a Renewable Future.

been among the world's largest energy consumers. Since China's Open-Door Policy in 1978, the country's annual Gross Domestic Product (GDP) and annual energy consumption have grown on average 10% and 5.2% respectively,[10] constituting a five-fold since the 1970s. The International Energy Agency (IEA) predicts that Chinese energy demand will reach 9594 TWh in 2035, which equals an average increase of 5.3% each year.[11]

China's growing energy demand has mostly been supplied through cheap and easily available coal, which has been the single most important cornerstone of China's massive development growth within the past three decades. China stands as the world's leading coal producer, consumer, and importer, responsible for nearly half of the coal consumption worldwide, almost as much as all other countries combined. Aside from coal, China ranks also the world's second largest oil consumer, second-largest net importer of crude oil and petroleum products. Yet after three decades of massive coal exploitation and consumption, China's coal dependence and its adverse effects on the environment and climate have engendered major public concern and have stipulated questions regarding the longevity and sustainability of China's growth model. Although coal mining and combustion have been subject to recent technological modernization, there are still some major concerns that must be addressed. These concerns include the accumulation of coal gangue, leakage of contaminated water, and uncontrolled discharges of coal-bed methane. In China, the coal-processing industries, such as coal-fired power, coking, steel, and building materials, account for approximately half of the country's emissions of sulfur dioxide (SO_2), carbon dioxide (CO_2), and Particulate Matter (PM). In addition, coal mining and coal-processing industries require large amounts of water that – if discharged without proper treatment- can lead to acid rain and the contamination of groundwater, seas, and rivers with heavy metals, mercury, and other toxins and pollutions found in coal ash, coal sludge, and coal waste. Health concerns have played a major role in fueling the discussion about China's coal dependence since air pollution from coal is eroding China's health and increasing mortality rates in all sectors of society.[12] Air pollution[13] is proven to be a health hazard[14] that significantly increases the risk of cardiorespiratory diseases such as strokes, heart disease, and lung cancer. Worldwide, between 3 and 7 million deaths each year are attributed to air pollution.[15] In China, however, air pollution accounts for 17% of all deaths per year, equaling an average of 1.6 million deaths per year and 4,400 deaths per day.[16] The largest health impacts stem from Particulate Matter of the size 2.5 microns or smaller ($>PM_{2.5}$), which was previously associated with numerous sources such as

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10 Davidson, M. (2014, January 14). Renewable Energy Momentum in China | The Energy Collective. Retrieved March 18, 2015, from http://theenergycollective.com/michael-davidson/279091/transforming-china-s-grid-sustaining-renewable energy-push.

11 Cheung, K. (2011). Integration of Renewables: Status and Challenges in China. *International Energy Agency (IEA)*, 134.

12 Rohde, R. A., & Muller, R. A. (2015). Air pollution in China: Mapping of concentrations and Sources. *PloS One*, *10*(8), e0135749.

13 Air pollution refers to the occurrence of 6 common pollutants: particulate matter < 2.5 microns (PM2.5), particulate matter < 10 microns (PM10), sulfurdioxide (SO2), nitrogen dioxide (NO2), ozone (O3), and carbon monoxide (CO).

14 Beelen, R., Raaschou-Nielsen, O., Stafoggia, M., Andersen, Z. J., Weinmayr, G., Hoffmann, B., … Hoek, G. (2014). Effects of long-term exposure to air pollution on natural-cause mortality: an analysis of 22 European cohorts within the multicentre ESCAPE project. *The Lancet*, *383*(9919), 785–795. http://doi.org/10.1016/S0140-6736(13)62158-3.

15 Yang, G., Wang, Y., Zeng, Y., Gao, G. F., Liang, X., Zhou, M., … Murray, C. J. L. (2013). Rapid health transition in China, 1990–2010: findings from the Global Burden of Disease Study 2010. *The Lancet*, *381*(9882), 1987–2015.http://doi.org/10.1016/S0140-6736(13)61097-1

16 Rohde, R. A., & Muller, R. A. (2015). Air pollution in China: Mapping of concentrations and Sources. *PloS One*, *10*(8), e0135749. https://doi.org/10.1371/journal.pone.0135749.

automobiles, agricultural dust, loess soil, and coal. However, recent studies suggest that the primary sources of $PM_{2.5}$ pollution are predominantly associated with coal combustion used for electric power, for industrial energy, and for heating.[17] Similarly, coal burning in power plants and industrial facilities is responsible for more than 90% of the sulfur dioxide (SO^2) levels.[18] Although national safety standards in China mandate that daily exposure to harmful $PM_{2.5}$ pollution may not exceed 35 micrograms per cubic meter, China's air pollutant benchmark is four times higher than recommended by the World Health Organization (WHO) and is one of the most highest worldwide.[19] Even despite these generously stipulated limits, around 92% of Chinese cities were unable to meet the national air quality standards in 2013.[20] In June 2014, the Vice Minister of Environmental Protection, Li Ganjie, admitted that the state of air quality in China is considered "serious".[21] In 2015 it was reported that pollution levels of $PM_{2.5}$ particulates rose to 568 micrograms per cubic meter, which is 20 times higher than the recommended WHO limit.[22] The desolate state of air pollution in China can be illustrated by the term "Airpocalypse," a compound word made up of "air" and "apocalypse", which has recently become a common term used by mass media to describe air pollution in China.[23]

Above that, coal extraction and combustion have also recently started taking its toll on other vital pillars of the economy such as China's water sector and soil sector.[24] China's 2013 *State of the Environment Report* reveals that the quality of the water has deteriorated significantly, around 59.6% of the tested groundwater sites were described as having a "poor" or "very poor" water quality.[25] In addition, acid rain was affecting 11% of the Yangtze River watershed.[26] In 2013, a report by the Geological Survey of China revealed that 90% of the country's groundwater was polluted[27] and approximately one-fourth of the water that flows through China's seven major river systems and their tributaries is considered unsuitable for even agriculture or industry. Aside from pollution, water scarcity is becoming another serious challenge. At least ten provinces in China (which account for 45% of the mainland's GDP), of the national agricultural output, and more than half of China's industrial production, were ranked below the World Bank's water poverty level of 1,000 cubic meters (m^3) per person per year. In 2012 the vice minister of water resources, Jiao Yong, announced that more than 400 cities in China were without sufficient water resources, 110 of which faced serious scarcity.[28] Water resources, however, are a vital pillar of the Chinese

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[17] Ibid.

[18] Lu, Z., Zhang, Q., & Streets, D. G. (2011). Sulfur dioxide and primary carbonaceous aerosol emissions in China and India, 1996–2010. *Atmospheric Chemistry and Physics*, *11*(18), 9839–9864. http://doi.org/10.5194/acp-11-9839-2011

[19] The WHO recommends maximum 25 micrograms per cubic meter and ideally no more than 10 micrograms per cubic meter

[20] Greenpeace East Asia. (2014, April). The End of China's Coal Boom: 6 facts you should know. *Greenpeace*.

[21] Xinhua News. (2014, June 5). China faces "serious" environmental challenges. *Xinhua News*.

[22] British Broadcasting Corporation (BBC). (2015, January 15). China pollution: Beijing smog hits hazardous levels. *BBC*
News Asia.

[23] See for example Stevenson, A. (2014, March 3). China's Airpocalypse: 'Breathing Together, Sharing the Fate'. *Huffington Post*.

[24] Stevenson, A. (2014, March 3). China's Airpocalypse: 'Breathing Together, Sharing the Fate.' *Huffington Post*.

[25] Ministry of Ecology and Environment of the People's Republic of China. (2013). *Report on the State of the Environment*. Beijing, China.

[26] The Yangtze River is the world's third-longest river and stretches over 6,300 kilometers

[27] Tortajada, C., & Biswas, A. K. (2013, March 5). The problem of water management. *People's Daily China*. Beijing.

[28] Wang, F. (2012, March 26). China's water crisis a growing threat. *China News Service (CNS)*.

economy and are crucial for China's growing middle class, urbanization, and increased agricultural needs.

The country's soil condition is in a similarly deteriorated state. A report by the Ministry of Environmental Protection and the Ministry of Land and Soil in April 2014 noted that vaporized mercury from coal-fired power plants and other evaporated heavy metals had severely tainted cropland in China, polluting 16% of the total territory and 19% of the agricultural land.[29] The inorganic structure of heavy pollutants (such as cadmium, lead, mercury, nickel and arsenic) allows them to accumulate in soils and become absorbed by plants, which in turn may lead to serious contamination of food crops. Due to high levels of pollution, nearly 3.33 million hectares of Chinese farmland has already become too polluted to grow crops, which is beginning to put pressure on China's food supplying industry.[30] Water and soil contamination have taken a serious toll on issues such as *food security*. Food imports have surged, and China has nearly doubled its imports of wheat, corn, and rice over the past four years. This has had far-reaching geopolitical consequences and has led to sharp increases in global food prices. The long-term food security in China is therefore interchangeably connected to the questions of how the government will address environmental issues in future and how it will shift its energy supply away from coal.

Environmental pollution has also become a major destabilizing factor in the region and has become the source of much public anger and social unrest. In July 2014, the Ministry of Environmental Protection admitted that 80% of public complaints were driven by air pollution, resulting in 30,000 to 50,000 of large-scale incidents of civil disobedience, known as *mass incidents,* each year.[31] The increase in public protest has been mainly associated with the rising number of influential and international scientific studies that have been published since 2010 that have documented and highlighted the detrimental effects of pollution on human health.[32] Many studies have found, for instance, that young children are especially at risk when exposed to air pollution since their immune systems and lungs have not yet fully developed. During a particularly strong episode of polluted air and smog in 2013, state media reported that more than 9,000 children were hospitalized and treated for respiratory ailments each day. In a society where most families are confined to only one child and where children are essential for the financial well-being at retirement age, risk factors for children can easily attract public anger. Other supporting factors for the rise of public protests have been a general increase of environmental awareness, a rise of domestic Twitter-like services (such as *Sina* and *Weibo*), a growing popularity of environmental documentaries[33] and the emergence of celebrity-supported public campaigns.

[29] Ministry of Environmental Protection and Ministry of Land Resources of the People's Republic of China (MEP and MLR). (2014). *The Bulletin of Nationwide Soil Pollution Status Survey* (Index No. 000014672/2014-00351.). Beijing, China.

[30] Stanway, D. (2013, December 30). China says over 3 mln hectares of land too polluted to farm. *Reuters*.

[31] Bloomberg News. (2013, March 6). Chinese Anger Over Pollution Becomes Main Cause of Social Unrest. *Bloomberg News*.

[32] An example hereof is the public debate that was stipulated by scientific findings that life expectancy of Chinese residents living in the North was on average 5.5 years shorter than their Southern counterparts (see for instance Chen, Y., Ebenstein, A., Greenstone, M., & Li, H. (2013). Evidence on the impact of sustained exposure to air pollution on life expectancy from China's Huai River policy. Proceedings of the National Academy of Sciences of the United States of America PNAS, Proceedings of the National Academy of Sciences, 110(32), 12936–12941.

[33] An example hereof is the documentary "Under the Dome (*Qiongding zhi xia*)" by investigative journalist Chai Jing, which was viewed over 150 million times within three days of its release.

Air and other types of environmental pollution have therefore often been referred to as China's "public enemy number one".[34]

Last but not least, there are also several strategic considerations that mandate a greater use of solar energy. It is estimated that the costs for environmental pollution, public health, and social externalities related to China's coal industry (excluding climate change impacts) sum up to 1.7 trillion Renminbi (CNY) (0.25 trillion US Dollar) each year.[35] Moreover, exploitation and the use of coal are also undermining China's national security strategy. The reasons for this are attributed to the geographic disparity between coal-mining regions (which lie in the country's Northwest) and regions of high coal consumption (which are located in the coastal areas of East China). These geographic disparities between coal mining and coal consumption are bridged by long and unwieldy roads and railways that offer only limited transport capacity and are highly vulnerable to disruption (such as chronic congestions, massive traffic jams[36] and even natural disasters[37]). Such logistical challenges have increased the prices of domestic coal and have made those prices less competitive compared to imported coal from Australia, Indonesia, or South Africa. In 2013 alone, China imported 267 million tons of coal, which marks an increase of 14% compared to the previous year. In its quest for cheap energy, China has thus become more dependent on imported fuels and consequently more vulnerable to sudden price fluctuations in global energy markets. Therefore, the contemporary energy structure, which is largely built on coal, constitutes one of the greatest foreign policy and energy security concerns for present-day China, it is considered by some the most significant determinant of the country's future peace and prosperity.[38]

In view of these daunting environmental, social, and economic challenges and their severe and global implications, it is imperative that a rigorous and timely understanding of this topic be generated. The Chinese government has recently sped up its efforts in reducing environmental hazards and shifting the country's energy mix away from fossil fuels and towards more innovative and sustainable energy technologies. Solar Photovoltaic (PV) has played a key role in this process, especially given its potential to "re-establish the links between the development of the economy as a whole and environmental cycles, [and] stable regional business structures."(p.34).[39] Since renewable technologies have reached a "transformative tipping point" (p.1), [40] Chinese policymakers have begun to recognize solar energy as a viable source of energy and a practical way of capping carbon emissions in the coming decades. This has not only led to a boost in clean energy investments, but more importantly, to a burgeoning of new solar targets, policies, and regulations, all of which are evidence of the "fundamental shift in energy policy" (p.1) that is

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[34] China Daily. (2015, May 19). Air quality top public environmental complaint in China. *Xinhuanet News*.

[35] Mao, Y., Sheng, H., & Yang, F. (2008). *The true cost of coal*. *Greenpeace*. Retrieved 21.04.2015, from https://www.greenpeace.org/eastasia/PageFiles/301168/the-true-cost-of-coal.pdf

[36] The most serious of which occurred in August 2010 along the China National Highway 110 (G110) and the Beijing Tibet Expressway (G6) in Hebei Province and Inner Mongolia. It was named the "China National Highway 110 traffic jam" and it stretched more than 100km and was reported to have lasted between 10 and 20 days.

[37] In early 2008, prolonged snow and icy weather damaged power grids and blocked the transport of coal causing power blackouts in 17 Chinese provinces (see Xinhua News. (2008, January 31). Power blackout hits 17 provinces. *Xinhua News*.

[38] Florini, A. (2014, May 21). Governing Energy: Asia's Future and the G20. *The Brookings Institution*. Retrieved on 21 April, 2015, from http://www.brookings.edu/research/opinions/2014/05/13-asia-energy-g20-florini.

[39] Scheer, H. (2004). The solar economy: Renewable energy for a sustainable global future. London: Earthscan/James & James.

[40] Florini, A. (2014, May 21). Governing Energy: Asia's Future and the G20. *The Brookings Institution*. Retrieved from http://www.brookings.edu/research/opinions/2014/05/13-asia-energy-g20-florini.

happening in China today.[41] The following graph illustrates the recent expansion of solar policies and indicates the overall increase in the share of renewable energies (key elements of China's solar energy policy framework are indicated by squares).[42]
The recently observed dynamics and politically induced burgeoning of solar policies raises the general questions as to how and why solar policies have re-emerged in the recent past and how these seemingly sporadic flare-ups of contemporary solar policies and government commitment fit into the overall trajectory of solar policies. The sudden shift toward solar energy is also reflected in the projected target for total installed solar PV to be achieved by the end of 2015, which was adjusted altogether four times, changing from the initial 5GW in March 2011, to 10GW in April 2011, to 20GW in September 2012, finally arriving at 35GW in January 2013.[43] According to estimates the actual additional installed capacity could add up to 43-45GW, exceeding the national target by another 20%. These "rather aggressive"[44] targets for developing solar PV are a sign that the conditions for solar policies have never been so favorable and, more importantly, that the Chinese government is determined to become the world's leading solar energy nation in terms of installed capacity.
Despite such ambitious goals, reasonable doubt remains as to whether China's energy sector is capable of creating the effective and long-lasting support mechanisms that are necessary for developing the solar sector. Large-scale deployment of solar energy will require a coherent and comprehensive set of policies aimed at cost reduction, technological advancement, remuneration, grid connection and economies of scale. More importantly, a large-scale development of solar energy in China will require concerted action from all levels of government to develop market infrastructure, improve information access, improve commercial capabilities in the renewable energy field, and put in place efficient market-based incentives. Yet recent studies paint a rather gloomy image of China's solar development and openly question China's ability to produce the type of policy support that is needed to scale up solar energies. For instance, Zhang et al. (2013, p.902)[45] assert that policy efforts are "not ideal" due to the "very erratic path" of previous solar policies.[46] Similarly, Liu and Shiroyama (2013)[47] criticize the lack of consistency, which is not only the case for solar policies at the national level but also at lower levels of government where

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[41] Sudworth, J. (2015, March 11). China eyes fundamental shift in energy policy. *British Broadcasting Cooperation (BBC) News*. Shanghai. Retrieved 21.04.2015, from http://www.bbc.com/news/business-31689722
[42] Included were all solar policy types in China (i.e. all economic Instruments, Information and Education, Policy, Support, Regulatory Instruments, Research, Development and Deployment (RD&D) and Voluntary Approaches) irrespective of their policy status (e.g. ended, in-force, planned, superseded, under review). See International Energy Agency (IEA). (n.d.). *Global Renewable Energy*. Retrieved on April 11, 2014, from https://www.iea.org/policiesandmeasures/renewableenergy/?filter=solar&filter=solar
[43] Haugwitz, F. (2015, May 21). China's future solar ambitions – at home and abroad. *PV Tech.Org*. Retrieved on June 11, 2016, from http://www.pv-tech.org/guest_blog/chinas_future_solar_ambitions_at_home_and_abroad
[44] Haugwitz, F. (2015, March 24). China 17.8 GW, a record solar PV installation target for 2015. *PV Tech,.Org.* Retrieved on March 30, 2015 from http://www.pv-tech.org/guestblog/china_17.8gw_a_record_solar_pv_installation_target_for_2015._achievable
[45] Zhang, S., Andrews-Speed, P., & Ji, M. (2014). The erratic path of the low-carbon transition in China: Evolution of solar PV policy. *Energy Policy*, (67), 903–912. http://doi.org/10.1016/j.enpol.2013.12.063.
[46] Zhang, S., Andrews-Speed, P., & Ji, M. (2014). The erratic path of the low-carbon transition in China: Evolution of solar PV policy. *Energy Policy*, (67), 903–912. http://doi.org/10.1016/j.enpol.2013.12.063
[47] Liu, D., & Shiroyama, H. (2013). Development of photovoltaic power generation in China: A transition perspective. *Renewable and Sustainable Energy Reviews*, *25*(0), 782–792. http://doi.org/http://dx.doi.org/10.1016/j.rser.2013.05.014

policies can change frequently and dramatically.[48] Such observations are consistent with the more general perception of energy sector policies in China. Above that Cunningham (2007, p.1) even frames energy institutions in China as being unable to produce "focused energy policy"[49] referring to the fact that "China's system of environmental governance is both very much in the making and under constant change and transition due to a fluid social environment, both nationally and internationally".[50] China has remained in a state of transition where neoliberal market forces interfere and compete with state-owned utilities, which in turn has created an unstable environment of contemporary institutions and "moving targets" (p.7).[51] Energy policies and energy sector governance in China are thus perceived as a vast and highly complicated issue.[52] Downs (2004, p.22)[53] goes as far as to describe China's contemporary energy sector as the epitome of "a struggling regulatory governance system, where long-established institutional structures, vested interests and institutional deficiencies impede with planned structural changes". This has led to an "energy policy vacuum in Beijing"[54] and a "glaring deficit of governmental regulatory and administrative capacity"[55], both of which have rendered energy policy a complex battleground of negotiation between powerful actors with conflicting interests in all levels of government.[56] For this reason Lester and Steinfield (2007)[57] (assert that China's real problem is not one of "[energy] appetite, ambition, state strategy, or active disregard" but perhaps China's problem is its "inability to govern coherently".

China's ambition to develop solar PV is therefore not as much a question of political determination but perhaps, more importantly, a question of how solar policies can be designed and implemented in ways that are coherent, effective, and sustainable in establishing long-lasting structures. This correlates with sustainability transition research, which argues that niche innovations- including solar Photovoltaics- require a certain degree of government policy support to attenuate the societal, economic, and political conflicts that arise from sustainable

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48 Zhang, P., Yanli, Y., Jin, S., Yonghong, Z., Lisheng, W., & Xinrong, L. (2009). Opportunities and challenges for renewable energy policy in China. *Renewable and Sustainable Energy Reviews*, *13*(2), 439–449. http://doi.org/10.1016/j.rser.2007.11.005

49 Cunningham, E. A. (2007). China's Energy Governance: Perception and Reality. Retrieved January 20, 2015, from https://www.files.ethz.ch/isn/32082/07-04 Chinas_Energy_Governance_Perception_Reality.pdf

50 Mol, A. P. J., & Carter, N. T. (2006). China's environmental governance in transition. *Environmental Politics*, *15*(2), 149–170. http://doi.org/10.1080/09644010600562765.

51 Mol, A. P. J., & Carter, N. T. (2006). China's environmental governance in transition. *Environmental Politics*, *15*(2), 149–170. http://doi.org/10.1080/09644010600562765.

52 Lieberthal, K. (2014). China's Clean Energy Challenges. Washington D.C., USA: The Brookings Institution. Retrieved on 11 March, 2015, from http://www.brookings.edu/~/media/events/2014/2/06-china-clean-energy/020614brookingschina_ia.pdf

53 Downs, E. S. (2004). The Chinese Energy Security Debate. *The China Quarterly*, *177*, 21–41. http://doi.org/10.1017/S0305741004000037

54 Rosen, D. H., & Houser, T. (2007). China Energy: A Guide for the Perplexed. Center for Strategic and International Studies and the Peterson Institute for International Economics, 46(7).

55 Lester, R., & Steinfeld, E. (2007). China's Real Energy Crisis. *Harvard Pacific Review*, *9*(1), 35–38.

56 Cunningham, E. A. (2007). *China's Energy Governance: Perception and Reality*. Retrieved January 20, 2015, from https://www.files.ethz.ch/isn/32082/07-04 Chinas_Energy_Governance_Perception_Reality.pdf

57 Lester, R., & Steinfeld, E. (2007). China's Real Energy Crisis. *Harvard Pacific Review*, *9*(1), 35–38.

innovations.[58] These so-called "protective spaces"[59] are essential to shield off innovative technologies from selection pressures and to allow innovative technologies to mature to the point of being competitive with conventional energies. In the book *Energieautonomie,* Hermann Scheer[60] goes as far as to claim that the actual challenge for introducing solar energies is neither *technological* or *economic* in nature, but instead the challenge is *political* and *cognitive* in nature. Hence, researchers and policy makers alike conclude that preeminent success factors for sustainably developing solar energies include a strong supportive framework that integrates new legislation, international treaties, and investment incentives. Another preeminent, and more important, factor for success is a paradigm change that reflects the political and cognitive changes in the way that society and decision makers think about solar energies. China is no exception in this sense since the development of solar energy in China hinges on how well political barriers are overcome. In other words, "government support is the key and initial power for the development of renewable energy"[61] in China.

1.2 Current State of Research: Are China's Solar Energy Policies Erratic and Inconsistent?

A thorough review of literature reveals that contemporary scholarly work[62] has not sufficiently addressed the aforementioned concerns and has not yet been able to produce explanations as to why solar policies are referred to as dramatic, frequently changing, and seemingly erratic. This section gives a brief account of the most recent scholarly work in order reflect and synthesize the most important findings and theories that are used to explain China's solar policymaking and to enable us to gain a new perspective on the research topic. The literature review complies with Cooper's (1988)[63] *Taxonomy of Literature Reviews* and adheres to the concepts of Hart (1998)[64] and Gall et al. (1996)[65]. The coverage of reviewed literature is *purposive*; hence only purposive samples (i.e. central or pivotal articles) were selected and cited. A comprehensive overview of recent scholarly work is provided in Annex I.

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[58] Hess, D. J., & Mai, Q. D. (2014). Renewable electricity policy in Asia: A qualitative comparative analysis of factors affecting sustainability transitions. *Environmental Innovation and Societal Transitions*, *12*, 31–46. https://doi:10.1016/j.eist.2014.04.001.

[59] Smith, A., & Raven, R. (2012). What is protective space? Reconsidering niches in transitions to sustainability. *Research Policy*, *41*(6), 1025–1036. Retrieved on 25 September, 2015, from http://doi.org/10.1016/J.RESPOL.2011.12.012

[60] Scheer, H. (2005). *Energieautonomie: Eine neue Politik für erneuerbare Energien* (6th ed.). München: Anja-Kunstmann-Verlag.

[61] Zhang, J. (2011). China's Energy Security: Prospects, Challenges, and Opportunities. *The Brookings Institution Center for Northeast Asian Policy Studies*, 1–32. Retrieved on 2 March, 2014, from http://www.brookings.edu/~/media/research/files/papers/2011/7/china%20energy%20zhang/07_china_energy_zhang_paper.pdf.

[62] It must be noted that owing to the surge in solar policy developments, scholarly work has likewise increased. Therefore this literature review only takes into consideration literature that was relevant during the time that the research questions were formulated (2012-2013). Literature that has been published since then will be taken into consideration in the discussion chapter.

[63] Cooper, H. M. (1988). Organizing knowledge syntheses: A taxonomy of literature reviews. *Knowledge in Society*, *1*(1), 104–126. http://doi.org/10.1007/BF03177550

[64] Hart, C. (1998). Doing a literature review: Releasing the social science research imagination. London, UK: *Sage Publications Ltd.*, 1-352.

[65] Gall, M. D., Borg. W. R., & Gall, J. P. (1996). Educational research: An introduction (6th ed.). White Plains, NY, England: *Longman Publishing.*

The growing importance of solar energy is also reflected in the considerable amount of scholarly work that has been recently produced in this field.[66] Surprisingly however, most of this scholarly work neglects a thorough analysis and explanation of solar policy patterns and trajectories as researchers have traditionally paid more attention to *describing* rather than *explaining* solar energy policies in China. In general much of the scholarly work on China's solar energy policies seems to take a very parochial perspective and narrow stance towards solar policies by focusing solely on individual facets such as industrial aspects (for instance Zhi et al. (2014)[67]); policy instruments aspects (for instance Zhang and He (2013)[68]); national planning documents (for instance Yuan and Zuo (2011)[69]) or dissimilarities with other countries (for instance Zhang et al. (2013)[70], Lee (2012)[71] or Grau et al. (2012)[72]). Most scholarly work in this research field provides therefore only a descriptive account of the development and prospects of solar PV or individual PV programs, circumventing the question as to *why* Chinese solar policies have developed in the recent past.[73] There are a few studies that stand out among the growing body of literature, such as the works by Liu and Shiroyama (2013)[74]; Zhang et al. (2013)[75]; Zhang et al. (2014)[76]; Zhi et al. (2014)[77]; Zhao et al. (2011)[78]; Liu et al. (2010)[79] and Zhao (2011)[80]. These studies are among the few exceptions that attempt to *explain* the emergence and development of solar policies.

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66 Rizzi, F., van Eck, N. J., & Frey, M. (2014). The production of scientific knowledge on renewable energies: Worldwide trends, dynamics and challenges and implications for management. *Renewable Energy*, *62*, 657–671. http://doi.org/10.1016/J.RENENE.2013.08.030

67 Ibid.

68 Zhang, S., & He, Y. (2013). Analysis on the development and policy of solar PV power in China. *Renewable and Sustainable Energy Reviews*, 21, 393-401. http://doi:10.1016/j.rser.2013.01.002

69 Yuan, X., Zuo, J., & Ma, C. (2011). Social Acceptance of Solar Energy Technologies in China- End Users' Perspective. *Energy Policy*, 39(3), 1031–1036. https://doi.org/10.1016/j.enpol.2011.01.003.

70 Zhang, Y. H., & He, H. M. (2014). Analysis of China PV Application Market Development Support Policy Based on NPV Model. *Advanced Materials Research,* 853, 547-552.

71 Lee, K. H. (2011). Industrial Evolution and National Institutional Advantage: A Comparative Analysis of the Photovoltaic Industry in Germany, China and South Korea. Brighton, U.K.: University of Sussex (DPhil thesis). Retrieved on 21 March, 2015, from http://sro.sussex.ac.uk/42076/1/Lee%2C_Kyoung_Hoon.pdf.

72 Grau, T., Huo, M., & Neuhoff, K. (2012). Survey of photovoltaic industry and policy in Germany and China. *Energy Policy*, 51, 20-37. https://doi.org/10.1016/j.enpol.2012.03.082.

73 Zhang, S., Andrews-Speed, P., & Ji, M. (2014). The erratic path of the low-carbon transition in China: Evolution of solar PV policy. *Energy Policy*, 67, 903–912. http://doi.org/10.1016/j.enpol.20.

74 Liu, D., & Shiroyama, H. (2013). Development of photovoltaic power generation in China: A transition perspective. *Renewable and Sustainable Energy Reviews*, *25*(0), 782–792. http://doi.org/http://dx.doi.org/10.1016/j.rser.2013.05.014.

75 Zhang, S., Andrews-Speed, P., Zhao, X., & He, Y. (2013). Interactions between renewable energy policy and renewable energy industrial policy: A critical analysis of China's policy approach to renewable energies. *Energy Policy*, 62, 342-353. https://doi.org/10.1016/j.enpol.2013.07.063.

76 Zhang, S., Andrews-Speed, P., & Ji, M. (2014). The erratic path of the low-carbon transition in China: Evolution of solar PV policy. *Energy Policy*, (67), 903–912. http://doi.org/10.1016/j.enpol.20.

77 Zhi, Q., Sun, H., Li, Y., Xu, Y., & Su, J. (2014). China's solar photovoltaic policy: An analysis based on policy instruments. *Applied Energy*, *129*, 308–319. http://doi.org/10.1016/J.APENERGY.2014.05.014.

78 Zhao, R., Shi, G., Chen, H., Ren, A., & Finlow, D. (2011). Present status and prospects of photovoltaic market in China. *Energy Policy*, 39(4), 2204-2207. http://doi:10.1016/j.enpol.2010.12.050.

79 Liu, L. Q., Wang, Z. X., Zhang, H. Q., & Xue, Y. C. (2010). Solar energy development in China - A Review. *Renewable and Sustainable Energy Reviews*,14(1), 301-311. https://doi.org/10.1016/j.rser.2009.08.005.

80 Zhao, Y., Wang, S., Wang, W., Li, X., Liu, Z., Qiu, D., Song, S., & Grant, R. (2008). Report on the Development of the Photovoltaic Industry in China 2006–2007. *Renewable Energy Development Project (REDP),* 1-87. Retrieved on 3 March, 2011, from http://www.martinot.info/REDP_China_PV_Industry_2006-2007.pdf.

Zhang et al. (2014)[81] for instance examines renewable energy policy and industrial policy to extract the underlying ideas that led to China's solar policy development. Similarly, Liu and Shiroyama (2013a) apply the transition theory to explain the parameters that drive solar policies in China. Zhang et al. (2014, p.903) apply the concept of socio-technical regime to understand why Chinese solar policies had followed such an "erratic" path. Contrary to this, Zhi et al. (2014) reviews industrial policy instruments to gain understanding on how China's PV policies have evolved and attempts to identify a possible rationale behind solar policy decisions.

Contemporary studies suggest that solar policies are products of "external pressure and learning"[82] and are perhaps evidence of the government's learning ability and pursuit towards international trends by importing successful policy experiences from other countries (Zhi et al., 2014b, p.). Liu and Shiroyama (2013) argue that solar policies are the outcome of significant pressures at the landscape level, which in turn have instigated government action and institutional reforms. Such macro-level factors that lead to solar policies are stipulated by research trends in science and technology (for instance energy saving technologies, carbon capture and storage innovations) or relevant infrastructural novelties (for instance transmission and on-grid infrastructure innovations). Several scholars point to the importance of understanding the unique government administration contexts in order to make sense of recent policies. Hence tentative explanations in literature seem to suggest that pressures from an exogenous environment are responsible for steering solar policies in China.

It is also worthwhile to examine the various analytical frameworks that scholars have applied to explain solar policy processes in China since these reflect contrasting concepts of *innovation* and *transition*. Liu and Shiroyama (2013) as well as Zhang et al. (2014) examine Chinese solar policies from a *Multi-level Perspective* (MLP) and *Transition Theory Perspective*[83]. The MLP is an analytical and heuristic concept, which was developed from the *multi-level framework*[84] and which is often used to explain complex dynamics of sociotechnical change. It is based on two fundamental views of *evolution*, the first being the view of evolution as a process of variation, selection, and retention, and the second being the view of evolution as a process of unfolding and reconfiguration. This evolutionary concept of innovation also forms a central aspect of the *Transition theory,* which places a strong emphasis on the co-evolution of technical, economic and institutional, and cognitive and behavioral changes. [85] *Transition theory* assumes that

[81] Zhang, S., Andrews-Speed, P., Zhao, X., & He, Y. (2013). Interactions between renewable energy policy and renewable energy industrial policy: A critical analysis of China's policy approach to renewable energies. *Energy Policy*, 62, 342-353. http://doi:10.1016/j.enpol.2013.07.063.

[82] Zhi, Q., Sun, H., Li, Y., Xu, Y., & Su, J. (2014). China's solar photovoltaic policy: An analysis based on policy instruments. *Applied Energy*, *129*, 308–319. http://doi.org/10.1016/J.APENERGY.2014.05.014.

[83] Rip, A., & Kemp, R. P. M. (1998). Technological Change. In S. Rayner & E. L. Malone (Eds.), *Human choice and climate change. Vol. II, Resources and Technology* (pp. 327–399). Columbus, Ohio: Battelle Press.

[84] Kemp, R. (1994). Technology and the transition to environmental sustainability: the problem of technological regime shifts. *Futures*, *26*(10), 1023-1046. https://doi.org/10.1016/0016-3287(94)90071-X; Schot, J., Hoogma, R., & Elzen, B. (1994). Strategies for shifting technological systems: The case of the automobile system. *Futures*, *26*(10), 1060–1076. http://doi.org/10.1016/0016-3287(94)90073-6; Rip, A., & Kemp, R. P. M. (1998). Technological Change. In S. Rayner & E. L. Malone (Eds.), *Human choice and climate change. Vol. II, Resources and Technology* (pp. 327–399). Columbus, Ohio: Battelle Press; Kemp, R., Schot, J., & Hoogma, R. (1998). Regime shifts to sustainability through processes of niche formation: the approach of strategic niche management. *Technology Analysis & Strategic Management*, 10(2), 175-198.

[85] Rip, A., & Kemp, R. P. M. (1998). Technological Change. In S. Rayner & E. L. Malone (Eds.), *Human choice and climate change. Vol. II, Resources and Technology* (pp. 327–399). Columbus, Ohio: Battelle Press.

technological transitions follow a pre-defined process: First, niche-innovations reach an internal momentum for instance through learning processes or influence from powerful groups. This inevitably impacts the landscape and creates pressure on the existing regime (for example through tensions or shifts in the landscape). Finally, such events and pressures culminate and destabilize the regime, creating a "window of opportunity" for niche-innovations.[86] Transition theorists therefore understand transition not as a result of a sudden shift from one regime to another, but as a stepwise and gradual accumulation of niches over time.[87] Within this system's equilibrium, innovation appears as an occasional and single event that comes from the outside and which temporarily imbalances the equilibrium until after a period of adjustment a new equilibrium is established.

Zhang et al. (2013) on the other hand, attempt to explain contemporary solar policies with policy constellations and changes that occur at institutional and actor levels by applying the concept of *National Innovation System*[88] (NIS). NIS is based on Friedrich List's idea of national systems of production[89] and was further developed by the works of Johnson, Edquist and Lundvall (2004)[90], Freeman (1982 and 1987)[91], Freeman and Lundvall.[92] Among the many definitions that exist on NIS, Freeman (1987, p.1) defines NIS as a distinct "network of institutions in the public and private sectors whose activities and interactions initiate, import, modify, and diffuse new technologies". Similarly, Metcalfe (1997)[93] specifies NIS as "a system of interconnected institutions to create, store and transfer the knowledge, skills and artifacts, which define new technologies." NIS theory therefore assumes that innovations are the outcome of interactions between various components (such as inventions, research, technical change, learning, and innovation) and actors at the micro-level (such as government agencies, universities, national laboratories, banks, state-owned enterprises, and private companies). The activities and behavior of independent actors and institutions at micro-level have substantial effects of the efficiency and coordination at macro-level.[94] Moreover, the NIS theory places great emphasis on *institutions* as

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[86] Geels, F. W., & Schot, J. (2007). Typology of sociotechnical transition pathways. *Research Policy*, 36(3), 399-417. https://doi.org/10.1016/j.respol.2007.01.003

[87] See for instance Levinthal, D. A. (1998). The slow pace of rapid technological change: gradualism and punctuation in technological change. *Industrial and Corporate Change*, 7(2), 217-247. https://doi.org/10.1093/icc/7.2.217; Van den Ende, J., & Kemp, R. (1999). Technological transformations in history: How the computer regime grew out of existing computing regimes. *Research Policy,* 28(8), 833-851. https://doi.org/10.1016/S0048-7333(99)00027-X.

[88] See for instance Senghaas, D. (1841). Friedrich List, Das nationale System der politischen Ökonomie. In *Schlüsselwerke der Politikwissenschaft* (pp. 255–258). Stuttgart/Tübingen: VS Verlag für Sozialwissenschaften. http://doi.org/10.1007/978-3-531-90400-9_69

[89] List, F., & Wendler, E. (2008). *Friedrich List: Das nationale System der politischen Ökonomie*. Baden-Baden: Nomos Verlagsgesellschaft mbH & Co. KG.

[90] Johnson, B., Edquist, C., & Lundvall, B. Å. (2004). Economic development and the national system of innovation approach. *Georgia Institute of Technology*. Retrieved on 3 May, 2013, from https://smartech.gatech.edu/bitstream/handle/1853/43154/BengtAkeLundvall_2.pdf?sequence=1&isAllowed=y

[91] Freeman, C. (2004). Technological infrastructure and international competitiveness. *Industrial and Corporate Change*, 13(3), 541-569. https://doi.org/10.1093/icc/dth022.

[92] Lundvall, B-Å., & Freeman, C. (1988). *Small Countries Facing the Technological Revolution*. London: Pinter Publishers.

[93] Metcalfe, J. S. (1995). Technology systems and technology policy in an evolutionary framework. *Cambridge Journal of Economics*, 19(1), 25–46. https://doi.org/10.1093/oxfordjournals.cje.a035307

[94] Fuchs, G., Wassermann, S., Weimer-Jehle, W., & Vögele, S. (2011). Entwicklung und Verbreitung neuer Kraftwerkstechnologien im Kontext dynamischer (Nationaler-) Innovationssysteme. In *7. Internationale Energiewirtschaftstagung an der TU Wien (IEWT)*. Wien. Retrieved on 1 March, 2014, from

they are considered elementary for the development and spreading of new technologies because they constitute the frame in which firms develop strategies and governments form and implement new policy programs that push the innovation process. National innovation systems are thus considered the result of long historical processes and have strong national features that stem from the uniqueness of the governing institutions. Unlike the MLP and *Transition theory*, NIS Theory is therefore based on the idea that innovation is a "ubiquitous" (p.8), "cumulative" or sometimes "radical" (p.13) phenomenon, which is inherent to modern economy and the idea that learning, searching, and exploring are on-going processes in all parts of the economy at all times.[95]

Concluding, the question of why and how solar policy patterns evolve in the Chinese context has not been sufficiently answered in literature. Scholarly work in this field is mostly two-dimensional and descriptive and neglects to explain why solar policies and which pattern or trajectory can be derived from it. Existing explanations revolve around the obvious and external factors that endorse China's latest solar policy strategy, but they do not shed light on specific patterns and explanations of the shifts from phases of stasis to punctuations. Based on the theoretical framework and models, contemporary scholarly work on solar policy in China exhibits contrasting views about *innovation* and *transition* in China's political landscape.

1.3 Research Questions and Purpose

The overall aim of this study is therefore to gain an in-depth understanding of the policy change and the dynamics that are taking and have taken place in China’s solar sector throughout the past decades. At the outset, I develop an analytical framework drawing from concepts on policy analysis, the Punctuated Equilibrium Theory (PET) and the Fragmented Authoritarianism (FA) Model. I then apply and test the framework against the solar policy trajectory with the following questions in mind:

- How and why have solar policies emerged in the recent past and how do these seemingly sporadic flare-ups of contemporary solar policies and government commitment fit into the overall trajectory of solar policies?
- What are the specific drivers and constraints of solar policy development in China and is there a distinguishable pattern of policy change in the solar policy trajectory?
- Is the emergence of solar policies in China a *gradual, incremental and continuous process* of structural changes as suggested by previous studies using transition theory, or is it instead a *constant change of innovation with no existing equilibrium* as national innovation system theorists assume?

The purpose and significance of this study is to provide new empirical data to the research topic and to shed light on the policy trajectory and dynamics of policy change in China for the period from 1990 to 2013. To identify an overall pattern of policy development, this study will examine landmark policies at the national level that best illustrate how and why policies emerge, how they fit into the more general political agenda and paradigm of that time, and how institutional frameworks, actors, and institutional logics shape solar policy processes. Based on existing theories, this research will apply PET and agenda theories to identify a model for the Chinese policymaking process that comprises the institutions, stakeholders, and the environment within which policy decisions are made.

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http://eeg.tuwien.ac.at/eeg.tuwien.ac.at_pages/events/iewt/iewt2011/uploads/fullpaper_iewt2011/P_283_Wassermann_Sandra_31-Jan-2011,_17:41.pdf.

[95] Lundvall, B. Å. (Ed.). (2010). National systems of innovation: Toward a theory of innovation and interactive learning (Vol. 2). London, UK: Anthem press.

The ultimate rationale for this study relates to improving the understanding of China's policy innovation, policy making and future development in clean energy technologies. A growing recognition exists that intellectual components and cognitive understanding of policy transition, key players, and institutional processes are mandatory prerequisites for improving our understanding of the policy-making process.[96] The purpose of this study is therefore to improve and perhaps overcome existing barriers that prevent effective and consistent solar policy-making in China. This corresponds to Lasswell's argument that policy processes ought to serve to improve society and act as a "form of public education"[97]. To this end, this study will conclude with an outlook chapter in which the study will provide an outlook and estimation on whether or not China will be able to achieve its ambitious solar targets and establish a policy framework that is beneficial for solar PV development.

1.4 Analytical Approach, Theoretical Frame and Research Purpose

With China's urgent need to develop solar energy alternatives on one side and the pronounced difficulty in creating effective and coherent regulations and policies on the other, a more general understanding of *policy processes* in China's solar sector is necessary. *Policy processes*, however, are inherently complex, lengthy, and multi-layered by nature and are often steered by highly diverse actors and interests. They consist of a multitude of seemingly glacial and disjoint sequences, actors, and institutions that all add to the complex and opaque fabric of policy decisions. According to Sabatier (2007)[98] the "staggering complexity" (p.4) of policy processes leaves researchers with "little choice but to look at the world through a lens consisting of a set of simplifying presuppositions"(p.5). These presuppositions are drawn from conceptual frameworks, theories, and models that help the analyst explain fairly general sets of phenomena by telling him which variables or relationships to look for and which can safely be ignored. Explanations of the policy-making processes typically rest on models and theories that are grounded in a theoretical framework.[99]

Against this background and owing to the specific research questions, this study applies *policy analysis* and chooses as its theoretical frame a combination of *Punctuated Equilibrium Theory,* Concepts of *Agenda Setting and the Fragmented Authoritarianism Model*. The aim of this study is two-fold: The primary aim is to apply and test the applicability, cogency, strengths, and weaknesses of the abovementioned conventional theories in regard to the formulated research questions and within the context of the Chinese solar sector ("*theory testing*") (p.75, p.109-115).[100] With support from the empirical evidence and based upon *theory testing*, the secondary

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[96] See for example Braun, D. (1999). *Theorien rationalen Handelns in der Politikwissenschaft*. Wiesbaden: VS Verlag für Sozialwissenschaften. http://doi.org/10.1007/978-3-663-11645-5; Lindblom, Charles E. & Woodhouse, Edward J. (1993). *The policy-making process*. Englewood Cliffs, N.J: Prentice Hall.

[97] See for example Hudson, J.; Lowe, S. (2009). *Understanding the Policy Process: Analysing Welfare Policy and Practice* 2nd edition). Bristol, UK: Policy Press.

[98] Sabatier, P. A. (Ed.). (2007). *Theories of the policy process* (2nd ed.). Boulder, Colorado: Westview Press. http://doi.org/10.1081/E-EPAP2-120041405

[99] Ostrom, E. (2007). Institutional Rational Choice: An Assessment of the Institutional Analysis and Development Framework. In P. A. Sabatier (Ed.), *Theories of the Policy Process* (2nd ed., pp. 21–64). Cambridge, MA: Westview Press.

[100] George, A. L., & Bennett, A. (2005). Case studies and theory development in the social sciences. MIT Press.

aim of this study is to advance the geographic scope of the tested theories ("*theory development*") (p.75, p.109-115).[101]

The *Policy Analysis* Approach is a powerful tool that –according to Thomas S. Dye (1976)[102] –is capable of producing answers to the questions *what* governments do, *why* they do it, and what *difference* it makes. It allows us to find explanations for the emergence, development, and success of policies and allows us to pay attention to the specific situational and structural conditions and determinants that shape concrete political outcomes and their implementations.[103] Policy analysis is rooted in Lasswell's grand vision of a multidisciplinary enterprise that bridges various disciplines and sciences and that becomes capable of producing a "policy orientation" (p.3). According to Schubert and Bandelow (2003, p.3), policy analysis is also understood as *problem-oriented* and concerned "with the concrete content, determinants and effects of political action"[104] because it examines the determining key players, events, and influencing factors. For this study *policy analysis* provides a suitable analytical approach that will enable us find explanations to answer *how* and *why* new solar policies have emerged in China. The results of the policy analysis (Part 4) constitute the status quo of the analysis of solar energy policies in the electricity sector in China. Influencing events, factors, and major actors will be identified.

The centerpiece of our analytical approach is the *Punctuated Equilibrium Theory*. The Punctuated Equilibrium Theory (PET) initially originated from evolutionary biology and was first described by the paleontologists Stephen Jay Gould and Niles Eldrege in 1977.[105] They observed that during the course of evolution, new species developed only during very short, interruptive periods that were then superseded by extended phases of only incremental and marginal change. When applied to the U.S. policy context, Baumgartner and Jones (1991)[106] discovered that this theoretical approach was highly valuable in explaining policy change in various policy subsystems, such as the *issue areas*, *urban policy*, *nuclear power* and the *smoking and tobacco* subsystems[107]. PET pays attention to the particularly disruptive phases and characteristics of political processes intending to explain the periodical reoccurrences of radical policy changes, particularly when considered over longer periods of time. PET is therefore a highly conducive tool for understanding why policymakers suddenly abandon a chosen path[108] and why new pathways and policy directions are explored. PET is therefore devoted particularly to the question of *when* and *why* political changes occur and seeks to understand the nature of policy change more generally.[109] Although PET has been developed, predominantly applied, and tested within the U.S. and European policy contexts, this study applies PET theoretical presumptions to the Chinese context.

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[101] Ibid.

[102] Dye, Thomas R. (1976). Policy analysis: what governments do, why they do it, and what difference it makes. Tuscaloosa, USA: University of Alabama Press.

[103] Bandelow, N. C. (2003). *Lehrbuch der Politikfeldanalyse*. (K. Schubert, Ed.). München: De Gruyter Oldenbourg.

[104] Ibid.

[105] Gould, S. J., & Eldredge, N. (1977). Punctuated Equilibria: The Tempo And Mode Of Evolution Reconsidered. *Paleobiology*, 3(02), 115-151. http//doi.org/10.1017/S0094837300005224.

[106] Baumgartner, F. R., & Jones, B. D. (1991). Agenda Dynamics and Policy Subsystems. *The Journal of Politics*, *53*(4), 1044–1074. http://doi.org/10.2307/2131866.

[107] Baumgartner and Jones, for example, applied it to the subsystems "issue areas": "urban policy", "nuclear power", "smoking and tobacco", "pesticides", "child abuse", "drug and alcohol abuse","automobile safety". See Baumgartner, F. R., & Jones, B. D. (1991). Agenda Dynamics and Policy Subsystems. *The Journal of Politics*, *53*(4), 1044–1074. http://doi.org/10.2307/2131866.

[108] Bandelow, N. C. (2003). *Lehrbuch der Politikfeldanalyse*. (K. Schubert, Ed.). München: De Gruyter Oldenbourg.

[109] Baumgartner, F. R., Jones, B. D., & Mortensen, P. B. (2014). Punctuated Equilibrium Theory: Explaining Stability and Change in Public Policymaking. In C. M. Weible & P. A. Sabatier (Eds.), *Theories of the Policy Process* (3rd ed., pp. 59–103). Boulder, Colorado: Westview Press.

Although China's case exhibits distinct cultural, institutional, and administrative features- such as the overwhelming role of the state, extensive bureaucracy, and distinct political culture and identity- there are striking similarities observable between policy changes described in PET and those observed in China. To the author's knowledge, the Punctuated Equilibrium Theory has not yet been used to explain policy changes and transitions in the Chinese energy context. This study therefore represents a new and additional examination of PET's strengths and weaknesses and attempts to geographically extend the validity and applicability of Baumgartner and Jones' hypothesis to the Chinese policy context. The theoretical significance of this study is thus to compare and test the PET's findings against existing (western) theories about policy processes, policy change, and agendas in order to contribute to our understanding of policymaking and policy change in China. Therefore, this work provides an important contribution to extend the validity and PET to non-North American states.

Complementary to our PET approach, theories from *agenda setting* are applied to understand why some policy issues- such as solar energy in the case of China- materialize themselves in the national political agenda while others fail. Agenda setting, like all other stages of the policy process, does not occur in a vacuum. The likelihood that an issue will rise on the agenda is a function of the issue itself, the actors that get involved, institutional relationships, and, often, random social and political factors that can be explained but cannot be replicated or predicted. Theories of agenda setting will thus enable us to better understand why and under which circumstances policy change is likely to occur.

Within the field of *policy analysis*, this study therefore joins a growing body of literature that seeks to bridge the study of policy transition and change, energy politics, theories of governance, and policy theories and governance forms in China. The focus will be laid specifically on solar electricity politics (as opposed to solar thermal energy) as this case exhibits strong dynamics and serves as an ideal exemplification of how political discourses, conflicting interests, actors, and institutions interact. Including solar and renewable policies in the industrial, thermal, and transport sector would go beyond the scope of this study and would prevent an in-depth understanding of the research area as well as weaken the overall explanatory framework that will serve as a foundation for future recommendations in the solar sector.

1.5 Structure of the Study

This thesis comprises of seven chapters, which are supplemented by a number of Annexes. Part *2 Research Design and Methodology* begins with describing and explaining the specific research design and methods applied in this thesis, elaborating briefly on the need for a constructivist research paradigm, case study design, interviews. Part 3 *Analytical Approach and Theoretical Framework* develops the analytical lens through which this study will assess and examine policy change in China's solar energy sector. This theoretical lens amalgamates and includes elements from the Punctuated Equilibrium Theory, the Fragmented Authoritarianism Model and basic definitions, concepts, and presumptions related to the discipline of *policy analysis, policy processes, agenda setting and path dependence.* The *Punctuated Equilibrium Theory* provides a set of presumption on policy change, punctuations, serial and parallel information processing, venues, institutions and negative and positive feedback forces, whereas the *Fragmented Authoritarianism Model* explains the inner dynamics and working associated with policy processes and agenda setting specifically in the Chinese context. The chapter concludes with a set of hypothesis and presumptions, against which the solar policy development in China will be examined in Part 6. Part 4 *Setting the Stage: Framework of Solar Energy Policy* consists of four components, namely (i) the technological specifics of solar Photovoltaics, (ii) the policy rationale that warrants government intervention and the need for comprehensive solar policies; (iii) China's energy sectors, structures and subsystems; and (iv) the institutional landscape and policy processes of the energy sector in China. This section begins with highlighting the technological specifics of solar PV and then elaborates on the rationale for government intervention in the solar energy sector, in regard to resource availability, technological, geographic, environmental, economic and market opportunities and challenges of solar PV for China. It concludes by providing a concise picture of the institutional setup of the China energy sector: the main actors, the governance structure, the institutional setting and the success factors and categories of effective solar policies. Part 5 *Policy Analysis and Trajectory of Solar Policies in China* traces the most relevant solar policies and milestones in China since the 1990s and assesses chronologically the changing dynamics and milestones that have contributed to the deployment of solar power in China. Part 6 *Explaining China's Solar Policy Trajectory from the Punctuated Equilibrium Theory and Fragmented Authoritarianism Perspective* applies the presumptions of the PET theory and applies them to China's solar policy trajectory, thereby identifying a general pattern and dynamics that consists of incremental change, policy punctuations, triggers, negative and positive feedback forces. Part 7 *Conclusion and Outlook* provides the summary of analysis and embeds the study's findings into the overall body of scholarly work on solar energy and policymaking in China and briefly discusses the theoretical value that is added through this study. In the final sections it offers concluding remarks on the appropriateness of the analytical concept, the implications of the results for China's policymaking and the future development path and practical recommendations.

PART 2 Research Design and Methodology

2.1 Research Paradigm: The Rationale for Qualitative Research and Constructivism

The exploratory nature of this study warrants a *constructivist, qualitative* research approach. Nelson and Rosenberg (1993, p.4.)[110] describe qualitative research as "an interdisciplinary, transdisciplinary and sometimes counter-disciplinary field" that is "multi-paradigmatic in focus […] [*and*] sensitive to the value of the multi-method approach." (p.4)[111] *Constructivism* distinguishes itself from other cognitive approaches through its distinct perspectives on the nature of reality and the nature of the human being in the world (*ontological dimensions);* its assumptions about the constituents of knowledge and how to justify knowledge claims (*epistemological dimension*s); its assumptions about the procedures and the language of research (*methodological dimensions),* and its assumptions about the researcher's belief system, bias or worldview that affects research (*ethical/axiological dimensions*). The *constructivist* paradigm is mainly grounded in the works of Jean Piaget's (1976) *Genetic Epistemology*[112], Edmund Husserl's (1999) *Phenomenology*[113] and Wilhem Dithey's (2003) *Concept of Hermeneutics.*[114]
Constructivists place particular emphasis on the nature of *knowledge*, which is assumed to be the outcomes of individual or collective reconstructions of reality, which may coalesce around a certain degree of consensus. Knowledge is therefore *relativist* as it refers to *emergent*, *developmental*, *nonobjective,* and *socially-construed explanation by human beings* (as opposed to *positivist* theorists who believe in independent, external truth free from interpretation).[115] Given that constructivists regard knowledge as a coalescence of various subjective interpretations, the qualitative researcher itself takes on the role of an interpretive, narrative, theoretical, or political "*bricoleur*"(p.4)[116] who produces a "pieced-together set of representations that are fitted to the specifics of a complex situation" (p.4).[117] Because the reconstruction of reality is never without the influences of *language*, *gender*, *social class, race,* and *ethnicity*,[118] constructivists acknowledge that reality is *multiple* and *alterable* because it is an apperception of the "gendered, multiculturally situated" (p.11) inquiry.[119] Therefore constructivism does not preclude the existence of external reality, but merely claims that reality consists of interpretations that are

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[110] Nelson, R. R., & Rosenberg, N. (1993). *National Innovation Systems: A Comparative Analysis*. Oxford, UK: Oxford University Press.
[111] Ibid.
[112] See for example Piaget, J. (1976). Piaget's Theory BT - Piaget and His School: A Reader in Developmental Psychology. In B. Inhelder, H. H. Chipman, & C. Zwingmann (Eds.), (pp. 11–23). Berlin/Heidelberg, Germany: Springer Berlin Heidelberg. http://doi.org/10.1007/978-3-642-46323-5_2; Turner, T. (1973). Piaget's Structuralism. *American Anthropologist,* 75(2), 351–73. https://doi.org/10.1525/aa.1973.75.2.02a00010.
[113] See for example Husserl, E. (1999). *The Idea of Phenomenology*. Kluwer Academic Publishers.
[114] Dilthey, W. (2003). The development of hermeneutics. In G. Delanty & P. Strydom (Eds.), *Philosophies of Social Science: The Classic and Contemporary Readings*. Open University.
[115] Fosnot, C. T. (2013). *Constructivism: Theory, Perspectives, and Practice* (2nd ed.). New York, USA: Teachers College Press.
[116] Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. London, UK: Sage Publications.
[117] Lincoln, Y. S., Lynham, S. A., & Guba, E. G. (2011). Paradigmatic Controversies, Contradictions, and Emerging Confluences, Revisited. In Y.S. Lincoln & N. K. Denzin (Eds.), *The SAGE Handbook of Qualitative Research* (4th ed., pp. 97-128). Thousand Oaks, USA: SAGE Publications.
[118] Searle, J. R. (1995). *The construction of social reality*. New York, USA: Simon and Schuster Inc.
[119] Denzin, N. K., & Lincoln, Y. S. (2011). *The Sage Handbook of Qualitative research: Chapter 1. The Sage Handbook of Qualitative Research* (4th ed.). Thousand Oaks, USA: SAGE Publications Inc. http://doi.org/10.1063/1.448234.

based on perceptual experiences. Along these lines, particular emphasis is placed on the role of *environment* and *context*, as constructivist theorists argue that knowledge is *transactional* and therefore created during a symbiotic and "interactively linked" (p.111)[120] process with the environment.[121] Therefore the focus on subjective evidence presupposes a deep understanding of the surrounding environment of the participants in order to understand in which context the interpretation of reality takes place. Similarly, qualitative research is also inherently multi-method in focus[122] as the qualitative researcher must employ "whatever strategies, methods or empirical materials are at hand" (p.4).[123] Since constructivists believe that objective reality can never be fully captured, the use of multiple methodological practices is understood as a strategy that "adds rigor, breadth, complexity, richness and depth to any inquiry" (p.229)[124]. Therefore, the *constructivist* and *qualitative* paradigm with its specific ontological, epistemological, axiological, and methodological assumptions will serve as the philosophical underpinnings that guide the research process.

2.2 Case Study: Definition, Typology and Size

The exploratory nature of this study's research questions and the actuality of China's recent solar developments warrant a *case study* design. *Case studies* are an empirical inquiry that stand in the constructivist tradition and are a common research tools in the policy analysis discipline. Yin (2014)[125] argues that case studies are especially conducive to investigate "a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (p.13)[126] Case study designs also add *rigor* to the analysis, as it is "an *intensive description* and *analysis* of a phenomenon or social unit such as an individual, group, institution, or community […] [*that*] seeks to *describe* the phenomenon *in depth*" (p.11).[127] Case study design is therefore especially valuable when the contextual conditions of a research object are highly pertinent to the phenomenon itself and when the researcher deliberately seeks to include the entangled situation between phenomenon and context in their research.[128] This *sensitivity* to the specific context is particularly advantageous for doing research in China, a country that, according to Carlson,[129] epitomizes many different contexts that relate to its developing economy, authoritarian polity, and Asian culture.

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[120] Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. *Handbook of Qualitative Research*, *2*, 163–194.
[121] Lincoln, Y. S., Lynham, S. A., & Guba, E. G. (2011). Paradigmatic controversies, contradictions, and emerging confluences, revisited. *The Sage Handbook of Qualitative Research*, *4*, 97–128.
[122] Ibid.
[123] Denzin, N. K., & Lincoln, Y. S. (2011). *The Sage Handbook of Qualitative research: Chapter 1. The Sage Handbook of Qualitative Research* (4th ed.). Thousand Oaks, USA: SAGE Publications Inc. http://doi.org/10.1063/1.448234.
[124] Flick, U. (2009). *An introduction to qualitative research* (4th ed.). London, UK: SAGE Publications Inc.
[125] Yin, R. K. (2014). *Case study research: Design and Methods* (5th ed.). Thousand Oaks, USA: SAGE Publication Inc.
[126] Ibid.
[127] Merriam, S. B. (2002). Introduction to Qualitative Research. In S. B. Merriam & R. S. Grenier (Eds.), *Qualitative Research in Practice: Examples for Discussion and Analysis* (1st ed., Vol. 1, pp. 3–19). San Francisco, USA: John Wiley & Sons, Ltd.
[128] Yin, R. K. (2014). *Case study research: Design and Methods* (5th ed.). Thousand Oaks, USA: SAGE Publication Inc.
[129] Carlson, A., Gallagher, M. E., Lieberthal, K., & Manion, M. (2010). *Contemporary Chinese politics: New sources, methods, and field strategies*. New York, USA: Cambridge University Press.

Qualitative case studies vary in *size* (such as individuals, groups, entire program or activity) or *intent* (e.g. explanatory, exploratory, descriptive, comparative). The unit of analysis (or the *case*) may include concrete entities (such as individuals, small groups and organizations) or less concrete matters (such as a decision processes and specific projects).[130] It can be used as an arena, host or fulcrum to bring many functions and relationships together for study.[131] There are different variations in case study design, ranging from *single instrumental*, *collective* or *multiple,* to *intrinsic case study.*[132] Case study design is therefore an all-encompassing method applicable for "testing theories, creating theories, identifying antecedent conditions, testing the importance of these antecedent conditions, and explaining cases of intrinsic interest" (p.55).[133] This study applies a *single instrumental case design* to illustrate an issue or concern within only one bounded case (that is the solar energy sector). In regard to *intent*, the case study applies a case study design that is conceptually situated between Yin's (2014)[134] understanding of an *explanatory* case study and Stake's (1995)[135] typology of *instrumental* case study design. It is *explanatory*[136] in the sense that it tries to explain the trajectories, drivers, and context of solar policies in China. At the same time it is *instrumental* as it seeks to provide insight into China's solar sector in order to facilitate our general understanding of solar energy governance and solar policy processes in China. For case study design it is also important to define boundaries in order to delineate the case study's *unit of analysis*. Such boundaries can be a specific *time*, *place*[137] or *activity*[138]. The boundaries of our case study are *time* and *place*, hence we consider only solar policy developments within the period from the 1990s to 2013 as relevant for our case and will choose the territorial boundaries of Mainland China's as the spatial criteria.

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[130] Yin, R. K. (2014). *Case study research: Design and Methods* (5th ed.). Thousand Oaks, USA: SAGE Publication Inc.

[131] Carlson, A., Gallagher, M. E., Lieberthal, K., & Manion, M. (2010). *Contemporary Chinese politics: New sources, methods, and field strategies*. New York, USA: Cambridge University Press.

[132] Yin (2003) distinguishes four types of case studies: (a) explanatory, (b) exploratory, (c) descriptive, and (d) multiple case studies. Explanatory case study serves the purpose of explaining the presumed causal links in real-life interventions that are too complex for a survey or experimental strategies. Exploratory case study aims to explore situations in which the intervention being evaluated has no clear, single set of outcomes. Descriptive case study describes an intervention or phenomenon and the real-life context in which it occurs. Lastly, multiple case study design enables researchers to explore differences/similarities between multiple cases. Similarly, Stake's typology of case studies comprises of (a) intrinsic, (b) instrumental, and (c) collective. Intrinsic case studies are motivated by the notion of better understanding a case itself, in all its particularity and ordinariness. Intrinsic case study does not generate/test theory and does not add to the understanding of a generic phenomenon as it centers only on understanding a particular situation. Instrumental case study, on the other hand, pursues to test/refine theory, hence the in-depth study of a case serves the purpose of building/testing theories. Collective case studies are similar to Yin's (2003) multiple case study.

[133] Van Evera, S. (1997). *Guide to Methods for Students of Political Science*. London, UK: Cornell University Press.

[134] Yin, R. K. (2014). *Case study research: Design and Methods* (5th ed.). Thousand Oaks, USA: SAGE Publication Inc.

[135] Stake, R. E. (1995). *The art of case study research*. Thousand Oaks, USA: SAGE Publications Inc.

[136] Yin, R. K. (2014). *Case study research: Design and Methods* (5th ed.). Thousand Oaks, USA: SAGE Publication Inc.

[137] Creswell, J. W. (2012). Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research (4th ed., pp. 1-672). Boston, USA: Pearson Education Inc.

[138] Stake, R. E. (1995). *The art of case study research*. Thousand Oaks, USA: SAGE Publications Inc.

2.3 Data Sources, Data Collection and Data Analysis

For the purpose of *methodological versatility* and *data creditability,*[139] this study included a multitude of differing data sources. Research for this study was conducted mainly from 2012 to 2015, during which around 30 semi-structured interviews were conducted in Beijing and Shanghai. During three academic semesters from September 2012 to March 2014, Tsinghua University[140] hosted me as a visiting scholar, funded by the China Scholarship Council (CSC)[141] and the German Academic Exchange Service (DAAD).

Given the "dearth of high-quality data" in China,[142] *elite or expert interviews*[143] served as a productive method to gain a more concise and in-depth understanding of the relevant stakeholders, policy venues and institutions, unwritten rules and underlying paradigms that shape policy processes in China and that are often not explicitly found in official and written documents. For the sake of *explicitness*, *rigor* and *objectivity*, a heterogeneous group of interviewees from various disciplines and working fields (government, private, research and civil society) were interviewed (see Annex II for a detailed list of interviewees). The interviewees of this study fall into three broad categories: government officials working on energy and climate policy (particularly solar energy policy); practitioners from national or multinational companies and consultancies working in the field of solar energy in China; and researchers, academics and members from non-government organizations (NGOs). So-called *gatekeepers*[144] played an important role in identifying possible interviewees by recommending and establishing contact with peers, leading experts, practitioners and policymakers in the field. Semi-structured interviewees were carried out in accordance to Creswell's (2012, p.204)[145] method of *purposeful snowball sampling* where participants of a study recommend other possible interviewees, which are then chosen intentionally and selectively based on specific criteria.[146] The section criteria for interviewees applied in this study include: (i) knowledge and understanding of the solar energy sector in order to contribute to a better comprehension of China's solar policies; (ii) level of authority and position within their organization; (iii) type of organization to ensure heterogeneity of data sources, and -lastly but most importantly- (iv) their willingness to participate.

This study assumes interviewees to be highly qualified experts in their field who answered the interview questions in a truthful and accurate manner based on their personal experience and to

[139] Patton, M. Q. (1990). *Qualitative evaluation and research methods* (1st ed.). London, U.K.: SAGE Publications Inc.

[140] Tsinghua University is a research university located in Beijing, China, and one of the nine members in the elite C9 League of universities. The research stay was realized and supported through a German Academic Exchange scholarship and Scholarship from the China Scholarship Council.

[141] The China Scholarship Council (CSC) is a non-profit institution with legal person status affiliated with the Ministry of Education.

[142] Carlson, A., Gallagher, M., Lieberthal, K., & Manion, M. (Eds.). (2010). *Contemporary Chinese politics: New sources, methods, and field strategies*. New York, USA: Cambridge University Press.

[143] Experts are considered individuals who are either involved or have been closely following the decision-making and policy drafting processes, often belonging to the country's elite (officials from the relevant ministries, representatives of associations, parliamentarians, journalists, scientific policy advisors, and even ministers and state secretaries)

[144] Gatekeepers are defined by Creswell (2012) as individuals who have an official or unofficial role at the study site and can therefore provide access to the study site, help locate interviewees, and assist in the identification of places to study. In this study, the main gatekeepers were the GIZ office in Beijing and Annie Liu, who is an independent energy consultant.

[145] Creswell, J. W. (2012). Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research (4th ed.). Boston, USA: Pearson Education Inc.

[146] Creswell, J. W. (2012). Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research (4th ed.). Boston, USA: Pearson Education Inc.

the best of their individual abilities. Interviewees were questioned in a Mandarin, German and English in person or via telephone. The interviews were carried out in a semi-structured manner, leaving room for Rubin and Rubin's (2011) concept of *responsive interviewing*[147], in which the interviews resemble guided conversations rather than structured queries. This facilitated a *fluid* (as oppose to *rigid*) stream of questions and answers that allowed for participants to voice and formulate in their own words their individual thoughts without being overly constrained by the researcher's bias and perspective. Most interviews were recorded (with only a few exceptions where anonymity was requested), translated, and afterwards coded, themed, analyzed and cross-verified with written documents.

This study also relies heavily on government documents (such as laws, regulations, notices, and press releases), scientific literature, newspaper articles, and archival records (see Table 2). There are known problems with data reliability in China that can make research there challenging. Moreover, politically sensitive aspects of energy and climate change issues in China can lead to further problems with data reliability that could limit the accuracy of information collected and therefore the effectiveness of the research. Whenever possible data was validated by cross-referencing data points across multiple sources and multiple interview subjects. When there are inherent uncertainties with some of the information presented, I have tried to characterize the nature of this uncertainty.

Table 2 Overview of used Databases and Sources

Database	***Lang.***	***Description***	***Link***
General Scientific Literature			
FU Library Portal 'Primo'	English	Website of FU Berlin that covers a total of about 55,000 journals from more than 50 providers (including Jstor, Wiley Online Library, Springer, etc.)	http://www.ub.fu-berlin.de
Scholar Google	English	Website that includes most peer-reviewed online academic journals and books, conference papers, theses and dissertations, preprints, abstracts, technical reports, and other scholarly literature	www.scholargoogle.com
Online Databases on Chinese Legislation			
IEA database	English	Website that offers a range of recent energy policies and instruments.	www.iea.org
ChinaLaw Info	English/ Chinese	Website affiliated with the Peking University Law School offering a broad range of laws, regulations, journal articles and legal news.	http://www.lawinfochina.com

147 A hallmark of Rubin and Rubin (2011) responsive interviewing is that it does not rely exclusively on predetermined questions but rather enforces researchers to base their questions on what they hear from the interviewees. In this approach, interviewees are seen as partners rather than objects of research. The core of responsive interviewing involves formulating and asking three kinds of questions: main questions, probes, and follow up questions. Main questions address the overall research problem and structure the interview; probes help manage the conversation and elicit detail; and follow-up questions explore and test ideas that emerge during the interviews. Particularly the follow-up questions are considered critical to the model because they create the interaction with the interviewee. See Rubin, H. J., & Rubin, I. S. (2011). *Qualitative Interviewing: The Art of Hearing Data* (3rd ed.). Thousand Oaks, USA: SAGE Publications Inc.

iSinoLaw	English	Website of a Hong-Kong based research center established in 2000, covering a comprehensive overview of Chinese legal documents and considered one of the most comprehensive, updated and authoritative online China legal library.	http://www.isinolaw.com
Ceilaw	Chinese	Website affiliated with China's State Council and existent since 1997. It used to be connected to Chinese government agencies via an internal government communication network.	http://www.ceilaw.com.cn
Official Government Resources on Legislation and Regulations			
Central Government Website,	English/ Chinese	This is China's official government website that provides an overview of recent government activities, regulations and legislative framework.	http://www.gov.cn
China's Supreme People's Court	Chinese	Official Website of China's Supreme Court (SPC) that covers most of the judicial interpretations issued by the SPC.	http://www.court.gov.cn
Chinacourt.org	English	Website that is sponsored by the PRC's Supreme People's Court providing free access to judicial news and legal information (yet excluding court judgments).	http://www.chinacourt.org/index.shtml
AsianLII	English	Website that contains systematic list of laws of the PRC derived mainly from government websites including *ChinaLaw* (Information Centre for Legislative Affairs Office of the PRC State Council) and *ChinaCourt* (Supreme Peoples' Court).	http://www.asianlii.org/cn/legis/cen/laws/
SinoLaw	English	Website affiliated with the Chinese information service agency in Beijing and that focus mostly on commercial and business laws, but also contains basic laws, major statutes, and regulations of the PRC.	http://www.sinolaw.com.cn
China Law Digest	English/ Chinese	Website based in USA that offers the latest news on legal developments and judicial reform to domestic and foreign subscribers interested in Chinese legal issues.	http://www.chinalawdigest.com
Chinese Legal Research	English	Website of the University of Washington School of Law, Gallagher Law Library offering a broad range of legislative topics.	http://guides.lib.uw.edu/chineselawa-z
EastView Online	English/ Chinese	Website with full text journal database houses a comprehensive range of research articles, including legal literature.	http://online.eastview.com/login_china/index.jsp
Chinese Newspapers and Articles			
Xinhuanet	English/ Chinese	Website of China's official government affiliated news agency.	http://www.chinaview.cn/china/index.htm

People's Net (*Renmin wang)*	Chinese	People's Net is the most visible of the main media sites and is run by the official newspaper of the Chinese Communist Party, the People's Daily. The site is organized into a number of issue specific sectors and contains channels dedicated to the rubrics government, party, the National People's Congress, and the Chinese People's Political Consultative Conference	http://www.people.com.cn
China Net (Zhongguo wang)	Chinese	China Net is a news portal that is sponsored by the State Council's Information Office. It publishes both world news as well as news about Chinese foreign policy.	http://www.china.org.cn
People's Daily (*Renmin ribao)*	Chinese	Official newspaper that stands under the direct supervision of state units. The paper is an official newspaper of the Chinese Communist Party and therefore provides direct information on the policies and viewpoints of the government.	http://paper.people.com.cn/rmrb/html/2016-07/17/nbs.D110000renmrb_01.htm
Worker's Daily (Zhongguo zhi wang)	Chinese	Official newspaper with broad range of daily news.	www.cnki.net

2.4 Limitations and Scope

As Sabatier (2007) connotes "one simply cannot look for, and see, everything" (p.10)[148] as each study site is subject to certain limitations and circumstances that are outside the researcher's control. This is especially true for the "staggering complexity" (p.10) that is inherent to policy processes.[149] Therefore, section will briefly address two central limitations of the study that will help clarify and delineate the scope of this study.

Working with state-generated data in China generally leads to concerns about *accessibility and reliability of state-generated data.* Scholars who study China are familiar with the fact that state-society relations are regarded sensitive by the Chinese government. Energy and supply of energy have unmistakably been important and strategic sectors ever since the founding of the People's Republic, therefore issues surrounding energy supply, including solar energy, are considered sensitive.[150] Empirical research and inquiries in this field are consequently faced with various restrictions such as limited access to government information and data, participants' reluctance to openly address sensitive issues, and dearth of information about sensitive issues. Such restrictions inevitably make it difficult for the researcher to elicit candid and informative answers. For a long time, the government tightly controlled the flow of critical information. Although state-generated data brings along some disadvantages, it also provides some unique advantages such

[148] Sabatier, P. A. (Ed.). (2007). *Theories of the Policy Process* (2nd ed.). Boulder, USA: Westview Press. http://doi.org/10.1081/E-EPAP2-120041405
[149] Ibid.
[150] Chen, X. (2010). State-generated data and contentious politics in China. In A. Carlson, M. E. Gallagher, K. Lieberthal, & M. Manion (Eds.), *Contemporary Chinese Politics: New Sources, Methods, and Field Strategies* (pp. 1–311). New York, USA: Cambridge University Press.

as bringing the state perspective into focus as well as enabling event analysis. Administrative data is particularly sensitive to the vagaries of bureaucratic policy or procedure unrelated to the external social phenomenon they may be taken to measure (e.g. changes in budgets, personnel, or internal incentives). Hence, in China perhaps more than other countries, "contacts, institutional ties, and chance often influence research access" (p.169).[151]
A second limitation concerns the *theoretical scope* and *generalizability* of the findings. Given that this study applies a single case study design and examines only the Chinese solar sector, all conclusions are therefore grounded in this specific context. Moreover, interview samples were limited mostly to Beijing and Shanghai, which represent a highly atypical sample of the urban Chinese population. This study therefore reflects the examination of only one sector of a complex and varied system. The extent to which its specific findings apply to other sectors awaits subsequent research. Any conclusions and theoretical findings that are drawn from this specific case study may perhaps only be evident and true for the case of solar energy policies in China. Therefore, this study is aware that the scope of its empirical findings and theoretical conclusions is very narrow. Findings of the Chinese solar energy sector are therefore not necessarily typical or representative[152] for the entire spectrum of decision-making in China.

[151] Hurst, W. (2010). Cases, questions, and comparison in research on contemporary Chinese politics. In A. Carlson, M. E. Gallagher, K. Lieberthal, & M. Manion (Eds.), *Contemporary Chinese Politics: New Sources, Methods, and Field Strategies* (pp. 1–311). New York, USA: Cambridge University Press.
[152] Hill, M. (2014). *The Public Policy Process* (6th ed.). London, UK: Routledge. http://doi.org/10.1016/B978-0-12-387000-1.01001-9

PART 3 Analytical Approach and Theoretical Framework

As Sabatier (2007)[153] describes, the complexity of real-life policy processes is overwhelming to such an extent that empirical researchers are left with little choice but "to look at the world through a lens consisting of a set of simplifying presuppositions" (p.5).[154] These presuppositions are provided through *theoretical frameworks*, *theories* and *models*. The presumptions encompass variables or relationships that are considered pertinent to the field of study and can be combined with one another in order to produce compelling explanations for the phenomena and mechanisms under study. Sabatier (2007)[155] encourages the use of several different theoretical perspectives (*multiple perspectives*) to elucidate differences in assumptions across frameworks and to accumulate evidence in favor of one perspective over another. This chapter thus explains this study's analytical and theoretical approaches: *Policy analysis*, *Punctuated Equilibrium Theory (PET), Fragmented Authoritarianism* and concepts of *Agenda Setting*. These theories and analytical concepts will provide a theoretical construct for understanding development patterns and policy change in the Chinese solar sector.

The frequent use of the terms *theoretical framework*, *theory* and *model* throughout this chapter warrants a brief conceptual differentiation.[156] Following the reasoning of Elinor Ostrom (2007)[157], these three terms differ in their level of abstraction (*logical rigor* versus *empirical scope*[158]). *Theoretical frameworks*[159] establish the foundation for inquiry by providing a composition of *variables and general relationships* that are considered explanatory for the specific research field. By framing the relevant variables, outlining key features and setting the boundaries of inquiry, *theoretical frameworks* are crucial for accumulating knowledge.[160] In addition, frameworks provide a "meta-theoretical language" (p.25)[161] that enables theories to learn form one another. And although *frameworks* themselves do not "provide explanations for, or predictions of, behavior and outcomes" (p.293)[162], they are of significant organizational value because they organize inquiry and "attempt to identify the universal elements that any theory relevant to the same kind of phenomena would need to include".[163] Frameworks, however, are incapable of *developing explanations* and *predictions* as these lie in the realm of *theories* (several of which may exist within a framework). *Theories* (and *models)* take a more parochial perspective and present researchers with a specific and logically coherent set of relationships and assumptions

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[153] Sabatier, P. A. (Ed.). (2007). *Theories of the Policy Process* (2nd ed.). Boulder, USA: Westview Press. http://doi.org/10.1081/E-EPAP2-120041405

[154] Ibid.

[155] Ibid.

[156] Policy scientists have not reached consensus on what defines these three terms. Sabatier and Ostrom (2007) for instance have a very different understanding of these terms than Schubert and Bandelow (2003). See Schubert, K., & Bandelow, N. C. (Eds.). (2003). *Lehrbuch der Politikfeldanalyse*. München, Germany: De Gruyter Oldenbourg.

[157] Ostrom, E. (2007). Institutional Rational Choice: An Assessment of the Institutional Analysis and Development Framework. In P. A. Sabatier (Ed.), *Theories of the Policy Process* (2nd ed., pp. 21–64). Boulder, USA: Westview Press. http://doi.org/10.1081/E-EPAP2-120041405

[158] Ibid.

[159] Here theoretical framework will be used synonymously with "framework".

[160] Ostrom, E. (2007). Institutional Rational Choice: An Assessment of the Institutional Analysis and Development Framework. In P. A. Sabatier (Ed.), *Theories of the Policy Process* (2nd ed., pp. 21–64). Boulder, USA: Westview Press. http://doi.org/10.1081/E-EPAP2-120041405

[161] Ibid.

[162] Schlager, E. (2007). A Comparison of Frameworks, Theories, and Models of Policy Processes. In P. A. Sabatier (Ed.), *Theories of the Policy Process* (2nd ed., pp. 293–344). Boulder, USA: Westview Press. http://doi.org/http://doi.org/10.1081/E-EPAP2-120041405

[163] Ibid.

about relevant elements within a framework. Unlike theoretical frameworks, *theories* attach specific values to the variables and specify how relationships may vary. Theories therefore enable researchers to diagnose a phenomenon, explain its processes and predict outcomes. However, theories themselves are not able to yield hypotheses.[164] Creating a hypothesis lies in the realm of *models*, which are clustered within one theory. Models are much narrower in scope and present more restricted and precise assumptions about social and political relationships. Models are therefore valid for only a very narrow spectrum of situations. Schlager[165] contends that the interaction between these three concepts is *dynamic*, *interactive* and *non-hierarchic*.

3.1 Policy Analysis

Policy Analysis is a sub-discipline of policy science that specifically deals with the *descriptive* and *explanatory* dimensions of policy (as opposed to *policy science*, which deals with the *prescriptive* and *normative* dimensions). [166] *Policy analysis* examines the concrete *topic*, *determinants* and *impacts* of political actions.[167] In doing so, policy analysis contributes to science as much as it does to actual problem solving and constructively shaping future political decision-making. The term *policy* is central to the understanding of policy analysis and has been subject to various interpretations, some of which are provided in the table below.[168]

Table 3 Definitions of "Public Policy"

Definition	Author
"Who gets what, when, and how"	Lasswell[169]
"*Policy* may usefully be considered as a course of action or inaction rather than specific decisions or actions"	Heclo (1972, p.85)[170]
"A web of decisions and actions that allocate… values"	Easton (1953, p.130)[171]
"A set of interrelated decisions… concerning the selection of goals and the means of achieving them within a specified situation"	Jenkins (1978, p.15)[172]

[164] Mill, J. S. (1966). On Liberty. In *J.S. Mill, A Selection of his Works* (pp. 1–147). London, UK: Macmillan Education UK. http://doi.org/10.1007/978-1-349-81780-1_1.
[165] Schlager, E. (2007). A Comparison of Frameworks, Theories, and Models of Policy Processes. In P. A. Sabatier (Ed.), *Theories of the Policy Process* (2nd ed., pp. 293–344). Boulder, USA: Westview Press. http://doi.org/http://doi.org/10.1081/E-EPAP2-120041405
[166] Windhoff-Héritier, A. (Ed.). (2013). *Policy-Analyse: Kritik und Neuorientierung*. Wiesbaden, Germany: Springer Fachmedien Wiesbaden (Ursprünglich erschienen bei Westdeutscher Verlag 1993). http://doi.org/10.1007/978-3-663-01473-7
[167] Schubert, K., & Bandelow, N. C. (Eds.). (2003). *Lehrbuch der Politikfeldanalyse*. München, Germany: De Gruyter Oldenbourg.
[168] Hill, M., & Varone, F. (2014). *The public policy process*. *The Public Policy Process* (6th ed.). London, UK: Taylor and Francis Group. http://doi.org/10.4324/9781315693965
[169] Lasswell, H. D. (1950). *Politics: Who gets What, When, How*. New York, London: Whittlesey House, McGraw-Hill
[170] Heclo, H. H. (1972). Policy analysis. *British journal of political science*, *2*(1), 83-108.
[171] Easton, D. (1953). The Political System: An Inquiry into the State of Political Science (2nd ed.). New York, USA: Alfred A. Knopf.
[172] Jenkins, W. I. (1978). Policy analysis: A political and organizational perspective. London, UK: M. Robertson.

The definitional problem of defining *policy* indicates that there are great difficulties in treating the concept of *policy* as a very specific and concrete phenomenon.[173] Although *policy* is often used synonymously with government activities, it is actually very broad and refers to every abstract plan for action and each "projected program of goal values and practices" (p.71).[174] Several key attributes of *policy* are discernible across various interpretations: *policy* can be understood as a single or group of decisions or actions that demonstrate the will to change the course in a specific direction. Since political activity may also imply the maintaining of the status quo and the resisting of political change, it entails action as much as it entails inaction. Moreover, policies are impossible to be associated with specific occasions.

The meaning of *policy* can be further elaborated through David Easton's *political system theory,*[175] in which he distinguishes a political space from its surrounding environment:

> "A political system, therefore, will be identified as a set of interactions, abstracted from the totality of social behavior, through which values are authoritatively allocated for a society." (Easton 1965, 57)

Easton's input/output model is conducive to our understanding of *policy* because he clearly delineates a political space or policy field that is obviously distinguishable from its environment. Moreover, it not only emphasizes the importance of the internal dynamics within the political system itself, but also highlights the need to consider policy *inputs* and *outputs* that are external to the political system. In addition, it allows one to draw a temporal distinction of the term *policy*. Easton's system theory defines policy processes as a *black box* that is subject to demands and support from its social or physical environment (*policy inputs*). The concrete and oftentimes immediate implementation of action of the political system regarding such demands and supports comes in form of decision-making (*policy output). Policy impact,* on the other hand, reflects the medium and long-term changes and effects of policies on society and on human behavior in general, whereas *policy outcome* denotes to the reaction of the system in the long-term.[176]

The term *policy* is amenable to further elaboration by contrasting *policy* with the terms *politics* and *polity.*[177] In this sense, *policy* refers to *content* and *material*-related aspects, such as political laws, regulations, decision, programs and measures. *Polity,* on the other hand, refers to the formal, structural, constitutional and normative aspects and comprises of questions regarding the political regime and the underlying theory (e.g. political ideas and ideologies). *Politics* describes the process-related dimensions that encompass the (peaceful, conflict-laden or even neutral) political processes and activities of political actors. In reality however, *policy*, *polity* and *politics* strongly correlate with each other as demonstrated by Héritier's (1987) reasoning that policies are inevitably interwoven within a specific *policy landscape* that may produce positive and negative external effects in promoting or hindering individual policies. Similarly, Krasner[1] analogizes

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[173] Hill, M., & Varone, F. (2014). *The public policy process*. *The Public Policy Process* (6th ed.). London, UK: Taylor and Francis Group. http://doi.org/10.4324/9781315693965.

[174] Lasswell, H. D. (1950). *Politics: Who gets What, When, How*. New York, London: Whittlesey House, McGraw-Hill.

[175] The System theory can be attributed to Easton (1965, 1965a), Thomas Dye (1966, 1972) and Richard I. Hofferbert (1974).

[176] Windhoff-Héritier, A. (1987). *Policy-Analyse: Eine Einführung*. Frankfurt, Main New York: Campus Verlag; Schubert, K., & Bandelow, N. C. (Eds.). (2003). *Lehrbuch der Politikfeldanalyse*. München, Germany: De Gruyter Oldenbourg.

[177] This semantic distinction exists only in the English language. In German, for instance, these three dimensions are summarized in the general term "Politik"

policies to pieces of rock that are scattered in a landscape. *Policy analysis* therefore integrates all these three dimensions in practice as it combines the empirical analysis of *policies,* the given political context and relevant processes, and conflicts throughout the course of policy making.[178] The causal and complex relationship between *policy*, *polity* and *politics* led to Theodore Lowi's well-known proposition "policies determine politics" (p.299).[179] Lowi's (1972) model is based on the presumption that it is not the actual *outcomes* but rather the *expectations* of relevant stakeholders as to what the outcomes could be that frame the issue and determine their politics.[180] Therefore policies have distinct effects on politics since they can trigger certain reactions and expectations, which in turn may influence the political discourse, decision-making and implementation of policies.[181] According to Lowi (1972),[182] the specific interests and degree of affectedness that surround all policies types (i.e, *distributive, regulatory* and *redistributive*) lead to distinct actor constellations and compositions within a given policy field or *policy arena*.[183] Such *policy arenas* therefore constitute the sphere of action for opposing views, competing agendas, and contending groups and expectations. This may or may not result in contests and conflicts. Similarly, Héritier (1987)[184] concludes that *policy fields* (or *arenas*) exhibit clear boundaries in terms of policies, institutions, and actor constellations and shared visions.[185]

As mentioned above, *policy arenas (*and eventually *politics*) are therefore shaped and determined by the interests, agendas, perceptions and interactions of specific *policy actors*, who are formal or informal actors that seek to influence policies. *Policy actors* are equipped with different degrees of information, power, influence and access to political decision-makers and policy arenas.[186] Here, an important distinction is made between *individual* and *complex* policy actors.[187] Schubert and Bandelow (2003)[188] argue that the choice for policy actors to pursue a common goal individually (*individual actor*) or collectively (*complex actors*) depends on several factors.[189] The collective action among *complex actors* can take many forms. These include a natural alignment of individual actions due to common preferences and common situational conditions (*action assemblies/aggregates*), independent actions yet with some degree of coordination via information exchange (*collective actors* such as movements, alliances, clubs, associations) and a

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178 Schubert, K., & Bandelow, N. C. (Eds.). (2003). *Lehrbuch der Politikfeldanalyse*. München, Germany: De Gruyter Oldenbourg.

179 Lowi, T. J. (1972). Four Systems of Policy, Politics, and Choice. *Public Administration Review*, *32*(4), 298. http://doi.org/10.2307/974990

180 It should be noted here that Low theory is based on the distinction of distributive, regulatory and redistributive policies which will not be further elaborated here.

181 Windhoff-Héritier, A. (1987). *Policy-Analyse: Eine Einführung*. Frankfurt, Main New York: Campus Verlag; Schubert, K., & Bandelow, N. C. (Eds.). (2003). *Lehrbuch der Politikfeldanalyse*. München, Germany: De Gruyter Oldenbourg.

182 Lowi, T. J. (1972). Four Systems of Policy, Politics, and Choice. *Public Administration Review*, *32*(4), 298. http://doi.org/10.2307/974990

183 Schneider, V., & Janning, F. (2006). *Politikfeldanalyse: Akteure, Diskurse und Netzwerke in der öffentlichen Politik* (1st ed.). Wiesbaden, Germany: VS Verlag für Sozialwissenschaften, GWV Fachverlage GmbH. http://doi.org/10.1007/978-3-531-90267-8

184 Windhoff-Héritier, A. (1987). *Policy-Analyse: Eine Einführung*. Frankfurt, Main New York: Campus Verlag; Schubert, K., & Bandelow, N. C. (Eds.). (2003). *Lehrbuch der Politikfeldanalyse*. München, Germany: De Gruyter Oldenbourg.

185 Ibid.

186 Ibid.

187 Schubert, K., & Bandelow, N. C. (Eds.). (2003). *Lehrbuch der Politikfeldanalyse*. München, Germany: De Gruyter Oldenbourg.

188 Ibid.

189 One example is the number of actors. They argue the more actors the more likely the occurrence of free-riders and the stronger need for proxies.

strategic channeling of resources to establish a proxy for action (*cooperative actors*, e.g. trade unions, corporate associations, parliaments). Especially the latter form of cooperation among policy actors offers several compelling advantages. First, it enables a decoupling of the initial situation and ensures that common goals are pursued in the long run; second, it overcomes cognitive limitations of humans and allows for a high specialization and parallel processing of societal problems. Here, Herbert Simon (1957)[190] uses *bounded rationality*[191] to explain that individuals are only capable of devoting conscious attention to one thing at a time (*serial processing*), whereas organizations have more flexibility, capacities and attention resources to handle many issues simultaneously and in parallel (*parallel processing*). Cognitive limitation in human decision-making also serves as an explanation as to why policy subsystems exist; political systems contain many subsystems that facilitate attention to many issues simultaneously and that allow issues to be considered within a respective community of experts.[192]

Modern societies involve many forms of collective and cooperative actors who are nested within each other and who operate in parallel.[193] It is also important to emphasize, as reasoned by Nakamura (1987),[194] that the intention and motivation of political actors and organizations may change over time. Given this flawed political foundation, policies can therefore be considered "moving targets" (p.13) that are capable of undergoing remarkable transition during the course of their "lifespan" (p.13)[195]. The discussion also implies that policy is not merely the decision of a single unit (such as the government) but rather the result of complex and oftentimes conflict-laden interactions among many *policy actors* who come together only for the purpose of shaping and influencing specific policies.[196] Such actor constellations are not establishment that lasts forever but are frequently dissolved and re-assembled during new conflicts and new actors. Therefore, policies are constantly subject to political justifications, public debates and new and perhaps conflicting ideas.[197] The discussion also indicates that stable networks consisting of actors from ministries, interest groups and parliamentary committees are in fact the true locus of policymaking (*policy network perspective*).[198] Here, an important distinction is made between powerful policy networks that exhibit clear boundaries and a limited number of participants (described as *sub-*

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[190] Simon, H. A. (1957). *Models of man: social and rational; mathematical essays on rational human behavior in society setting.* New York: John Wiley & Sons; Simon, H. A. (1977). The Logic of Heuristic Decision-Making. In R.S. Cohen & M. W. Wartofsky (Eds.*), Models of Discovery* (pp. 154-175). Den Haag, Netherlands: Springer Verlag; Simon, H. (1983). Reason in human affairs. Stanford, CA, USA: Stanford University Press; Simon, H. A. (1985). Human nature in politics: The dialogue of psychology with political science. *American Political Science Review*, 79(02), 293-304; Cohen, L., Manion, L., & Morrison, K. (2013). *Research methods in education* (7th ed.). Abingdon-on-Thames, UK: Routledge.

[191] Bounded rationality argues that human beings are subject to cognitive limitations in their decision-making and selection of choices

[192] Jones, B. D. (1994). Reconceiving decision-making in democratic politics: Attention, choice, and public policy. Chicago, USA: University of Chicago Press.

[193] Schubert, K., & Bandelow, N. C. (Eds.). (2003). *Lehrbuch der Politikfeldanalyse*. München, Germany: De Gruyter Oldenbourg.

[194] Nakamura, R. T. (1987). The textbook policy process and implementation research. *Review of Policy Research*, 7(1), 142-154. http://doi:10.1111/j.1541-1338.1987.tb00034.x.

[195] Windhoff-Héritier, A. (Ed.). (2013). *Policy-Analyse: Kritik und Neuorientierung*. Wiesbaden, Germany: Springer Fachmedien Wiesbaden (Ursprünglich erschienen bei Westdeutscher Verlag 1993). http://doi.org/10.1007/978-3-663-01473-7

[196] Marin, B., & Mayntz, R. (1991). *Policy networks. Empirical Evidence and Theoretical Considerations*. Frankfurt a.M., Germany: Campus Verlag.

[197] Ibid.

[198] Ibid.

governments[199] or more specifically *Iron Triangles*[200]*)* and policy networks that exhibit loose boundaries and a variety of diverse actors (referred to as *Issue Networks*[201]).

The foregoing discussion about policy actors warrants a brief explanation of the term *institutions*. Policy actors and political decision-making are embedded within distinct *institutional* structures that can shape and determine the path of policy processes. Scholars have attached different connotations to the term *institution* due to its "flimsy" (p.23) nature and invisible structure.[202] Nevertheless, Ostrom (2007)[203] explains *institution* as different types of entities that encompass both the organizations as well as the rules used to structure patterns of interactions within and across organizations. We therefore understand institutions to be fundamentally *shared concepts* among participants in repetitive situations organized by *rules,*[204] *norms,*[205] and *strategies,*[206] which exist in the minds of participants and are shared as implicit (unwritten) or explicit (written form) knowledge.[207] An explanation of the way that *institutions* can influence policies and the course of political decision-making is given by the notion of *path dependency. Path dependency* presupposes that *policymaking* and *policy outcomes* are deeply conditioned by their historic and institutional legacies and that policies are contingent upon a specific path, which is reinforced by powerful and enduring institutions.[208] Political decision-making is conceived as individual paths that are intersected by alternative paths of action. The choice of path depends on *positive* and *negative* feedback forces that either enforce or impede the switching or moving back to new paths. Certain paths, however, that have resulted from seemingly inconsequential choices, may lead to irreversible consequences (so-called *lock-ins*). [209] Path dependency therefore describes an unfolding sequence of political decisions that are shaped in a significant and persisting way by

[199] Subgovernment describes a space where bureaucrats, lobbyists and state authorities bargain for political decisions and shielded from the public obligations policy decisions and regional support. It describes the close cooperation links between political actors and private stakeholders in policy fields.

[200] Iron Triangles are policy networks that exhibit clear external boundaries and a small number of participants. They often describe policy-making relationship among the congressional committees, the bureaucracy, and interest groups. Iron Triangles often include only private interests within the specific subgovernment.

[201] Heclo and King (1978) describes Issue Networks as a loose conglomeration of actors that features open boundaries and a diversity and multitude of actors who come together for a specific topic within the policy process. In general Issue Networks work for a broader public interest than Iron Triangles. See for instance Heclo, H., & King, A. (1978). Issue networks and the executive establishment. *Public Adm. Concepts Cases*, *413*, 46-57.

[202] Ostrom, E. (2007). Institutional Rational Choice: An Assessment of the Institutional Analysis and Development Framework. In P. A. Sabatier (Ed.), *Theories of the Policy Process* (2nd ed., pp. 21–64).

[203] Ibid.

[204] Rules are defined as shared prescriptions (must, must not, or may) that are mutually understood and predictably enforced in particular situations by agents responsible for monitoring conduct and for imposing sanctions.

[205] Norms are defined as shared prescriptions that tend to be enforced by the participants themselves through internally and externally imposed costs and inducements

[206] Strategies are defined as regularized plans that individuals make within the structure of incentives produced by rules, norms, and expectations of the likely behavior of others in a situation affected by relevant physical and material conditions.

[207] Crawford, S. E.; Ostrom, E. (1995). A grammar of institutions. *American Political Science Review*, 89(03), 582-600.
https://doi.org/10.2307/2082975

[208] Schubert and Bandelow (2003) argue that such institutions endure for two particular reasons: firstly, the costs for the acquisition of an institution arises only one and then "sinks" and secondly institutions convey reliability for actors involved in the political processes, which is of high value considering the complexity of political decisions.208

[209] Schubert, K., & Bandelow, N. C. (Eds.). (2003). *Lehrbuch der Politikfeldanalyse*. München, Germany: De Gruyter Oldenbourg.

past events, which manifest themselves through *institutions*. Decision-makers are thus restricted in their decision-making freedom by the specific path and powerful institutions that prevent radical policy changes in the form of negative feedback forces.[210] Nevertheless, radical policy change – that is, the venturing of new paths – is possible during so-called *critical junctures*[211] that emerge as a result of crisis and exceptional historic circumstances.[212] The venturing of new paths can also result from smooth and subtler changes such as small and incremental modifications within existing institutions (which add up to *transformative results*) or the gradual emergence of new institutions.[213] Consequently, the notion of path dependency challenges the orthodox conception of an ahistorical temporality of social processes because it recognizes a dynamic and evolutionary development of policymaking that is strongly governed by its own history. It provides us with a useful measure of precision in describing dynamic policy changes that are neither completely deterministic nor purely random in their workings and in which the specific details of history govern the unfolding course of development.[214] The recognition of path dependence asserts a broader and more influential role of history, institutional settings and past policy decision and is ultimately a tacit acknowledgement that history does matter.[215] A major focus of this thesis is *policy processes,* which Schlager (1999)[216] describes as follows:

> "The term process connotes temporality, an unfolding of actions, events, and decisions that may culminate in an authoritative decision, which, at least temporarily, binds all within the jurisdiction of the governing body. In explaining policymaking processes, the emphasis is much more on the unfolding than on the authoritative decision, with attention devoted to the structure, context, constraints and dynamics of the process, as well as to the actual decisions and events that occur" (Schlager, 1999, p.293)[217]

Policy processes are innately complex, which Sabatier (2007)[218] accords to the following factors:

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[210] See for instance Starke, P. (2006). The politics of welfare state retrenchment: A literature review. *Social Policy & Administration*, *40*(1), 104-120.

[211] Schubert, K., & Bandelow, N. C. (Eds.). (2003). *Lehrbuch der Politikfeldanalyse*. München, Germany: De Gruyter Oldenbourg.

[212] Collier, R. B., & Collier, D. (2002). Shaping the political arena: Critical junctures, the labor movement, and regime dynamics in Latin America. Notre Dame, France: University of Notre Dame Press.

[213] Streeck und Thelen (2009) identify five mechanisms through which institutions can gradually change and create the opportunity for change: the dissolution of existing institutions and their replacement by new ones (Displacement); the incorporation and combination of new structures into existing institutions (Layering); the gradual change of an institution by the institution's inability to adapt to a changing environment (Drift); converting the content of existing institutions without actually creating new institutions (Conversion) and lastly, the complete breakdown of an institution (Exhaustion). Streeck, W., & Thelen, K. (2009). Institutional change in advanced political economies. *Debating Varieties of Capitalism: A Reader*, 95–131.

[214] David, P. A. (2007). Path dependence: a foundational concept for historical social science. *Cliometrica*, *1*(2), 91–114. http://doi.org/10.1007/s11698-006-0005-x

[215] Ibid.

[216] Schlager, E. (2007). A Comparison of Frameworks, Theories, and Models of Policy Processes. In P. A. Sabatier (Ed.), *Theories of the Policy Process* (2nd ed., pp. 293–344). Boulder, USA: Westview Press. http://doi.org/http://doi.org/10.1081/E-EPAP2-120041405.

[217] Ibid.

[218] Sabatier, P. A. (Ed.). (2007). *Theories of the policy process* (2nd ed.). Boulder, Colorado: Westview Press.

- *Policy processes* imply the presence, action and involvement of a plethora of actors who pursue their individual or shared set of agenda, norms, perceptions, interests, and preferences.
- *Policy processes* may unfold over the period of several decades,[219] given the timely protraction between policy formulation, implementation and evaluation.[220]
- *Policy processes* are often steered and guided by implicit forces that are difficult to grasp or measure, as they may involve deeply held values, hidden interests, bias, coercion, collusions, money, corruption, and so on. Consequently, policy debates and results are much more likely to be the outcome of personal agendas, economic conditions, popular cultural attitudes, distorted information, selective evidence or hidden interests rather than that of rational choice and scientific evidence.[221]
- Given their multidisciplinary nature, *policy processes* often span various policy arenas and require the cooperation of many levels of government and policy subsystems to operate on the given policy issue simultaneously.[222]
- *Policy processes* is further obfuscated by the often very technical disputes among policy actors over the acuteness of a policy issue, its causes and consequences. Therefore, comprehension of the policy processes also implies a proper understanding of the roles such debates play in the policy process.[223]

An early framework in political sciences to conceptualize the policy process was the *Stages Heuristic*[224] (and later the *Policy Cycle*).[225] Both heuristics are based on the assumption that ideas and proposals move through certain *stages* or *cycles* before materializing into public policies.[226] The stages heuristics defines a sequences of stages throughout the policy lifespan, which encompass (i) problem identification and agenda setting, (ii) policy formulation, (iii) policy adoption, (iv) policy implementation and (v) policy evaluation. The stages heuristics was a novel

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[219] David, P. A. (2007). Path dependence: a foundational concept for historical social science. *Cliometrica*, *1*(2), 91–114. http://doi.org/10.1007/s11698-006-0005-x; Sabatier, P., & Jenkins-Smith, H. C. (Eds.). (1993). *Policy change and learning: An advocacy coalition approach*. *Journal of Policy Analysis and Management*. Boulder, USA: Westview Press. http://doi.org/10.1002/pam.4050150111
[220] Kirst, M., & Jung, R. (1982). The Utility of a Longitudinal Approach in Assessing Implementation. In W. Williams, R. F. Elmore, J. S. Hall, R. Jung, M. Kirst, & S. A. MacManus (Eds.), *Studying Implementation: Methodological and administrative issues* (pp. 119–148). Chatham, UK: Chatham House.
[221] Sabatier, P. A., & Weible, C. M. (1999). *Theories of the policy process*. (P. A. Sabatier & C. M. Weible, Eds.) (1st ed.). Boulder, Colorado: Westview Press.
[222] Hjern, B., &, Porter, D. (1981). Implementation Structures: A New Unit of Administrative Analysis. *Organization Studies,* 2(3), 211-227; Hjern, B., & Porter, D. (1981). Implementation Structures: A New Unit of Administrative Analysis. *Organization Studies*, 2(3), 211-227; Ostrom, E. (1983). A public service industry approach to the study of local government structure and performance. *Policy & Politics*, 11(3), 313-34.
[223] Sabatier, P. A., & Weible, C. M. (1999). *Theories of the policy process*. (P. A. Sabatier & C. M. Weible, Eds.) (1st ed.). Boulder, Colorado: Westview Press.
[224] Sabatier (1999) strongly refrains from using the term "policy model" and uses instead the term "heuristics". He argues that the phases heuristics are not a model in the classical sense, because it does not connect if-then sentences in a logical and consistent manner. He therefore argues it is merely an organizational framework that enables new discoveries about the policy process.
[225] A term that was first labeled by Nakamura, R. T. (1987). The textbook policy process and implementation research. *Review of Policy Research*, *7*(1), 142–154. http://doi:10.1111/j.1541-1338.1987.tb00034.x.
[226] Initially based on the idea of evolving stages is rooted in Harold Lasswell (1956) model that encompasses seven stages: Intelligence, promotion, prescription, invocation, application, termination, and appraisal.

and useful approach to systematize and organize the otherwise complex and opaque policy process into a predetermined scheme of consecutive stages and to concentrate on causal factors distinct to each phase. It gained overwhelming popularity in American policy studies in the 1970s and early 1980s due to its many prominent proponents such as Lasswell (1956),[227] Jones (1970),[228] Anderson (1975),[229] Brewer and deLeon (1983),[230] Jenkins (1978)[231] and deLeon (1999)[232]. Despite its irrefutable merits, the stages heuristic was subject to heavy criticism that questioned the policy cycle's status as a theoretical framework, model or heuristic and its inability to produce a coherent set of hypotheses within and across stages.[233] Critics also alluded to the oversimplified structure and rigidness of the stages model, which claims the existence of only one single policy cycle within the policy process and ignores the simultaneous interaction of multiple policy cycles at various levels of government.[234] Parallels were drawn with an "assembly line production model" (p.11)[235] which assumes that human behavior is *calculable, rational and economic*[236] and which rules out the existence of *unexpected phenomena* (such as *windows of opportunity, creativity or spontaneity*)[237] in the policy making process. Here, Héritier (1993)[238] argues that an orderly separation and association of policies to specific policy stages proves impossible as policies intersect, overlap and reverse.[239] Last but not least, the stages heuristic was also criticized for what Héritier (1993) refers to as a "democracy deficit" (p.14), which denotes a legalistic, top-down bias that idealizes democratic steering and legitimation.[240] Despite the profound criticism related to the 'stage-ism' of policy cycles, the stages heuristics remains a useful conceptualization and tool for understanding the compound policy process.[241] More importantly, it has formed the basis for new analytical frameworks, theories and models to emerge that focus specifically on individual stages of the policy making process.

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227 Lasswell, H. D. (1956). *The decision process: Seven categories of functional analysis*. *University of Maryland, Bureau of Governmental Research*. College Park, USA.
228 Jones, C. O. (1970). *An introduction to the study of public policy*. Pittsburgh, USA: University of Pittsburgh.
229 Anderson, J. E. (1975). *Public Policy-Making*. *Basic concepts in political science* (3rd ed.). New York, USA: Praeger.
230 Brewer, G., & deLeon, P. (1983). *The foundations of policy analysis*. Monterey, USA: Brooks/Cole Publishing Company.
231 Jenkins, W. I. (1978). Policy analysis: A political and organizational perspective. London, UK: M. Robertson.
232 DeLeon, P. (1999). The Stages Approach to the Policy Process. In P.A. Sabatier (Ed.), *Theories of the Policy Process* (2nd ed., pp. 19-32). Boulder, USA: Westview Press.
233 Hjern, B., & Hull, C. (1982). Implementation research as empirical constitutionalism. *European Journal of Political Research*, 10(2), 105-115.
234 Sabatier (2007) gives the example of abortion activists, who are involved in multiple policy cycles in order to consolidate their ideas in legislation
235 Héritier, A. (Ed.). (1993). *Policy-Analyse: Kritik und Neuorientierung*. Wiesbaden, Germany: Springer Fachmedien Wiesbaden (Ursprünglich erschienen bei Westdeutscher Verlag 1993). http://doi.org/10.1007/978-3-663-01473-77
236 Ibid.
237 For example, Nakamura (1987) argues that policy formulation/legitimation and the implementation of legislation by bureaucrats takes place simultaneously
238 Héritier, A. (Ed.). (1993). *Policy-Analyse: Kritik und Neuorientierung*. Wiesbaden, Germany: Springer Fachmedien Wiesbaden (Ursprünglich erschienen bei Westdeutscher Verlag 1993). http://doi.org/10.1007/978-3-663-01473-77
239 Ibid.
240 Ibid.
241 Anderson, J. E. (1975). *Public Policy-Making*. *Basic concepts in political science* (3rd ed.). New York, USA: Praeger.

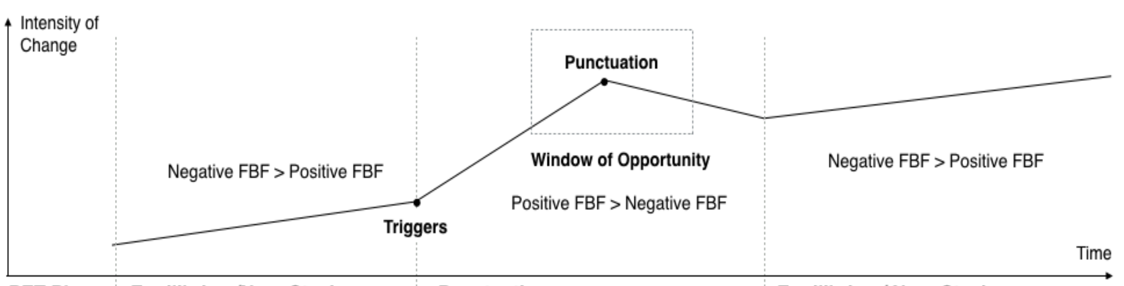
The plethora of competing frameworks, theories and models explain that the policy process has caused some scholars to argue that the non-existence of one single theory that can explain the policy process demonstrates the failure of this particular science.[242] Others, however, contend that the facets and effects of the policy process are far too complex and multifaceted to be explained by one 'general' theory. They also contend that diversity in explanatory models creates room for the inception of new concepts and ideas, thereby allowing for a multi-angle perspective of the world that preempts scholarly bias and theory tenacity.[243] In this study we acknowledge the shortcomings of the stages heuristics, but nevertheless recognize the possibility of interactions, feedback loops, and non-linear or parallel developments between policy cycles.

3.2 Policy Change and Punctuated Equilibrium Theory

PET is based on the observation that policy patterns are generally characterized by extended periods of equilibrium or near stasis as well as brief periods of disequilibrium, both of which cause profound policy changes to occur (so-called *punctuations*), as shown in Figure 2. Stasis, rather than crisis, typically characterizes most policy areas. Therefore, stasis and dramatic policy change are dual foci of the punctuated-equilibrium approach. PE theorists contend that in order to understand policy change, equal attention must be paid to the mechanisms that induce stability and equilibrium (*negative feedback processes*) as well as policy punctuations and substantial changes (*positive feedback forces*).

[242] See for example Smith, K., & Larimer, C. (2012). *The Public Administration Theory Primer*. (2nd ed.). Boulder, USA: Westview Press.
[243] Weible, C. M., Heikkila, T., & Sabatier, P. A. (2012). Understanding and influencing the policy process. *Policy Sciences,* 45(1), 1-21.

Figure 2 Diagram of PET Theory



PET Phase	Equilibrium/Near-Stasis	Punctuation	Equilibrium/ Near-Stasis
Policy Change	Incremental change (in favor of status quo)	Paradigm change (not in favor of new images)	Incremental change (in favor of status quo)
FBF	Negative FBF dominate	Positive FBF dominate	Negative FBF dominate
Arena	Homeostatic system: one dominant policy image and few actors	Heterogeneous system: many actors in the policy arena and emergence of policy image	Homeostatic system: one dominant policy image and few actors
Attention	*Diffuse* and *distributed* among several subsystem issues	*Focused* on one specific issue	*Diffuse* and *distributed* among several subsystem issues
Decision Making	Subsystem decision-making is decentralized to the iron triangles and issue networks of specialists in the bureaucracy, legislative subgroups, and interested parties	Subsystem decision-making enters the macro-political level, which means many new governmental actors enter and become involved in a new policy area	Subsystem decision-making is decentralized to the iron triangles and issue networks of specialists in the bureaucracy, legislative subgroups, and interested parties
Institutions/ Venues	Strong institutions with clear jurisdictional boundaries, institutions are stable enough to thwart off intervention from opposing policy actors who are trying to enter the policy arena.	Weak institutions, diffuse jurisdictional boundaries and overlapping responsibilities, unstable and ineffective in thwarting off opposing views and interests from entering the political debate of a policy issue	Strong institutions with clear jurisdictional boundaries, institutions are stable enough to thwart off intervention from opposing policy actors who are trying to enter the policy arena.

Source: Author

3.2.1 PET and Agenda Setting: Bounded rationality and information processing

The understanding of policy change ultimately leads to the question as to why some issues and societal concerns succeed or fail in becoming part of the national agenda. True, Jones and Baumgartner (2007) assert that a pre-condition for policy change and major policy punctuations is agenda access.[244] Here, True, Jones and Baumgartner (2007) define *agenda* as "the focus of collective organizational attention" (p.40),[245] that is when all organizations shift from parallel processing to serial, with its severe attention limits. Birkland (2006)[246] on the other hand, understands *agenda* as a "concrete […] list of bills that are before a legislature, but also […] a series of *beliefs* about the existence and magnitude of problems and *how* they should be addressed by government, the private sector, nonprofit organizations, or through joint action by some or all of these institutions".[247] *Agenda setting* can therefore be thought of as the mechanism by which

[244] True, J. L., Jones, B. D., & Baumgartner, F. R. (2007). Punctuated equilibrium theory: Explaining stability and change in American policymaking. In P. A. Sabatier (Ed.), *Theories of the Policy Process*. Boulder, USA: Westview Press.
[245] Jones, B. D., & Baumgartner, F. R. (2012). From There to Here: Punctuated Equilibrium to the General Punctuation Thesis to a Theory of Government Information Processing. *Policy Studies Journal*, *40*, 1–20. http://doi.org/10.1111/j.1541-0072.2011.00431.x
[246] Birkland, T. A. (2006). Agenda setting in public policy. In F. Fischer & J. M. Gerald (Eds.), *Handbook of Public Policy Analysis* (pp. 89–104). London, UK: Routledge.
[247] Ibid.

sufficient urgency and importance are attached to specific societal problems so that these are brought to the attention of institutions and individuals with public authority (in most cases the ruling elite).[248] However, the agenda setting stage itself can be differentiated into various levels since not all issues entering the political agenda naturally translate into policy formulation and legitimation. Here, Birkland (2006)[249] differentiates between (see Figure 3):

1. the broad *agenda universe,* which contains all issues that may or may not enter a political agenda;
2. the *systematic agenda*, which contains only those issues within the *agenda universe* that members of the political community commonly perceive as meriting public attention and as involving matters within the legitimate jurisdiction of existing governmental authority[250];
3. the *institutional agenda*, which includes only those issues in the systematic agenda that are explicitly up for the active and serious consideration of authoritative decision makers;[251] and
4. the *decision agenda,* which consists of only a small fraction of issues that are about to be acted upon by the government body or ruling elite.

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[248] Hilgartner, S., & Bosk, C. L. (1988). The Rise And Fall Of Social Problems: A Public Arenas Model. *American Journal of Sociology*, 94(1), 53-78.
[249] Birkland, T. A. (2006). Agenda setting in public policy. In F. Fischer & J. M. Gerald (Eds.), *Handbook of Public Policy Analysis* (pp. 89–104). London, UK: Routledge.
[250] Cobb, R. W., & Elder, CD (1983). *Participation in American Politics: The Dynamics of Agenda-building* (2nd ed.). Baltimore, USA: Johns Hopkins University Press.
[251] Ibid.

Figure 3 Levels of the Political Agenda

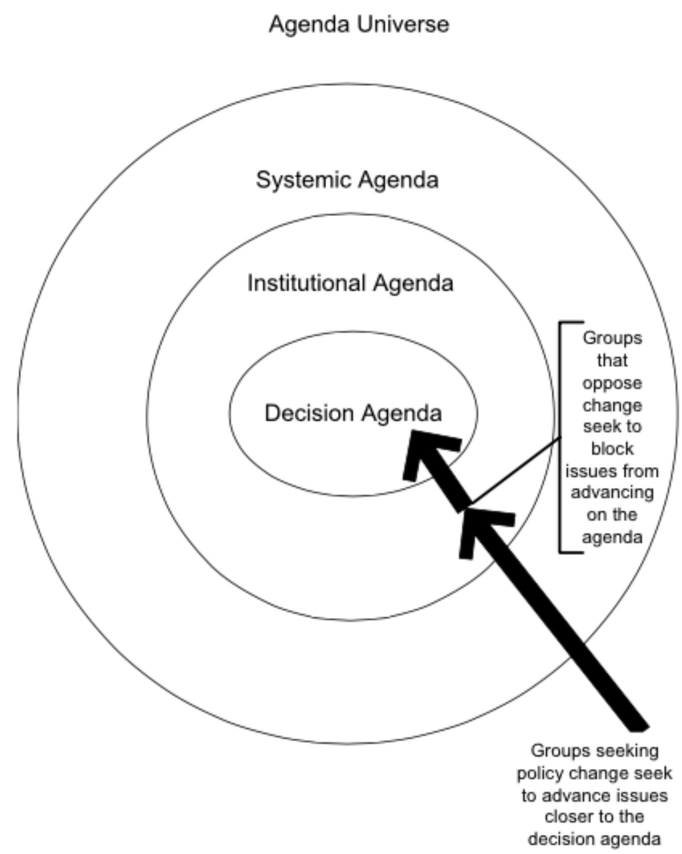

FIGURE 5.1 Levels of the Agenda.

Source: Birkland, T. A. (2006). Agenda Setting in Public Policy,

At its core, the stratification of the agenda stage results from the finite carrying capacity of each stage that is triggered by the cognitive limitations of human beings. Humans are subject to *bounded rationality*, which means that individuals, political systems, institutions and societies are limited in their attention spans, processing capacities, time and resources.[252] Decision-makers, especially, operate under severe time constraints, which limit their time to reach decisions. Therefore, decision-makers, like all human beings, have little choice but to ration their attention to only a limited number of issues and to address only those issues that appear most urgent. Consequently, the upward mobility of issues in the political agenda depends on the amount of attention issues receive from political decision-makers. Here Jones (1994)[253] explains:

[252] Simon, H. A. (1985). Human Nature in Politics: The Dialogue of Psychology with Political Science. *American Political Science Review*, 79(02), 293-304.
[253] Jones, B. D. (1994). Reconceiving decision-making in democratic politics: Attention, choice, and public policy. Chicago, USA: University of Chicago Press.

> "When a policy shifts to the macro-political institutions for *serial processing*, it generally does so in an environment of changing issue definitions and heightened attentiveness by the media and broader publics" (Jones (1994), p.185).

Herbert Simon (1957)[254] adds another important element to our understanding of attention and agenda setting by introducing the term *information processing.* Simon distinguishes between human beings, who are able to grasps only limited parts of the world at any given time (*serial information processing),* and organizations, who have more flexibility, resources and attention capacity to handle many issues simultaneously and in parallel (*parallel information processing*). In other words, individual attention or processing is serial, but systemic attention or processing is parallel. In general, parallel processing is more inhibitive in regards to redirecting its attention, so policy change as an organization is better shielded from the glare of publicity associated with high-agenda politics.[255] When macro-political forces intervene it is sometimes possible that parallel processing of issues culminates into serial information processing, which then allows new issues to move upwards on the political agenda. If at a later point another new issue or aspect attracts attention, attention may shift to that new dimension (known as *serial shift*).[256]

For these reasons, stratification of the agenda sphere acts as an indiscernible filter to separate important from non-important issues and to reduce the otherwise complex and multidimensional policy issues into an amount that decision-makers or institutions with their finite attention span can grasp. Policy subsystems serve the same purpose as political discussions, which are generally disaggregated into a number of issue-oriented policy subsystems that act as incubators of problems and solutions before such issues are brought to national-level decision-makers.[257] Because there are many policy communities (policy subsystems) but only one national government, many solutions and problems from various policy subsystems compete for the attention of a very limited number of decision-makers, a phenomenon that is known as *attention bottlenecks.*[258] The issues that the high-level national government eventually gives the most attention to depends, however, on *opportunity*, *bias*, *formal position* within an organization or government, and the number of alternative issues competing for attention. When an issue moves higher on the political agenda, it is usually because new participants have become interested in the debate. As Jones (1994)[259] explains:

> "When a policy shifts to the macro-political institutions for serial processing, it generally does so in an environment of changing issue definitions and heightened attentiveness by the media and broader publics." (Jones (1994), p.185)

In this sense macro-politics are understood as the politics of punctuation, large-scale change, competing policy images, political manipulation, and positive feedback forces. The bounded rationality inherent to political decision-makers also applies to the broader public and public debates in general. Yet prioritization and attention given to an issue are not indefinite but rather

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[254] Simon, H. A. (1957). *Models of man: social and rational; mathematical essays on rational human behavior in society setting*. New York: John Wiley & Sons.
[255] True, J. L., Jones, B. D., & Baumgartner, F. R. (2007). Punctuated equilibrium theory: Explaining stability and change in American policymaking. In P. A. Sabatier (Ed.), *Theories of the Policy Process*. Boulder, USA: Westview Press.
[256] Jones, B. D. (1994). *Reconceiving decision-making in democratic politics: Attention, choice, and public policy*. Chicago, USA: University of Chicago Press.
[257] Ibid.
[258] Ibid.
[259] Ibid.

subject to severe alterations as the future always harbors the possibility that issues are re-framed and suddenly perceived as prominent and more pressing than before.

3.2.2 Obstacles of Policy Change: Monopolies and Negative Feedback Forces

The Punctuated Equilibrium Theory (PET) offers additional explanations for understanding why some issues are more likely than others to permeate the sphere of political decision-making and how this affects the overall policy progression. As mentioned before, PET is based on the observation that policy patterns alternate between extended periods of time when there is only incremental policy change and short-lived punctuations that produce policy innovations. Here PET theorists introduce the notion of *policy monopolies*.[260] *Policy monopolies* are described as policy coalitions or single actors who are able to impose their specific and individual interest across a specific policy subsystem.[261] In each policy subsystem various actors and coalitions compete with each other in how issues are framed and how the public acknowledges alternative solutions. As Schattschneider (1975)[262] explains:

> "A *policy monopoly* has a definable institutional structure responsible for policymaking in an issue area, and its responsibility is supported by some powerful *idea* or *image*. This image is generally connected to core political values and can be communicated simply and directly to the public." (Schattschneider (1975), p.5-7)[263]

Policy monopolies therefore owe their existence to particular *images*, *symbols* and *ideas* that help frame and socially construe an issue in favor of the policy monopoly. *Images* and *symbols* have an "evocative power [*and*] the ability to arouse and fix attention" (p.29)[264] and are able to act as emotive and cognitive propellants to incite social processes. As Barbalet (2001)[265] explains:

> "Emotion is central to social processes not only in being central to identity and affiliation, in which its role is frequently acknowledged, but also in being the necessary basis of social action and in being responsible for the form action takes." (Barbalet (2001), p.65)

However, *symbols* and *images* can also lead to manipulation since they are relatively clear but highly simplified messages that oftentimes serve specific purposes.[266] *Policy images* are thus a

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[260] Baumgartner, F. R., & Jones, B. D. (1991). Agenda Dynamics and Policy Subsystems. *The Journal of Politics*, *53*(4), 1044–1074. http://doi.org/10.2307/2131866.
[261] Schattschneider, E. E. (1975). *The Semisovereign People: A Realist's View of Democracy In America*. New York, USA: Thomson Learning.
[262] Ibid.
[263] Baumgartner, F. R., & Jones, B. D. (1993). *Agendas and Instability in American Politics*. Chicago, USA: University of Chicago Press.
[264] Simon, H. (1983). *Reason in human affairs*. Stanford, CA, USA: Stanford University Press; Simon, H. A.
[265] Barbalet, J. M. (2001). Emotion, social theory, and social structure: A macrosociological approach. Cambridge, UK: Cambridge University Press.
[266] Sniderman, P. M., Brody, R. A., & Tetlock, P. E. (Philip E. (1993). *Reasoning and choice : explorations in political psychology*. Cambridge University Press; Etzioni, A. (1993). *Public policy in a new key*. New Brunswick, USA: Taylor & Francis; Cobb, R. W., & Elder, C. D. (1983). *Participation in American politics: the dynamics of agenda-building*. Baltimore, USA: Johns Hopkins University Press.

mixture of empirical information and emotive appeals[267] that steer the debate in a specific direction by raising emotional responses and attachments to the issues. Negative emotions and higher order symbols (those that affect the entire community), in particular, are able to create a more potent affect, a stronger uniformity of meaning across members of society and a greater durability of attention.

In the PET context, policy monopolies and policy advocates are therefore only successful if they can create sufficient emotional appeal by means of powerful *policy images/symbols* that manipulate and influence the way particular issues or solutions are framed and discerned among the public. This also implies that policy monopolies must ward off political outsiders who represent alternative framings that could instigate the questioning of the existing orthodoxy and prompt radical rethinking. Therefore, policy monopolies are also very much the result of exclusion, negligibility, lack of power and apathy of alternative interest groups. As True et al.[268] explain:

> "If the citizens excluded from a monopoly remain apathetic, the institutional arrangement usually remains constant, and policy is likely to change only slowly (the negative feedback process). As pressure for change builds up, it may be resisted successfully for a time. But if pressures are sufficient, they may lead to a massive intervention by previously uninvolved political actors and governmental institutions." (p.158) [269]

Venues play an important role in understanding why policy monopolies are able to consolidate their power and why alternative policy advocacy groups remain apathetic. *Venues* describe a level of government or institution in which political advocates are likely to gain the most favorable hearing. Venues can be thought of in institutional terms (i.e. legislative, executive, or judicial), in vertical terms (i.e. federal, state, local government) and even as news and social media[270]. Most commonly they are thought of as institutions that provide the rules for political decision-making and demarcate the boundary between political decision-makers and political "outsiders".[271] Institutions work according to standard operating procedures that are clear and that limit participation only to those granted authority. As mentioned in the *Chapter 3.1 Policy Analysis*, institutions are inclined to support homeostatic systems since they are the "most important legacies of agenda access" (p.24).[272]

Institutions serve the purpose of alleviating complex social problems for decision-makers. They are designed to cope with multidimensional issues in a deliberately one-dimensional way and through specific mandates. Institutions therefore play a substantial role in issue definitions, issue

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[267] True, J. L., Jones, B. D., & Baumgartner, F. R. (2007). Punctuated equilibrium theory: Explaining stability and change in American policymaking. In P. A. Sabatier (Ed.), *Theories of the Policy Process*. Boulder, USA: Westview Press.
[268] True, J. L., Jones, B. D., & Baumgartner, F. R. (2007). Punctuated equilibrium theory: Explaining stability and change in American policymaking. In P. A. Sabatier (Ed.), *Theories of the Policy Process*. Boulder, USA: Westview Press.
[269] Ibid.
[270] Barbalet, J. M. (2001). Emotion, social theory, and social structure: A macrosociological approach. Cambridge, UK: Cambridge University Press.
[271] Baumgartner, F. R., & Jones, B. D. (Eds.). (2002). *Policy Dynamics*. Chicago, USA: University of Chicago Press.
[272] Ibid.

framing and directing the attention of decision-makers toward specific aspects[273]. They serve as effective frontiers that preclude any opposing views and interests from entering the decision-making arena. They are therefore the central element of negative feedback forces and are crucial in upholding the dominance of policy monopolies. However, this is only the case if institutions are stable and institutional rules are clear and restrictive[274]. Although institutions are created, reshuffled and reorganized during periods of heightened attention to a given problem, they do not disappear after the attention fades, but rather are reassembled into new institutions. As Baumgartner, Jones and Mortensen (2014)[275] write:

> "After an issue is no longer part of the public agenda, the institution's procedures, and biases that these encourage, designed to achieve one set of goals rather than another, remain in place" (Baumgartner, Jones and Mortensen (2014), p.24)

To challenge a dominant policy monopoly in one venue, advocacy groups may seek audience in another venue as multiple venues may exist even within a branch of government. Venue shopping is therefore substantial in advancing policy goals and describes the process by which opposing advocacy groups strategically seek political influence by forming coalitions, mobilizing allies and entering new venues where they can gain hearing on their grievances with existing policies. Here True, Jones and Baumgartner (2007)[276] explain:

> "What determines whether an issue will catch fire with positive feedback or not? The interaction of changing images and venues of public policies does." (True, Jones and Baumgartner (2007) p.160)

It is important to note that policy monopolies also imply coercion; dominant advocacy groups are capable of compelling or forcing other policy groups in doing something even against their will. This includes persuasion as much as it does inaction.[277] It also implies that there is bias inherent to each political system, which allows for certain issues to move upwards the decision agenda and remain as policy monopolies while other issues remain excluded. As Schattschneider (1975)[278] describes:

> "All forms of political organization have a bias in favor of the exploitation of some kinds of conflict and the suppression of others because *organization is the*

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[273] For instance, one government agencies looks at a given issues from a different perspectives than another, due to different expertise, reporting requirements, priorities, and so forth.
[274] Baumgartner, F. R., & Jones, B. D. (Eds.). (2002). *Policy Dynamics*. Chicago, USA: University of Chicago Press
[275] Baumgartner, F. R., Jones, B. D., & Mortensen, P. B. (2014). Punctuated Equilibrium Theory: Explaining Stability and Change in Public Policymaking. In C. M. Weible & P. A. Sabatier (Eds.), *Theories of the Policy Process* (3rd ed., pp. 59–103). Boulder, Colorado: Westview Press.
[276] True, J. L., Jones, B. D., & Baumgartner, F. R. (2007). Punctuated equilibrium theory: Explaining stability and change in American policymaking. In P. A. Sabatier (Ed.), *Theories of the Policy Process* (2nd ed.). Boulder, USA: Westview Press.
[277] Baumgartner, F. R., Jones, B. D., & Mortensen, P. B. (2014). Punctuated Equilibrium Theory: Explaining Stability and Change in Public Policymaking. In C. M. Weible & P. A. Sabatier (Eds.), *Theories of the Policy Process* (3rd ed., pp. 59–103). Boulder, Colorado: Westview Press.
[278] Schattschneider, E. E. (1975). *The Semisovereign People: A Realist's View of Democracy In America*. New York, USA: Thomson Learning.

> *mobilization of bias*. Some issues are organized into politics while others are organized out." (Schattschneider (1975), p.71)

The dominance of policy monopolies and presiding policy images and symbols, as well as the suppression of partisan coalitions, provide the basis for what Baumgartner and Jones (2002)[279] refer to as *negative feedback forces.* Birkland (2011)[280] describes these as highly complex blocking powers to political change that are more a function of the nature and rules of the policy process rather than the particular attributes of the groups or interests themselves.[281] Negative feedback forces are self-correcting mechanisms that prevent political change by way of counterbalance, similar to the working principle of a "thermostat, which adjusts to falling temperatures by putting more heat"(p.9).[282] Such counter mobilization is an innate feature of political systems, since most public policies are explicitly designed to be homeostatic.[283] Negative feedback leads to stable and predictable outcomes and is therefore the main driving force of extended and stable periods of only incremental policy change. Consequently, as long as one aspect of a particular political issue dominates the decisionmakers' perception– that is, when negative feedback forces outweigh and policy monopolies dominate - there is likely to be little change (p.20).[284] But when new issues come to the attention of a broader public and decisionmakers exposed to more diversified opinions and interpretations, substantial policy change is more likely to happen. That being said, negative feedback forces are unable to dominate the policy arena indefinitely, as mobilization will always accumulate to the points when negative feedback forces are no longer able to counteract and resist the opposing views that challenge its predominance.

3.2.3 Drivers of Policy Change: Positive Feedback Forces, Mimicking, Windows of Opportunity

When bias, powerful images, symbols, and policy monopolies fade or collapse, it can create the possibility for considerable policy change (referred to as *punctuations*[285]*)*. The fading of policy monopolies is attributed to the effects of *positive feedback forces*. Positive feedback forces are able to reinforce and accentuate new ideas or reframe existing ones. They appear when modest, random or seemingly insubstantial policy events lead to "a cascade of subsequent events that dramatically change the status quo" (p.13)[286]. Baumgartner and Jones describe their impact as a "feeding frenzy" or a "bandwagon effect" because they set "a clustering of events" (p.13)[287] into

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[279] Baumgartner, F. R., & Jones, B. D. (Eds.). (2002). *Policy Dynamics*. Chicago, USA: University of Chicago Press.
[280] Birkland, T. A. (2011). An introduction to the policy process: Theories, concepts and models of public policy making (1st ed.). New York, USA: M.E. Sharpe.
[281] Baumgartner, F. R., & Jones, B. D. (Eds.). (2002). *Policy Dynamics*. Chicago, USA: University of Chicago Press.
[282] Ibid.
[283] The idea of negative feedback processes is also seen in other theories, such as in bounded rationality, incrementalism, administrative behavior.
[284] Baumgartner, F. R., & Jones, B. D. (Eds.). (2002). *Policy Dynamics*. Chicago, USA: University of Chicago Press.
[285] Baumgartner, F. R., & Jones, B. D. (1993). *Agendas and instability in American politics* (1st ed.). Chicago, USA: University of Chicago Press.
[286] Baumgartner, F. R., & Jones, B. D. (Eds.). (2002). *Policy Dynamics*. Chicago, USA: University of Chicago Press.
[287] Ibid.

motion. Positive feedback forces are short-lived, unpredictable and able to create escalating, explosive and reinforcing dynamics that are conducive to policy changes. Positive feedback processes are "changeable, fickle and erratic" (p.13).[288] The instable and ephemeral nature of positive feedback forces has much to do with serial shifts of attention (as explained with *information processing* in chapter PET and Agenda) and the fact that attention shifts may cause rapid, reverse or unforeseeable alterations to previous behavior.

The escalating nature of positive feedback forces can be attributed to the phenomenon of *mimicking* as an essential aspect of human behavior. *Mimicking* relates to how individuals make decisions when they observe the behavior and anticipate the reactions of their peers. It is a self-perpetuating dynamic that is steered by the strong desire of individuals to "be on the winning side" (p.14).[289] The likeliness of success (that is, the probability of being on the winning side) combined with expected benefits is likely to increase the willingness of political actors to invest in mobilizing forces and establish alliances to challenge the predominant policy image. The expected benefits in policy may arise only gradually, or not at all, because policy cycles may span several decades. The immediate benefits of such policy are not always immediately noticeable. Mimicking is especially strong when a 'critical mass' is reached. At this point, the t*hreshold effect* or *momentum* kicks in.[290] Because they are social debates in which participants are acutely aware of the behaviors of those around them, public debates, in particular, are prone to *mimicking* and positive reinforcing effects.[291]

Positive feedback processes are likely to occur when new issues appear on the macro-political agenda (which translates into heightened attention from the public and decision-makers). This often occurs during *windows of opportunity*, which are defined as critical points in time during which the chance that a policy will be adopted by policy-makers is significantly enhanced. Kingdon (1995)[292] explains that windows of opportunity can also be understood as fleeting "opportunities for advocates of proposals to push their pet solutions, or to push attention to their special problems." Windows of opportunity may emerge as the result of a single or multiple events. Here True, Jones and Baumgartner (2007)[293] explain:

> "[A] landslide need not be caused by a large-scale event; it may be caused by the slow and steady buildup of very small changes." (True, Jones and Baumgartner (2007) p.160)[294]

The events that cause *windows of opportunity* and *policy punctuations* are known as *triggers* or *focusing events.* Similar to the effects of "earthquakes or landslides" (p.160),[295] they occur rarely,

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[288] Ibid.
[289] Ibid.
[290] This was first observed by Schelling, T. C. (1978) Egonomics, or the art of self-management. *The American Economic* Review 68(2), 290-294.
[291] Baumgartner, F. R., & Jones, B. D. (Eds.). (2002). *Policy Dynamics*. Chicago, USA: University of Chicago Press.
[292] Kingdon, J. W. (1995) *Agendas, Alternatives and Public Policies* (3rd ed.). New York, USA: Harper Collins College Publisher.
[293] True, J. L., Jones, B. D., & Baumgartner, F. R. (2007). Punctuated equilibrium theory: Explaining stability and change in American policymaking. In P. A. Sabatier (Ed.), *Theories of the Policy Process* (2nd ed.). Boulder, USA: Westview Press.
[294] Ibid.
[295] Ibid.

suddenly and capture attention from the media and the broad public[296]. They are commonly perceived as crises that result from the release of new studies and statistics, presidential pronouncements, or other pre-mediated or stochastic events.[297] Triggers are not necessarily new information but must cause a new dimension of a perceived problem to become more salient in the course of a political debate. Other examples include information that was previously known for a long time by a niche group (such as non-government organizations (NGOs)) that is suddenly noticed by a broader public due to certain events. Focusing events and triggers can either occur as a single "mighty blow" (p.22) or by "relative minor events that add up over longer periods of time" (p.22)[298]. Because *triggers* and *focusing events* often involve new cognitions of a problem, they are inherently related to the issue of social learning and shifts in paradigm.

3.2.4 Policy Punctuations

Policy changes vary in the scope and degree of innovation – which warrants a brief clarification of the different types of policy change. Hall (1993)[299], for instance, distinguishes between three types of policy changes: simple adjustments in existing policy instruments (*first order* policy changes*)*, introduction of new instruments resulting from social learning mainly within the state itself (*second order policy changes)* and emergence of entirely new sets of goals and systems (paradigms) resulting from social learning across the entire society (*third order policy changes).* Hall (1993)[300] connotes:

> "*Third order change* is likely to involve the accumulation of anomalies, experimentation of new forms of policy and policy failures that precipitate a shift in the locus of authority over policy and initiate a wider contest (…) [*which*] will end only when the supporters of a new paradigm secure positions of authority (…) [*and*] institutionalize the new paradigm" (Hall (1993) p.280–81)[301]

Given that third order changes involve an overhaul in perception and paradigm across the entire society, they occur more seldom than first and second order changes and are synonymous with an abnormal, atypical, relatively unstable and usually short-lived process resulting from changes in policy ends and a shift in the locus of authority and venues.[302]

Policy change (*punctuations*) are therefore understood as the immediate result of powerful groups who loose control of the agenda while previously less powerful groups enter the policy debate through successful venue shopping and draw attention to their issues. When the policy monopoly begins to lose its supporting policy image, rival institutions and opposing actors within the government may assert the authority to become involved. This increases the number of hostile agencies who are able to enter the political decision-making venue. A growing number of hostile

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[296] Birkland, T. A. (1997). *After disaster: Agenda setting, public policy, and focusing events*. Washington, D.C., USA: Georgetown University Press.
[297] Baumgartner, F. R., & Jones, B. D. (Eds.). (2002). *Policy Dynamics*. Chicago, USA: University of Chicago Press.
[298] Ibid.
[299] Hall, P. A. (1993). Policy paradigms, social learning and the state. *Comparative Politics*, *25*(3), 275–296.
[300] Ibid.
[301] Ibid.
[302] Baumgartner, F. R., & Jones, B. D. (1991). Agenda Dynamics and Policy Subsystems. *The Journal of Politics*, *53*(4), 1044–1074. http://doi.org/10.2307/2131866; Baumgartner, F. R., & Jones, B. D. (Eds.). (2002). *Policy Dynamics*. Chicago, USA: University of Chicago Press.

actors in the political decision-making venue substantially effects the way that decision-makers calculate the willingness of possible allies and their expectation of success.[303] This creates momentum and sets off a virtual cycle of greater degradation in image, allowing new actors to enter and a greater probability that actors will mobilize in favor of policy change. Given that positive feedback forces eventually subside due to limited public attention spans, policy punctuations eventually settle back into a new state of equilibrium. In this state of stability, only modest and incremental policy changes occur. These incremental phases are more predominant and longer lasting than short-lived punctuations. Although policymaking during this stage is relatively stable, it will never reach perfect equilibrium due to a constant state of disequilibrium.[304] In summary, PE theory contends that a) policymaking processes make leaps and undergo periods of near stasis as issues surface on and recede from the public agenda; b) the tendency toward punctuated equilibrium is exacerbated by political institutions, mimicking, and cognitive limitations; and c) policy images play a more critical role in making issues known to a broader public than specialists who occupy prevailing policy monopolies. Policy processes therefore describe a constant struggle between equilibrium and disequilibrium forces.

3.3 China's Policymaking, Processes and Policy Arena: An Analytical Framework

Due to its idiosyncratic developmental pathway over the past thirty years, contemporary China is considered by some a "Black Swan" (p.8.) challenge or enigma to social and political sciences[305] China's unique style of politics that amalgamate both resilience and adaptability[306] has introduced "important unconventional, non-western techniques to the repertoire of governance in the twenty-first century" (p.4).[307] It challenges prevailing theories of modernization, democratization, and regime transitions, all of which have been unable to provide sufficient explanations for the case of post-Mao China.[308] This chapter therefore aims to develop a basic analytical framework to understand some of the fundamentals that guide policymaking in China, to delineate the different stages of policy processes involving agenda setting, policy choices, decision-making and implementation and to describe the characteristics of China's policy arena.

3.3.1 Analytical Models of Policymaking in China

In the past, various conceptual models have been used in the past to explain China's policy structures, agenda setting and institutional venues. In fact, the study of political processes in China is a relatively nascent field of research that reflects not only the transitioning and changing role of the government but also the gradual opening of the Chinese politics and society to western and Chinese scholars. Since the 1950s, the study of policy processes in China underwent three

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303 Baumgartner, F. R., & Jones, B. D. (Eds.). (2002). *Policy Dynamics*. Chicago, USA: University of Chicago Press.
304 Baumgartner, F. R., & Jones, B. D. (1993). *Agendas and instability in American politics* (1st ed.). Chicago, USA: University of Chicago Press.
305 For the "Black Swan" concept and its significance for social science epistemology and methodology, see Taleb, N. N. (2007). *The Black Swan: The Impact of the Highly Improbable* (1st ed.). New York, USA: Random House.
306 Heilmann, S., & Perry, E. J. (Eds.). (2011). Embracing Uncertainty: Guerrilla policy style and adaptive governance in China. Mao's Invisible Hand: The political foundations of adaptive governance in China (1st ed., Vol. 17). Cambridge, USA/ London, UK: Harvard University Asia Center. http://doi.org/10.2307/j.ctt1sq5tc.
307 Ibid.
308 Ibid.

significant stages with particular emphasis placed on the following attributes:[309] the study of *elites* and the *rational decision-making model* in the 1950s and 1960s; political *factions* and the *power model* in the 1960s and 1970s, and the study of *bureaucratic structures* and the *bureaucratic politics model* since the 1980s.

One of the western first scholars to study China's policy processes were Barnett (1967)[310] and Thomson (1993)[311] who contended that Chinese politics were the result of high-level and elite leaders who formulated policies according to their own interpretations of national interests. This *rational-decision-making model* assumes a linear "evolution of choices by a coherent group with shared perceptions of the values to be maximized through the policy process" (p.11).[312] The primary factor that keep the policy process going is assumed to be a shared and common interest among selfless policy actors to serve a higher purpose. This inevitably renders policy processes the result of reasoned debates and evaluations among high-level political decisionmakers that eventually culminate in policy processes and changes. Opponents of this model contend, however, that policy processes in China are not always linear but instead "complex, loose and very random" (p.14)[313] and that policy outcomes are often the de facto result of limited information, time pressure, strategic ambiguities, ambivalence of self-serving leaders or even "uninformed and unconsidered impulse" (p.14) of powerful leaders who cloak their hidden self-interests in an "ideological justifiable garb" (p.14).[314]

In the 1960 major political events such as the Cultural Revolution and the Gang of Four began to bridle the façade of a unified and homogenous political party, giving rise to *the power model* as the dominant school of thought to explain Chinese policy processes. The power model posits that political processes are steered by individual or fractional power interests at the top levels of the power hierarchy. Proponents of this theory included Nathan (1973)[315], Tsou (1976)[316] and Pye (1981)[317] who argued that policymaking was shaped by internal conflicts, competing factions and elite struggles "among the top leaders who are quite sensitive to the implications of alternative policy choices upon their stature and power" (p.17).[318] They argued that the political elite had failed to acquire higher positions through public elections because of China's political system and shifted political competition to the policy-making process, where they redistributed or adjusted resources and cultivated their own factions or "relationships" so as to reinforce their political

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[309] Chen, L. (2008). Bureaucratic System and Negotiation Network: A Theoretical Framework for China's Industrial Policy. In *OECD Reviews of Innovation Policy: China* (pp. 597-612). Paris, France: Organization for Economic Co-operation and Development (OECD).

[310] Barnett, D. (1967). *Cadres, Bureaucracy, and Political Power in Communist China* (2014/08/01). New York, USA: Columbia University Press. http://doi.org/DOI: 10.2307/1953446.

[311] Thomson, R.J. (1993), The Politics of China. In J.P. Almond*, Contemporary Comparative* Politics: Prospect of the World. Commercial Press.

[312] Lieberthal, K., & Oksenberg, M. (1988). *Policy Making in China: Leaders, Structures, and Processes*. Princeton, USA: Princeton University Press.

[313] Ibid.

[314] Ibid.

[315] Nathan, A. J. (1973). A factionalism model for CCP politics. *China Quarterly*, 34–66.

[316] Tsou, T. (1976), Prolegomenon to the Study of the Informal Groups in CCP Politics. *China Quarterly*, 65, 98-114.

[317] Pye, L. (1981), *The Dynamics of Chinese Politics*. Cambridge, USA: Oelgeschlager, Gunn, and Hain.

[318] Lieberthal, K., & Oksenberg, M. (1988). *Policy Making in China: Leaders, Structures, and Processes*. Princeton, USA: Princeton University Press.

strength.[319] Critics of this theory contended that the power model narrowed down policy outcomes as merely being the result of power struggles while neglecting the substantial issues at stake.[320]
The *third and final school of thought clusters around the Fragmented Authoritarianism (FA) Model,* which was first described by Lieberthal and Oksenberg (1988) other researchers in a series of publications starting in the 1980s.[321] The *FA Model*[322] places greater scrutiny on the interactive processes and the bureaucratic structures that shape political decision-making. The FA Model posits that governments are merely conglomerates of large and competing bureaucracies and political actors who differ substantially in their worldview, preference and interests. Given the "scattered, dissevered and layered governmental structure",[323] policy outcomes are therefore the result of *bargaining,*[324] *conflicts*[325] and *competitive persuasion*.[326] Bargaining and consensus seeking result in protracted and washed-out policy outcomes that significantly loose momentum as policies diffuse into lower levels of the multilayered state. Since the mid 1990s, several Chinese scholars have joined this growing field of research and have introduced new perspectives and ideas to describe China's governing system such as "crossing a river by feeling the stones",[327] "collective leadership",[328] "up-down and coming-going",[329] and "interaction ups and downs"[330] to reveal the dynamics of the Chinese policy process.
Despite the overall acceptance of the FA Model, scholars have pointed to recent changes that should be kept in mind when applying the model, such as (i) the recently *growing number of individuals, organizations and informal groups entering the policy arena* that dilute the influence of an elite group of decision makers; (ii) the *gradual standardization and systematization* of decision-making procedures in the legislative, judicial and government systems;[331] and (iii) recent policy dynamics that work contradictory to the fragmentation of authority. Naughton for instance, refers to the Tiananmen incident which led policymakers in Beijing to reverse many of their previous policy trends, seeking to recentralize, concentrate and strengthen political authority, mobilize political levers of control and defragment government administration and

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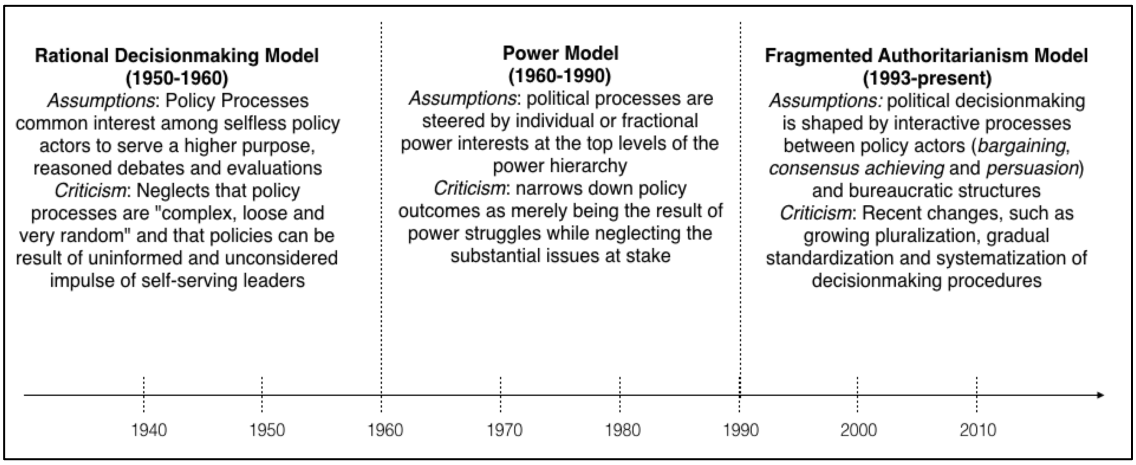
319 Lampton, D.M. (1986), *Paths to Power.* Ann Arbor, USA: University of Michigan's Center for Chinese Studies; Lampton, D.M. (1974). Health, Conflict, and the Chinese Political System. *Michigan Papers in Chinese Studies*, 18.
320 Lieberthal, K., & Oksenberg, M. (1988). *Policy Making in China: Leaders, Structures, and Processes*. Princeton, USA: Princeton University Press.
321 Ibid.
322 The Fragmented Authoritarianism Model is itself is rooted in the works of Graham Allison's bureaucratic politics model ("Essence of decision and Bureaucratic politics: A paradigm and some policy implications") which was developed during the time of the cold war and the imminent danger of the Cuban Missile Crisis.
323 Lieberthal, K., & Oksenberg, M. (1988). *Policy Making in China: Leaders, Structures, and Processes*. Princeton, USA: Princeton University Press.
324 Dahl, R.A., & Lindblom, C.E. (1992), *Politics, Economics and Welfare*. New Brunswick, USA: Transaction Publishers.
325 Lampton, D.M. (1974). Health, Conflict, and the Chinese Political System. *Michigan Papers in Chinese Studies*, 18.
326 Halpern, Nina P. (1992). Information Flows and Policy Coordination in the Chinese Bureaucracy. In K. Lieberthal & D. Lampton (Eds.), *Bureaucracy, Politics, and Decision Making in Post-Mao China*. Berkeley and Los Angeles, USA: University of California Press.
327 Deng, X. (1993). *Essays of Deng Xiaoping* (3rd ed.). Beijing, China: People's Press.
328 Wen, L., & Wang, X. (2002). On Group Decision-making Model in Public Policy, *Journal of Jiangxi Administrative College*, 4(4).
329 Ning, S. (2001). *Public Policy*. Beijing, China: Higher Education Press.
330 Lu, M. (1998). Policy-making Process of Chinese Country Reform, *Twenty-first Century*, 50.
331 Chen, L. (2008). Bureaucratic System and Negotiation Network: A Theoretical Framework for China's Industrial Policy. In *OECD Reviews of Innovation Policy: China* (pp. 597-612). Paris, France: Organization for Economic Co-operation and Development (OECD).

bureaucracy.[332] Nonetheless the FA Model is regarded by many scholars the most durable heuristic through which to study Chinese politics.[333]

Figure 4 Dominant Analytical Models of Policymaking in China



Source: Author, based Chen, L. (2008). Bureaucratic System and Negotiation Network: A Theoretical Framework for China's Industrial Policy. In OECD Reviews of Innovation Policy: China (pp. 597-612). Paris, France: Organization for Economic Co-operation and Development (OECD).

3.3.2 Decision-making Structures: Fragmentation of Authority and the Distorting Influence of Bureaucratic Rank

One of the central assumptions of the FA Model is that authority below the very peak of the Chinese political system is *fragmented, segmented and disjointed* (see Chapter 4.4.2.1 *Key Actors in China's Energy Arena* for a detailed, visual description of China's power hierarchy).[334] The fragmentation of authority is rooted in what Lawrence and Martin (2013)[335] refer to as "the distorting influence of bureaucratic rank" (p.2).[336] China exerts a complicated administrative ranking system that attaches a hierarchical rank to each individual, official agency, bureaucratic institutions, state-owned company and territorial units, as shown in Table 4. The allocation of administrative *rank* determines a unit's *leverage, superiority and negotiation powers* within the political system and the way in which officials and agencies interact with each other.[337]

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[332] Naughton, B. (2008). SOE Policy: Profiting the SASAC Way. *Chine Economic Quarterly*, 12(2), 19-26.
[333] Mertha, A. (2009). Fragmented Authoritarianism 2.0: Political Pluralization in the Chinese Policy Process. *The China Quarterly*, *200*, 995–1012. http://doi.org/10.1017/S0305741009990592
[334] Lieberthal, K., & Lampton, D. M. (1992). *Bureaucracy, politics, and decision making in post-Mao China*. Berkeley, USA: University of California Press.
[335] Lawrence, S., & Martin, M. F. (2012). *Understanding China's political system. CRS Report for Congress*. Congressional Research Service.
[336] Ibid.
[337] Ibid.

Table 4 Selected Institutions and their Bureaucratic Rank[338]

Rank	Institutions
Full State (*highest*) (zhengguoji)	Communist Party Central Committee; Party and State Central Military Commissions; The State Council; National People's Congress Standing Committee; Chinese People's Political Consultative Conference National Committee; State Presidency
Vice/Quasi State (fuguoji)	Communist Party Central Disciplinary Inspection Commission (the Party's graft- fighting arm); Supreme People's Court; Supreme People's Procuratorate (the public prosecutor's office)
Ministry/Province (zhengbu shengji)	Party departments (e.g. Party Organization Department, Party Propaganda Department); ministries, commissions, and general administrations; regulatory commissions (e.g., for banking, insurance, and securities); provinces and autonomous regions; municipalities under the central government (Beijing, Shanghai, Tianjin, and Chongqing); Hong Kong and Macau; "mass organizations" such as the Communist Youth League and the All-China Federation of Trade Unions; the Xinhua News Agency; research academies (the Chinese Academy of Social Sciences, the Chinese Academy of Sciences, and the Chinese Academy of Engineering)
Vice/Quasi Ministry/Province Rank (fubushengji)	State bureaus, offices, and administrations (e.g., State Statistical Bureau, State Intellectual Property Office, State Oceanic Administration, and State Food and Drug Administration); 15 cities (Changchun, Chengdu, Dalian, Hangzhou, Harbin, Guangzhou, Jinan, Nanjing, Ningbo, Qingdao, Shenyang, Shenzhen, Wuhan, Xiamen, and Xian); China's five largest banks and four largest insurance companies; dozens of large state enterprises (e.g., the China National Tobacco Corporation); 32 universities
Department level (*zhengtingji*)	Counties, lesser-important SOEs

Source: Author, based on Lawrence, S. V.; Martin, M. F. (2012). Understanding China's political system

In principal, the fragmentation of authority emanates from the *dual ranking systems*, which refers to the co-existence of both *territorial ranks* and *functional ranks*. The *territorial ranks* divide China's vast territory into the center (highest rank), provinces, cities, counties, townships and villages. By contrast, *functional ranks* cluster around specific issues that are often headed by a ministry, which governs over a hierarchy of sub-ministerial units. *Functional hierarchies* include the State Council (highest rank), commissions, ministries, sub-ministries, and so forth. Lieberthal[339] refers to these two tiers of authorities as *vertical lines of authority* (*tiao,* functional) and *horizontal lines of authority* (*kuai, territorial*). Authority in China is therefore fragmented by

[338] Ibid.
[339] Lieberthal, K. (1997). China's governing system and its impact on environmental policy implementation. *China Environment Series*, *1*(1997), 3–8.

function, by territory and by rank.[340] The co-existence of these two incongruous lines of authority has inevitably complicated the way that administrative units coordinate and interact with each other.[341] This is particularly apparent at the province and township level, where subordinate administrative units are faced with the dilemma of serving two masters: a *functional* superior who coordinates according to its specific functions and a *territorial* superior who coordinates in relation to the needs of the locality that it governs.

In the 1970s and instigated through the empowerment of provinces, *territorial hierarchies* have grown more powerful than their functional counterparts, a trend referred to as "*making tiao serve kuai*".[342] In the context of decentralization reforms to spur economic at local level, the central government delegated substantial policy-making powers to the provinces, granting them entrepreneurial freedom, independent revenue streams and the right issuing and experimenting with policy innovations, as long as these would not conflict with national laws. The downside of such decentralization reforms has been *de facto federalism*[343]*,* the emergence of extremely powerful provincial leaders (who are ranked equal to central government ministers[344]) as well as discordance between local and central agendas and policy interests. The empowerment of these territorial lines of authority have led to significant power distortions and have made it increasingly difficult for the central government in Beijing "to impose its will on the provinces".[345]

The fragmented policymaking apparatus would probably collapse or stagnate if not for a number of unifying forces such as the omnipresent role of the Communist Party and to lesser degree political ideology.[346] Aside from that, the central government retains several levers, through which it disciplines subordinate units and imposes priorities on inferior ranks, such as the right of superior units to interfere in the affairs of the territorial governments one level down the national hierarchy within its area of jurisdiction.[347] This includes. In order to keep control over territorial

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[340] Ibid.

[341] Lawrence, S., & Martin, M. F. (2012). *Understanding China's political system. CRS Report for Congress*. Congressional Research Service.

[342] This means that Central government ministries have bureaus in the provinces, but they report both to their ministry in Beijing and to the provincial leadership. When priorities conflict, the leaders of such bureaus tend to put the provincial leadership's interests first, if only because the provincial leadership controls their careers.

[343] Shirk, S.L. (1992), The Chinese Political System and the Political Strategy of Economic Reform. In K.G. Lieberthal & D.M. Lampton (Eds.), *Bureaucracy, Politics, and Decision Making in Post- Mao China*. Berkeley, USA: University of California Press.

[344] Six Party Secretaries (provincial pendants to Party General Secretary) are concurrently members of the 25-member Politburo, China's highest decision-making organ.

[345] Although central government ministries have bureaus in the provinces, such bureaus tend to put the provincial leadership's interests over the functional interest, in accordance with the "making tiao serves kuai" principle.

[346] Pollack, J.D. (1992). Structure and Process in the Chinese Military System. In K.G. Lieberthal & D. M Lampton (Eds.), *Bureaucracy, Politics, and Decision Making in Post-Mao China* (pp. 153-180). Berkeley, USA: University of California Press.

[347] For instance, hierarchical superiors appoint their direct subordinate leaders; consequently, the Center appoints all provincial governors, vice governors, and party secretaries, while the provincial leaders then make comparable appointments at the next level, and so forth. The Center retains authority to approve or disapprove loans from all international financial institutions before those funds are made available for local projects. The Center establishes the regulatory environment, such as granting exemptions from specific regulatory requirements or loosening regulatory demands. The Center controls investment approvals for large projects, which can have significant economic re-percussions for various localities. The Center has the power to employ organs of coercion — the Public Security and State Security forces on the civilian side, in addition to the military — to bring recalcitrant localities into line. The Center can dispatch work teams (pendants to U.S. strike forces) into localities to investigate irregularities, remove offending officials, and clean up problems. For more information, see Lieberthal, K. (1997). China's

authorities, the Communist Party controls province appointments and promotions of all provincial Party Secretaries and governors, routinely rotating provincial leaders from province to province, and in and out of posts in Beijing, to ensure that they do not build up regional powerbases. Finally, Beijing's leverage over the provinces includes its ability to send the Party's Central Disciplinary Inspection Commission into provinces to investigate corruption allegations, and to send the General Auditor's Office into provinces to check their books.[348]

China's unique system of fragmented authority that entails a dichotomy between an apparently powerful central government and a unified system of governance versus fragmented and seemingly "disjoint bureaucratic structures" (p.22)[349] has led scholars to refer to China's political system as a *dual development state*,[350] *polymorphous state*[351] or *diffuse developmental state*.[352]

3.3.3 Agenda Setting and Policy Preferences

Policymaking begins with the stage of *problem representation* and *agenda setting*, which in the Chinese context is mostly determined by the cognitive approaches of the decision makers.[353] Although agenda setting in the past was a privilege granted to only the highest preeminent leaders (such as Mao Zedong and Deng Xiaoping), policy initiation and agenda setting today have become participatory and pluralized process.[354] Although the final decision remains to be a privilege of China's ruling elite, the ideas that stipulate policy initiation and innovation often originate from lower ranking institutions and hierarchies. The political elite is therefore far from being a key initiator of policy but instead receives policy ideas and innovations from lower-ranking institutions. Policy choices are thus inevitably interwoven with the *ideology, visions* and *political agenda* of China's political elite. These ideological foundations themselves, however, have also been subject to substantial change as reflected in the four state *constitutions* (*Zhonghua renmin gongheguo xianfa,* from 1954, 1975, 1978, 1982), which have slowly transitioned from emphasizing *class struggles* (1975 and 1978 constitutions) to a more market-oriented approach and *modernizing China's economy* (1982 state constitution).[355] Lieberthal and Oksenberg

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governing system and its impact on environmental policy implementation. *China Environment Series*, *1*(1997), 3–8.

[348] Saich, T. (2011). Governance and Politics of China. In *Governance and Politics of China (review)* (3rd ed., pp. 1–448). New York, USA: Palgrave Macmillan.

[349] Andrews-Speed, P. (2010). The Institutions of Energy Governance in China. Paris, France: Institut français des relations internationales (Ifri).

[350] Xia, M. (2003). *The Dual Developmental State: Development Strategy and Institutional Arrangements for China's Transition* (2nd ed.). London, UK and New York, USA: Routledge. http://doi.org/10.2307/3182205.

[351] Howell, J. (2006). Reflections on the Chinese State. *Development and Change*, *37*(2), 273–297. http://doi.org/10.1111/j.0012-155X.2006.00478.x

[352] Shirk, S.L. (1992). The Chinese Political System and the Political Strategy of Economic Reform. In K.G. Lieberthal & D.M. Lampton (Eds.). *Bureaucracy, Politics, and Decision Making in Post- Mao China*. Berkley, USA: University of California Press; Goodman, D.S.G (1999). The New Middle Class. In M. Goldman, & R. MacFarquar (Eds.), *The Paradox of China's Post- Mao Reforms* (pp. 241-261). Cambridge, USA: Harvard University Press.

[353] Meidan, M., Andrews-Speed, P., & Xin, M. (2009). Shaping China's Energy Policy: actors and processes. *Journal of Contemporary China, 18*(61), 591-616.

[354] See for instance Mertha, A. (2009). Fragmented Authoritarianism 2.0: Political Pluralization in the Chinese Policy Process. *The China Quarterly*, *200*, 995–1012. http://doi.org/10.1017/S0305741009990592.

[355] Emmerich, R., Cabestan, J. P., Heilmann, & S., Schubert, G. (2008). Stichwort Politisches System. In B. Steiger, S. Friedrich, H. W. Schütte, & R. Emmerich (Eds.). *Das große China-Lexikon-Geschichte, Geographie, Gesellschaft, Politik, Wirtschaft, Bildung, Wissenschaft, Kultur*. Darmstadt, Germany: Wissenschaftliche Buchgesellschaft.

(1988)[356] denote that agendas and policy interests among specific levels of China's power apex are highly heterogeneous especially among the levels of top leaders, the commissions and ministries. According to them, the highest leaders assume the perspective of national interest and make decisions in line with their responsibility and concerns with national interest, past experience and the game of politics in general. Among the top leaders exists a small fraction of *functional specialists* (such as ministers) who assume a more parochial perspective that aligns more with their functional duties, bureaucratic responsibilities, the official position and organizational rule of their specific bureaucratic unit.

The importance of cognition in policy choices warrants a closer look at the ideology and visions that guide China's policymaking. China's political system and institutional setting is oftentimes referred to as *centralized socialist party dictatorship.*[357] China's political system amalgamates central characteristics from the Soviet model of centralized state planning with distinct Chinese features. It has been subject to major reforms since the late 1970s, during which it shifted from an early Soviet-based prototype of total control in political, economic, societal and private spheres towards a more liberal and market-based model. Although the Communist Party of China (CPC) has been continually in power since 1949, its ideological and cultural foundation has been subject to substantial modification as a necessary response to the collapse of Communism in Eastern Europe in 1989, the disintegration of the Soviet Union in 1990, the Tiananmen Protests in Beijing 1989, and the death of Deng Xiaoping in 1997. This malleability and adaptability have become an invariable feature of the CPC decision-making, justified by Former General Secretary Jiang Zemin with the following argument:

> "The […] Party must always maintain the spirit of advancing with the times and constantly extend Marxist theory into new realms, […] break new ground and open up a new prospect in the modernization drive […] and constantly inject new vitality into itself" (Jiang Z. (1996)*,* p.879)[358]

China's political and ideological system today can be described as "*Consultative Leninism*" (p.865),[359] which describes a highly dynamic model that amalgamates *resilience*, *adaptability* and *flexibility* to cope with its surrounding environment and growing uncertainties in the national and global arena. The *Consultative Leninism* is based on the following pillars: [360]

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356 Lieberthal, K., & Oksenberg, M. (1988). *Policy Making in China: Leaders, Structures, and Processes*. Princeton, USA: Princeton University Press.

357 Emmerich, R., Cabestan, J. P., Heilmann, & S., Schubert, G. (2008). Stichwort Politisches System. In B. Steiger, S. Friedrich, H. W. Schütte, & R. Emmerich (Eds.). *Das große China-Lexikon-Geschichte, Geographie, Gesellschaft, Politik, Wirtschaft, Bildung, Wissenschaft, Kultur*. Darmstadt, Germany: Wissenschaftliche Buchgesellschaft.

358 At that time, the concept of the *Three Represents*. When Hu Jintao took over from Jiang, he gradually replaced the concept of the Three Represents with the idea of promoting a Socialist Harmonious Society which should feature "democracy, the rule of law, equity, justice, sincerity, amity and vitality" to produce "lasting stability and unity". Hu Jintao's concept of a Socialist Harmonious Society was therefore sign that the government would relinquish some of its control over the private sphere provided that the Party's monopoly remains unchallenged. Both Jiang Zemin and Hu Jintao concepts are sign of the ideological malleability that is characteristic of the CPC's Consultative Leninism. Jiang Z. (1996). *The Three Represents.* Beijing, China: Foreign Languages Press.

359 Tsang, S. (2009). Consultative Leninism: China's new political framework. *Journal of Contemporary China 18*(62), 865-880.

360 Ibid.

i) *Supremacy*, which refers to the CPC's obsessive focus to stay in power, for which maintaining stability in the country and pre-emptively eliminating threats to its political supremacy are deemed essential;
ii) *Reform*, which refers to the CPC drawing legitimacy from concrete reform plans both within the CPC and in the state apparatus in order to pre-empt public demands for democratization;
iii) *Adaptability*; which refers to the CPC's capacity to elicit, respond to and manipulate public opinion;
iv) *Economy*, which refers to CPC's strong devotion to sustained and rapid growth and economic development at all cost (even at ideological costs) as this serves as the main source of legitimacy for the CPC; and
v) *Nationalism* and *patriotism*, which refers to the encouragement of nationalism and national pride through the upholding of enemy images and state propaganda and which the CPC perceives as "the most reliable claim to the Chinese people's loyalty" (p.134).[361]

Last but not least, Heilmann and Perry (2011)[362] argue that China's proclivity for adapting to its surrounding is rooted in the CPC's revolutionary past. They argue that in the course of the protracted process, which took the Communists from the major cities into the rural hinterland and on a Long March from the southern to the northern regions of the country, the Chinese Communist Party gained invaluable lessons in adapting to a wide range of different environmental conditions and challenges. It is these rich revolutionary experiences and the array of "creative - proactive as well as evasive" (p.7)[363] tactics for managing sudden change and uncertainty that have persisted until to this day and that promote a "guerrilla-style policy-making" (p.1).[364] Heilmann and Perry (2011)[365] therefore argue that China's policymaking style is far from being that of a rigid, top-down or command-and-control regime, but instead is very sensitive towards the behavioral and cognitive readiness of its people to venture forth into unfamiliar environments. It should be noted, however, that such guerilla-style adjustments may also include ruthlessness and repressive methods of what remains essentially an anti-democratic, Leninist, elite organization.[366]

3.3.4 Policy Processes and Bargaining

The fragmentation of authority promotes a system of extensive *negotiation*, *competition*, *bargaining*, and *haggling* at all levels of policymaking to *achieve the necessary consensus* that is required to transfer policy issues to the national agenda. According to the administrative rules, units of equal rank are not authorized to issue binding orders to one another and not can they demand coordination with each other, as shown in Figure 5. Accordingly, bureaucratic units of same rank have no other choice than to "sit down at the bargaining table as equals: ministries with

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[361] Zhao, S. (2005). China's pragmatic nationalism: is it manageable? *The Washington Quarterly, 29*(1), 131-144.
[362] Heilmann, S., & Perry, E. J. (Eds.). (2011). Embracing Uncertainty: Guerrilla policy style and adaptive governance in China. Mao's Invisible Hand: The political foundations of adaptive governance in China (1st ed., Vol. 17). Cambridge, USA/ London, UK: Harvard University Asia Center. http://doi.org/10.2307/j.ctt1sq5tc.
[363] Ibid.
[364] Ibid.
[365] Ibid.
[366] Lawrence, S., & Martin, M. F. (2012). *Understanding China's political system. CRS Report for Congress*. Congressional Research Service.

provinces; bureaus with prefectures; and divisions with cities and counties" (p. 93-94).[367] If administrative units are unable to reach consensus, the policy issue at stake is either dropped (causing political gridlock)[368] or is referred to the very top of the government hierarchy for resolution (such as the level of commissions and the State Council).[369] Similarly, entities of lesser administrative rank seeking to coordinate with an entity of higher rank are faced with a "daunting challenge" (p.16).[370] Negotiation and bargaining also takes place between superiors and subordinate ranks, as superior units grant their subordinate counterparts just enough flexibility to enable them to develop their economy and to maintain social and political stability.[371] Here Lieberthal (1997) connotes that "at every level, key officials spend an enormous amount of time negotiating for additional flexibility and trying to devise ways to keep higher levels from becoming overly restrictive." (p.4-5)[372] Concomitant features of the fragmented authority include *fierce competition and limited informational flows* among political actors with equal rank for recognition from superior officials, scarce budget resources and so forth.[373] Another implication of the fragmented authority is that *communication flows exist* only within a *specific hierarchy and jurisdiction*, a phenomenon known as "stove-piping. It refers to the convention that individual ministries and other hierarchies share information only one level up or down their functional or territorial hierarchies, but not horizontally and with each other.

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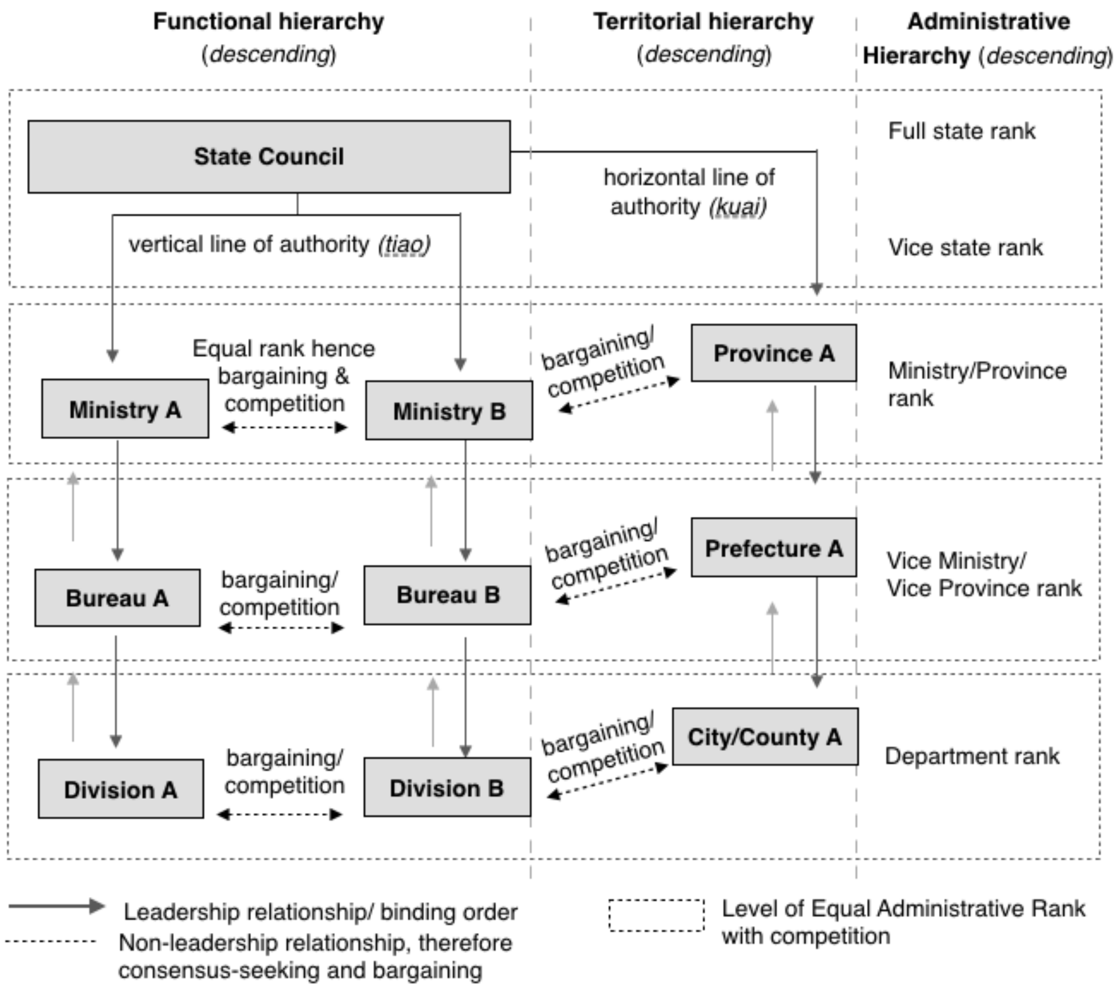
[367] Shirk, S. L. (1993). *The political logic of economic reform in China*. Berkeley, USA: University of California Press.
[368] Ibid.
[369] Lieberthal, K. (1997). China's governing system and its impact on environmental policy implementation. *China Environment Series*, *1*(1997), 3–8.
[370] Lawrence, S., & Martin, M. F. (2012). *Understanding China's political system. CRS Report for Congress*. Congressional Research Service.
[371] Lieberthal, K. (1997). China's governing system and its impact on environmental policy implementation. *China Environment Series*, *1*(1997), 3–8.
[372] Ibid.
[373] Lawrence, S., & Martin, M. F. (2012). *Understanding China's political system. CRS Report for Congress*. Congressional Research Service.

Figure 5 Diagram of Bargaining, Consensus Seeking and Bureaucratic Rank in China[374]



Source: Author, based on Lieberthal (1997)

Fragmentation of authority also has significant implications for agenda setting and decision-making, which go through three distinct phases.[375] First, policy initiatives circulate as drafts within the relevant state ministries and authorities to mobilize sufficient allies and support from the relevant ministries and agencies. This implies that policy *drafts* circulate within the state bureaucracies and undergo substantial refinement and reworking. Once sufficient support has been mobilized, the initial draft is promulgated to the public as a *decision,* which provides the policy initiative with the necessary sufficient clout to overcome and remove bureaucratic barriers and obstacles. This stage is known as *fangzhen*, which indicates that political consensus is reached among the top leaders (Politburo) and that provides the general direction and framework in which bureaucratic activity should move. In practice, this policy process implies that "top political leaders announce a bold initiative before its details have been decided or before its ramifications

[374] Author, based on Lawrence, Lawrence, S., & Martin, M. F. (2012). *Understanding China's political system. CRS Report for Congress*. Congressional Research Service.; Mertha, A. (2009). Fragmented Authoritarianism 2.0: Political Pluralization in the Chinese Policy Process. *The China Quarterly*, *200*, 995–1012. http://doi.org/10.1017/S0305741009990592.

[375] Lieberthal, K. (1997). China's governing system and its impact on environmental policy implementation. *China Environment Series*, *1*(1997), 3–8.

are well understood" (p.229).[376] For new policy initiatives to reach this step, they often require the firm and enthusiastic support from one or more top leaders[377]. The publicity that top leaders attach to this new orientation and goal becomes a tactic for generating support and creating a sense of certainty to its realization.[378] Nevertheless, this stage "does not by itself ensure that the substance of the decision will be implemented" (p.25).[379] In subsequent months and years, policy initiatives enter the third and final step, during which activities and concrete policies (*zhengce*) are fleshed out. This step usually involves negotiations and bargaining between government agencies or provincial authorities, leaving enough room for various bureaucracies to manipulate the policy process on their turfs or to shape policies favorable to their particular interest.[380] Sometimes, these protracting dynamics may bear constructive results, but in other times they may lead modest programs or policies to eventually become "non-decisions" (p.25).[381] Policymaking in China is therefore a *complex, arduous and protracted process* that requires *consensus from top leaders* and involves *extensive negotiation, bargaining, exchange, and consensus seeking at lower levels of the power hierarchy.*[382] China's policymaking system is thus "held together by a formal structure of authority, by the networks of individuals bound by mutual obligations and loyalties who are embedded in the formal organization, and by the total web of bargains among hundreds of thousands of units which comprise the system" (p.26).[383] China's vast and bureaucratically fragmented political system enables therefore policy processes that allow for a great amount of bottom-up input, which some scholars believe to have been key to the country's *political resilience and adaptive governance.*[384]

Last but not least, fragmentation and the influence of distinctive hierarchies also extends to the legal framework. There are national laws, ministerial regulations, guiding opinions, measures and procedures, local rules and regulations, self-regulation rules of the industry and internal governance rules for each of the state-owned power companies and grid companies. Interestingly, use is also made of the concept of 'trial' rules and procedures, whereby new concepts are introduced for stakeholder comment, before becoming fully effective. The national laws provide broad guidance and are procedurally more difficult to amend. Accordingly, it is the secondary regulations and rules that truly drive the reforms in the industry.

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[376] Lieberthal, K., & Oksenberg, M. (1988). *Policy Making in China: Leaders, Structures, and Processes.* Princeton, USA: Princeton University Press.

[377] Policy initiatives are likely to gain support from top leaders if one the following requirements are fulfilled: (i) the natural interest of individual top leaders in specific policy issues (e.g. historic and personal connections), (ii) urgency or seriousness are specific policy issues (e.g. natural disasters or concerns with national security), (iii) the imposing through powerful bureaucracies, (iv) present and implicit pressure through the presence of foreigners (e.g. major foreign firms may require very high-level assurances before they commit to a particular project or obtain audiences with the highest level of Chinese leaders); or (v) Procedural requirements, specifically for budgetary commitments, that require approval from the State Council.

[378] Lieberthal, K., & Oksenberg, M. (1988). *Policy Making in China: Leaders, Structures, and Processes.* Princeton, USA: Princeton University Press.

[379] Ibid.

[380] Ibid.

[381] Ibid.

[382] Ibid.

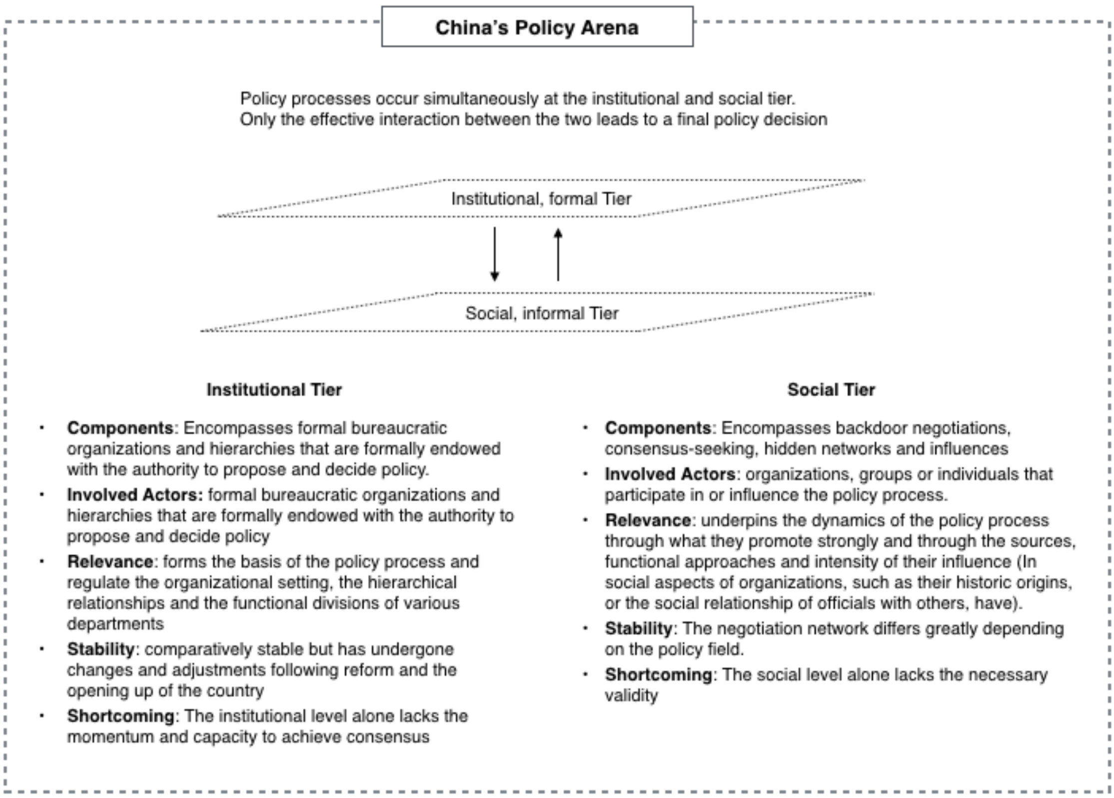
[383] Ibid.

[384] Heilmann, S., & Perry, E. J. (Eds.). (2011). Embracing Uncertainty: Guerrilla policy style and adaptive governance in China. Mao's Invisible Hand: The political foundations of adaptive governance in China (1st ed., Vol. 17). Cambridge, USA/ London, UK: Harvard University Asia Center. http://doi.org/10.2307/j.ctt1sq5tc.

3.3.5 China's Two-Tier Policy Arena

As a consequence of this fragmentation, multiple centers of power and influence exist within China's governance arena. Given the strong social component to policy processes, the policy arena can be divided into two layers, a *formal, institutional tier* and *an informal, social tier*.[385] The *institutional tier* encompasses the formal bureaucratic organizations and hierarchies that are formally endowed with the authority to propose and decide policy. They are the basis of the policy process and regulate the organizational setting, the hierarchical relationships and the functional divisions of various departments. They thus control which departments develop policy, what procedures policies follow and finally how policies are issued and executed. This formal institutional tier has been comparatively stable but has undergone changes and adjustments following reform and the opening up of the country. The bureaucratic organizations on the institutional level formally regulate the policy process, in which process policy pressure, the conveying and converging of opinion, and the achieving of consensus follow a definite procedure.

Figure 6 Diagram of China's Two-Tier Policy Arena[386]



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[385] Chen, L. (2008). Bureaucratic System and Negotiation Network: A Theoretical Framework for China's Industrial Policy. In *OECD Reviews of Innovation Policy: China* (pp. 597-612). Paris, France: Organization for Economic Co-operation and Development (OECD).

[386] Author, based on Lieberthal, K., & Oksenberg, M. (1988). *Policy Making in China: Leaders, Structures, and Processes*. Princeton, USA: Princeton University Press; Lawrence, S., & Martin, M. F. (2012). *Understanding China's political system. CRS Report for Congress*. Congressional Research Service.

Source: Author, based on Chen, L. (2008). Bureaucratic System and Negotiation Network: A Theoretical Framework for China's Industrial Policy. In OECD Reviews of Innovation Policy: China (pp. 597-612). Paris, France: Organization for Economic Co-operation and Development (OECD).

By contrast, the *social tier* constitutes China's "informal politics", [387] such as backdoor negotiations, consensus-seeking, hidden networks and influences by organizations, groups or individuals that participate in or influence the policy process. In social aspects of organizations, such as their historic origins, or the social relationship of officials with others, have underpinned the dynamics of the policy process through what they promote strongly and through the sources, functional approaches and intensity of their influence. The negotiation network differs greatly depending on the policy field and is generally classified according to the degree to which the various actors participate in the three policy process levels: decision-making, formulating and influencing. The policy negotiation network on the social level provides the policy process with momentum; its mode of applying policy pressure or of conveying opinion and achieving consensus is generally discontinuous.

China's policy processes occur simultaneously at the institutional and social tier. The bureaucratic organizations on the institutional level formally regulate the policy process, in which process policy pressure, the conveying and converging of opinion, and the achieving of consensus follow a definite procedure. Only an effective interaction between the two leads to a final policy decision as the institutional level alone lacks momentum and the capacity to achieve consensus on its own, while the social level alone lacks the necessary validity.

3.3.6 Policy Categories and Legal Framework

China's legislative framework is at a relatively nascent stage given its short history. Through much of China's history there was essentially no legislative body and no separate judicial system as these functions and responsibilities were always given to administrative officials at various levels.[388] The legal system developed mostly since China's open door policy in the 1978 and led to a "desperate mass of laws and regulations" (p. 711)[389] intended to fill the "legal vacuum in man sectors of society and economy".[390] The "chronic disorder of Chinese legislation" (p.711)[391] is attributed to several factors, such as (i) the absence of comprehensive legal frameworks; (ii) the multitude of issuing authorities; (iii) the fact that many laws and regulations adopted since the early 1980s have been overtaken by events which have rendered them ineffective; (iv) inconsistent laws; and (v) the fact that law often serve only as general guidelines that pave the way for subsequent policies and regulations at lower bureaucratic levels.[392] Moreover, most laws and regulations, which make the written sources of Chinese law does not possess sufficient unity to be regarded as a coherent body of law.

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[387] Tsou, T. (1976). Prolegomenon to the Study of the Informal Groups in CCP Politics. *The* China Quarterly, 65, 98-114.
[388] Andrews-Speed, C. P. (2004). *Energy Policy and Regulation in the People's Republic of China*. The Hague, London, New York: Kluwer Law International.
[389] Keller, P. (1994). Sources of order in Chinese law. *The American Journal of Comparative Law*, 42(4).
[390] Andrews-Speed, C. P. (2004). *Energy Policy and Regulation in the People's Republic of China*. The Hague, London, New York: Kluwer Law International.
[391] Keller, P. (1994). Sources of order in Chinese law. *The American Journal of Comparative Law*, 42(4).
[392] Ibid.

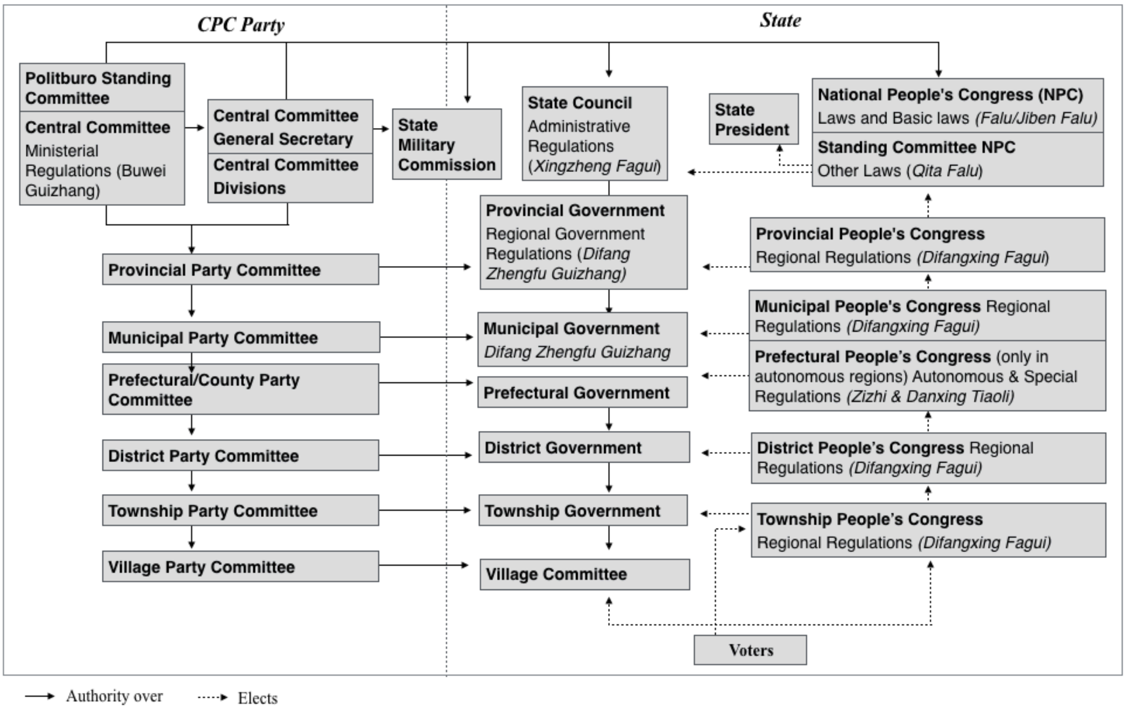
Despite these shortcomings, China's political system is surprisingly document-oriented. Signed documents serve as testimony of the approvability and consensus among policy makers.[393] A corollary of is that the oral statements of individual leaders are considered less decisive than documents officially approved and stamped by the collective leadership (that is CPC Central Standing Central Committee).[394] Officially there exist six types of policies:

1. Laws and basic laws (*Falu/ Jiben Falu*): Laws passed by the NPC or the Standing Committee of the NPC. They are legally binding on legislation by the State Council and on subordinate level People's Congresses and provincial and local governments. Although the State Council and individual ministries can issue lower-level policies, all laws much be approved by the NPC.
2. Administrative regulations *(Xingzheng Fagui)*: Regulations passed by the State Council. These are legally binding on ministries under the State Council and provincial and local governments.
3. Regional regulations *(Difangxing Fagui)*. Passed by lower-level People's Congresses of the provinces, autonomous regions, and the municipal areas directly under the Central Government's control (Beijing, Shanghai, Tianjin, Chongqing).
4. Ministerial regulations or rule (*Buwei Guizhang*). Passed by the central ministries and commissions under the State Council. Individual ministries generally have authority to pass rules that govern matters within the scope of authority awarded to them by the State Council.
5. Regional government regulations (*Difang Zhengfu Guizhang*). Passed by the local governments at the provincial level, and within the autonomous areas and municipalities.
6. Specific regulations and Special Autonomous regulations (*Zizhi & Danxing Tiaoli)*. Passed by the People's Congresses of local autonomous areas.

The provision of general guidelines and overall direction towards which government activities and efforts should proceed (*fangzhen)* are communicated only through laws, basic laws and administrative regulations approved by the NPC, NPC Standing Committee and State Council. Last but not least, the government also issues mid- and long-term policies, which are a legacy of the centrally-planned economy. At five-year intervals, the Communist Party General Secretary presents a report to the Party Congress outlining the Party's priorities for the country. These Five-year Plans (FYP) serve as blueprints that indicate the country's overall social, economic, and political goals, priorities and agendas for the next five years[395] Although FYPs are not followed to the letter, they have a powerful role in guiding official policy and paving the way for specific and concrete policy measures taken by lower level ministries, governments and commissions. In accordance with the national FYPs, lower level officials and authorities then formulate roadmaps and development plans for their specific sector.

[393] Lawrence, S., & Martin, M. F. (2012). *Understanding China's political system. CRS Report for Congress*. Congressional Research Service.
[394] Ibid.
[395] Ibid.

Figure 7 Legislation Categories in China's Administrative and Political System



Source: Author, based on Emmerich, R., Cabestan, J. P., Heilmann, S., & Schubert, G. (2009). Das Politische System der VR China. In B. Staiger, S. Friedrich, H. W. Schütte, & R. Emmerich (Eds.), *Das große China-Lexikon: Geschichte, Geographie, Gesellschaft, Politik, Wirtschaft, Bildung, Wissenschaft, Kultur* (2nd ed., pp. 573–581). Darmstadt, Germany: Wissenschaftliche Buchgesellschaft (WBG).

3.4 Summary and Hypothesis

China remains in many aspects a *Black Swan* challenge to social sciences, challenging not only conventional wisdom but also conventional models of political change.[396] Contemporary theories of policy processes and policy change have traditionally originated from the western, pluralist contexts and have repeatedly failed to grasp the complexity and uniqueness of China's policy systems. This study thus combines two distinct models and theories to develop an explanatory framework through which to examine solar policies in China.

PET Theory. PET builds upon the presumption that there are two types of policy change, both incremental adjustments within policy subsystems and non-incremental policy punctuations. Policy patterns describe a constant transition between prolonged periods of minimal and incremental policy changes (*equilibrium*) and short-lived periods of disequilibrium, during which profound policy change occurs (*punctuations*). Stasis and incremental policy changer, rather than crisis, typically characterizes most policy areas. The mechanisms that induce stability and homeostasis are strong negative feedback processes, dominant policy images/symbols in favor of the policy monopoly, stable institutions, and parallel information processing that mainly takes place in policy subsystems. Contrary to this, the mechanisms that reinforce policy change are

[396] Heilmann, S., & Perry, E. J. (Eds.). (2011). Embracing Uncertainty: Guerrilla policy style and adaptive governance in China. Mao's Invisible Hand: The political foundations of adaptive governance in China (1st ed., Vol. 17). Cambridge, USA/ London, UK: Harvard University Asia Center. http://doi.org/10.2307/j.ctt1sq5tc.

positive feedback forces, weak institutions with diffused jurisdictional boundaries and overlapping responsibilities, serial information processing at the macro-political level, the opening of windows of opportunity that result from triggers (either occurring as single large events or an accumulation over time), successful venue shopping, and the entering of new policy actors that introduce new policy images.

Punctuations and Policy Change. Policy changes can occur to varying degree and scope. Hall (1997) distinguishes three types of policy changes: *First Order Changes*, are those that lead to the adjustment and change of policy instruments as the result of experience, social learning and new knowledge, while the overall goals and instruments of policy remain the same. *Second order changes* are those that lead to the introduction of new instruments resulting from social learning mainly within the state itself (*second order policy changes)*. And *third order changes* are those that lead to entirely new sets of goals and systems (paradigms) resulting from social learning across the entire society. The first the and second order change are likely to be associated with incremental policy change, whereas the third closely associated with new paradigm and social learning across all levels of society. Punctuations and abrupt policy changes are inherently linked to the flow of information and prioritization of policy action. Policymakers, as boundedly rational decision makers with human cognitive constraints, must selectively focus on some issues while neglecting others. This selective attention process has critical consequences for policymaking, and especially how the political system prioritizes problems for policy action. PET theorists contend that the key question is how policymakers prioritize issues for action given the flow of information into the system. Both the bounded rationality of political actors and the resistance to change structured in most governmental system imply that the processing of information is disproportionate, hence the system will tend to shift from underreacting to overreacting to information.[397] This tendency toward the disproportionate processing of information means that problem prioritization will be stable for most of the time because the resistance will not be overcome by the flow of information. Hence, the policymaking process will appear to be stable and unchanging. When policies change, they will shift in a disjoint and episodic manner; as a consequence, policymaking will appear to be in a period of exception to the general rule of stability—or simply responding to unspecified "exogenous forces". But in fact the disjoint policy responses are part and parcel of the same policymaking process that generated the periods of stability. In a not-unfamiliar story line, a problem festers "below the radar" until a scandal or crisis erupts; policymakers then often claim "nobody could have known" about the "surprise" intervention of exogenous forces, and then scramble to address the issue.

Agenda Levels. PET's agenda-setting perspective recognizes the critical role of information in the policy process. Problem definition does not generally occur in a vacuum; it occurs when the flows of information indicate that a situation is worthy of governmental attention. An agenda-setting perspective takes one step back in the process, attending to the choice of issues that become the grist for political conflict. Because we look at issues over a long enough time frame, we can observe changes in attention patterns to issues, not just the selection of solutions. PET emphasize the great availability of information in most policymaking realms. Policymakers are bombarded with diverse information from many different sources, with varying reliabilities. Much of this information has implications for the prioritization of policy action. Policymakers, as boundedly rational decision makers with human cognitive constraints, focus on some of this information and

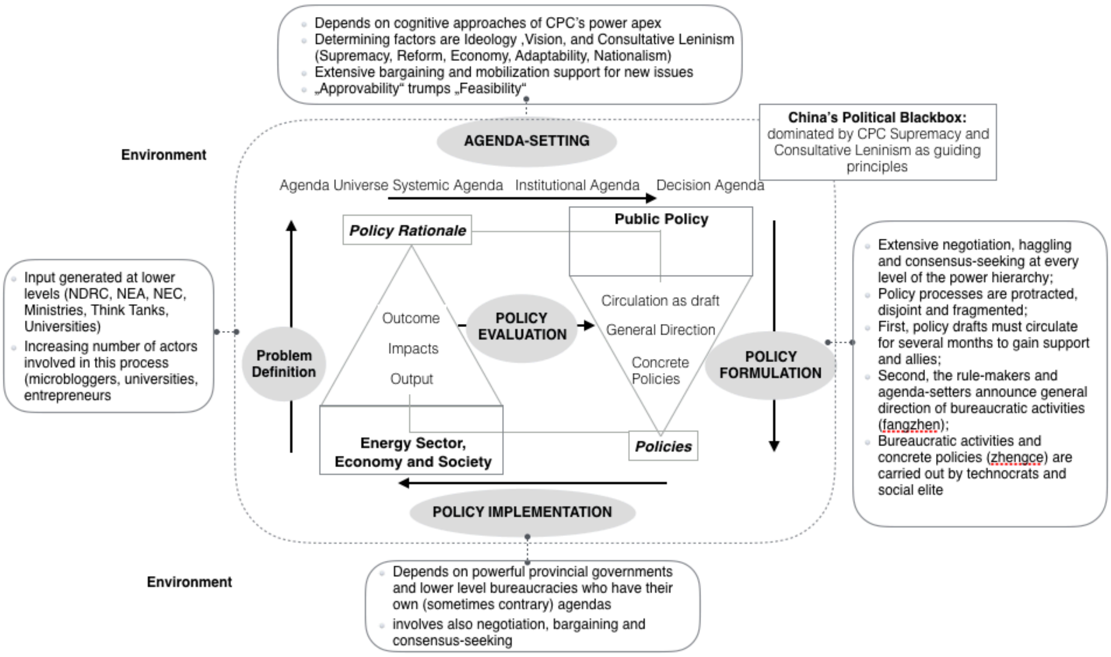
[397] Jones, B. D., & Baumgartner, F. R. (2012). From there to here: Punctuated equilibrium to the general punctuation thesis to a theory of government information processing. *Policy Studies Journal*, *40*(1), 1-20.

ignore most of it. This selective attention process has critical consequences for policymaking, and especially how the political system prioritizes problems for policy action.
Decision-making in China. China features a distinct upward mobility of issues in the political agenda depends on the amount of attention issues receive from political decision-makers. In China, before new policy issues emerge and materialize into policy, they must transcend the boundaries that separate the agenda universe, systematic agenda, institutional agenda and decision agenda by means of serial shifts and serial information processing at the macro-political level. In China, given the importance of consensus, "approvability" of a policy scheme trumps its "feasibility". In order to reach the agenda level, policy issues require strong and empathetic support from top leaders to overcome the bureaucratic barriers and protracting forces that impede new policy initiatives. In China Agenda setting will arguably align with the overall ideology and vision that is stated in official documents. Paradigm changes and the emergence of new images within China's ruling elite can be best studied through the political campaigns and the Five-Year Plans as these reflect the policy priorities and paradigms that serve as guidelines for all other government activities.

The FA Model. PET contends that policymaking as a continual struggle between the forces of balance and equilibrium, dominated by negative feedback processes, and the forces of destabilization and contagion, governed by positive feedback processes. In China and given the presence of backdoor negotiations, haggling, consensus seeking and the distorting influence of bureaucratic rank, issue networks and subsystems are likely to be less discernible and transparent than in other political systems. In general, China features an extensive number of subsystems (functional and territorial clusters with specific interest and agendas), which are arranged along the lines of functional and territorial ranks and authorities. In terms of decision-making, China applies a complicated and (oftentimes confusing) systems of bureaucratic rank, which defines specific rules of decision-making and authority. Throughout the course of decentralization and *de facto federalism,* territorial lines of authorities have gained significant influence ("making tiao serve kuai" principle), occasionally leading to competition and friction between local and central agendas and interests. The fragmented authority combined with bureaucratic rank promotes a system of extensive *negotiation*, *bargaining*, *exchange and consensus seeking* at every level of the policy process and political hierarchy. To ensure a smooth functioning despite the fragmented policymaking apparatus and extensive bargaining at every level of the power hierarchy, the Communist Party and to lesser degree political ideology serve as unifying forces that are able to avert policy gridlocks and non-decision by means of coercion and disciplinary actions.[398] In China, consensus seeking among fragmented authorities main purpose of policy process. Policy processes are a complex, arduous and protracted process that requires consensus from top leaders and involves extensive negotiation, bargaining, exchange, and consensus seeking at lower levels of the power hierarchy, leading to *protracted*, *disjointed* and *incremental policies*. Policymaking in China does therefore not align to the strict top-down decision-making scheme, but rather goes through a three-step process involving (i) the mobilization of policy support and allies, (ii) the announcement of the general direction (*fangzhen*) and (iii) developing the actual policies (*zhengce*). Approvability and consensus of a policy scheme trumps its "feasibility".

[398] Pollack, J.D. (1992). Structure and Process in the Chinese Military System. In K.G. Lieberthal & D. M Lampton (Eds.) *Bureaucracy, Politics, and Decision Making in Post-Mao China (*p. 153-180). Berkeley, USA: University of California Press.

Figure 8 Analytical Concept of Policy Processes in China



Source: Author

The abovementioned descriptions and presumptions lead us to our three *assumptions*, which are stated as follows:

- **Hypothesis I**: Solar energy issues surpassed four distinct levels of the agenda, from universe, systematic, institutional to decision agenda.
- **Hypothesis II**: Solar energy policies in China progress in the pattern described by the PET. In this pattern, extended periods of equilibrium, during which only incremental policy changes occur, are occasionally interrupted by policy punctuations that cause decision-makers to embark on dramatically new policy paths.
- **Hypothesis III:** Prior to the recent dynamics of solar energy, policy change was mostly incremental and in the state of equilibrium. This implies strong policy monopolies, dominant policy images, parallel information processing distributed among subsystems, and homogenous interests in subsystems.
- **Hypothesis IV:** The recent dynamics in solar policy in China are policy punctuations and are therefore preceded by a larger paradigm shift towards renewable energies, social learning across society, new policy images in favor of solar energy, weak institutions, heterogeneous interests in subsystems, and serial information processing at the macro-political level.

PART 4 Setting the Stage: Framework of Solar Energy Policy

This chapter provides a brief but comprehensive discussion about the technological basics, potentials and challenges that surround solar PV systems in China. The purpose of this chapter is to examine the *rationale* behind solar energy policies in China and to shed light on the distinct policymaking *structures* and *actors* that shape energy policies in China.

4.1 Solar PV Technologies: Characteristics, Application and Utilization

When political changes involve the introduction of new and innovative technologies, it is necessary -while analyzing the policy process to look at technology specifics.[399] As a factor in the progression, technology can have significant impacts on the political process. These potential impacts are indicated in Chapter *Theoretical Approach*, which states that negative emotions and symbols associated with new technologies can lead to public arousal, bias and - in the worst case - public refusal (an example is the *Not in my back yard* (NIMBY) phenomenon). This can substantially hinder and even paralyze a policy process. On the other hand, broad public acceptance and support can accelerate the policy process and lead to distinct windows of opportunity.[400] Moreover, understanding the technological specifics of so-called *new technologies* (as opposed to *old technologies* and conventional fossil fuels) allows for a greater distinction between solar policy subsystems and conventional energy subsystems and may provide an explanation for the dominance of one over the other. Therefore, this chapter serves to describe the distinct technological features of the solar energy policy in order to understand what sets it apart from conventional energy subsystems, how it challenges conventional technologies, and why it is perceived as an innovative technology.

4.1.1 Basic characteristics of solar PV systems

The word "*Photovoltaic*" is derived from the Greek word *Photo,* which means light in English and *Volt*, which refers to the electricity pioneer Alessandro Volta. Photovoltaic solar systems produce electricity and therefore distinguish themselves from solar thermal systems that produce heat. Photovoltaic (PV) modules are made up of interconnected PV cells that convert solar radiation (*photons*) into electricity (*voltage*). PV cells consist of two differently doped semiconducting materials, which are placed in close contact with each other. This produces an electrical current when exposed to sunlight. The sunlight provides the electrons with the necessary amount of energy to depart from their bounds and cross the junction between the two materials. This occurs more easily in one direction than in the other and gives one side of the junction a negative charge with respect to the other side (p-n junction), thus generating a voltage and a direct current (DC). This process is known as *Photovoltaic (PV) effect*[401] and has most commonly been generated with materials such as crystalline silicon (c-Si) and a range of thin-film semiconductors,[402] which are described in the next subsections. Given that the majority of

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[399] Sabatier, P., & Jenkins-Smith, H. C. (Eds.). (1993). *Policy change and learning: An advocacy coalition approach*. *Journal of Policy Analysis and Management*. Boulder, USA: Westview Press. http://doi.org/10.1002/pam.4050150111.

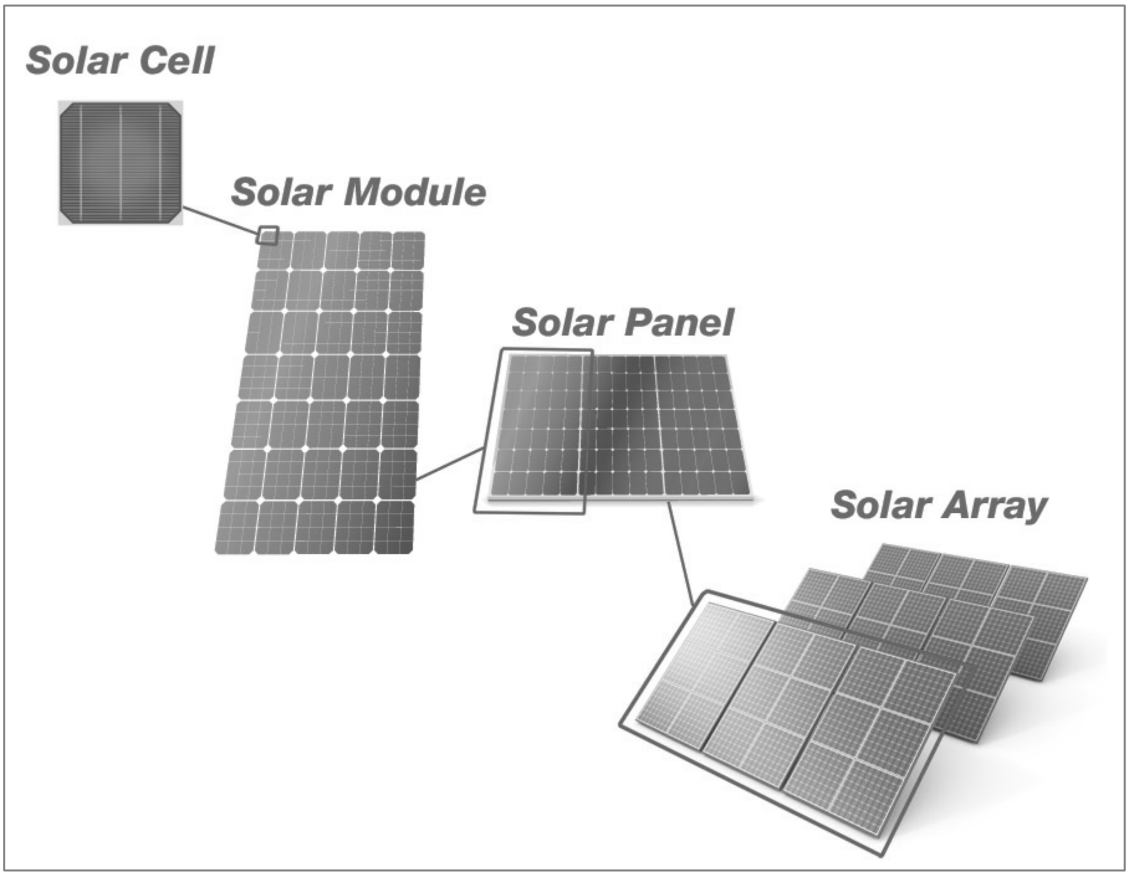
[400] Hirschl, B. (2008). *Erneuerbare Energien-Politik*. Wiesbaden: VS Verlag für Sozialwissenschaften. http://doi.org/10.1007/978-3-531-90890-8

[401] The PV effect was first observed in 1839 by the French physicist Alexandre Edmund Becquerel, which was followed by the first solar PV device in 1954 by scientists at Bell Labs in the United States.

[402] Semiconductor is the material that converts sunlight into electricity

electrical applications require alternating-current (AC) electricity, solar PV modules are additionally equipped with an *inverter* to convert and condition DC electricity into AC electricity suitable for customer use or transmission and a *transformer* to step the electricity up to the appropriate voltage. Additionally, PV modules are equipped with auxiliary components known as *Balance of System* (BOS). The BOS includes mounting, wiring and tracking hardware that help align the solar module surface in the direction of the sun (via tilted angle and tracking).
PV systems consist of several components; the smallest electric unit of a photovoltaic system layered semi-conducting material (*solar cell)*[403]. In order to boost the power output of PV cells, 40-72 solar cells are typically interconnected into so-called *solar modules*[404]. These solar modules in turn can be connected to form even larger *solar arrays*, which can be interconnected to produce more power, and so forth. In this way, PV systems can be built to meet almost any electrical requirement, ranging from the energy demands of individual electrical devices to those of an entire community. The interest in PV energy has increased drastically since the energy crisis of the 1970s and has instigated a growing interest in using solar cells to produce electricity in homes and businesses around the world.

Figure 9 Scheme from Solar Cell to Solar Array



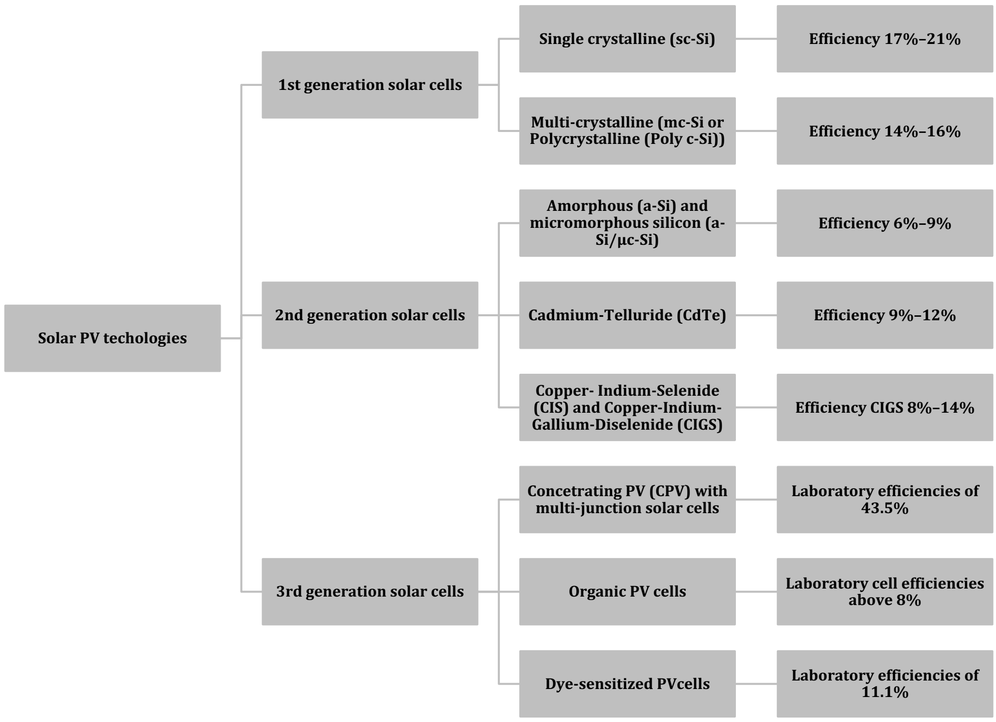
Source: http://etap.com/renewable-energy/photovoltaic-101.htm

[403] Solar cells have around 1-2 Watts of power and come in the sizes 12,5 cm2, 15cm2 and 20cm2.
[404] Solar modules are typically rated between 50-315 Watts of power and have a guaranteed life cycle of 25 years.

4.1.2 Solar Cells Materials

Due to the extensive research that is conducted in this field and to the promising potential of solar PV systems, a myriad of solar cells and solar photovoltaic systems have been developed already. Existing solar PV technologies are broadly distinguished into three generations according to *materials* and level of *commercial maturity*.

Figure 10 Overview Solar PV technologies



Source: Author, based on efficiency data from U.S. Department of Energy (2012), http://www1.eere.energy.gov

4.1.2.1 First-generation Solar Cells: Crystalline Silicon

First generation PV solar cells are made from crystalline *silicon,*[405] one of the most abundant elements in the earth‘s crust. There are two general types of crystalline, or wafer-based, silicon PV systems: *monocrystalline* (sc-Si, also known as single crystalline) and *multicrystalline* (mc-Si, also known as Polycrystalline (Poly c-Si)). *Monocrystalline* semiconductor wafers are cut from single-crystal silicon ingots, whereas *multicrystalline* semiconductor wafers are cut from directionally solidified blocks or grown in thin sheets. Monocrystalline ingots are more difficult, energy intensive, and expensive to grow than simple blocks of multicrystalline silicon but achieve higher cell efficiencies. Crystalline silicon technologies have reached market maturity and constitute about 85% of the current PV market.[406] In practice, c-Si modules have demonstrated operational lifetimes of more than 25 years.[407]

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[405] Silicon is a semiconductor material with an energy band gap405 of 1.1 eV.
[406] Mints, P. (2011). Global PV Demand 2011 and Beyond. In *Webinar: Vote Solar, January 12, 2011*.
[407] C. Jordan, D., & R. Kurtz, S. (2013). Photovoltaic Degradation Rates—an Analytical Review. *Progress in Photovoltaics: Research and Applications*, *21*(1), 12–29. http://doi.org/10.1002/pip.1182

4.1.2.2 Second-generation Solar Cells: Thin Film

Second-generation PV systems are based on thin-film PV technologies and generally include three families of thin-film semiconductor materials: Amorphous (a-Si) and micromorphous Silicon (μc-Si); Cadmium-Telluride (CdTe); and Copper-Indium-Selenide (CIS) and Copper indium gallium diselenide (CIGS). These semiconductor materials are deposited on a substrate/superstrate (such as glass or thin metal) inside a vacuum chamber and encapsulated by glass. Most thin films are direct bandgap semiconductors, which means they are able to absorb the energy contained in sunlight with a much thinner layer than indirect bandgap semiconductors such as traditional c-Si PV. Therefore Thin-film solar cells use only layers of semiconductor materials that are only a few microns (μm) thick; this is about 100 times thinner than current c-Si cells. This gives them a competitive advantage in terms of flexibility and usage since they can be used as a replacement of rooftop shingles and tiles, facades and skylights. Thin-film solar PV cells are, however, still in the early deployment stage and most research and development (R&D) in this area focuses on reducing costs by replacing, for example, traditional glass encapsulation with "ultra barrier" flexible glass to protect the highly water sensitive thin-film semiconductors. Thin-film modules have lower DC efficiencies than c-Si modules: about 9–12% for CdTe, 6–9% for a-Si, and 8–14% for CIGS.[408]

4.1.2.3 Third-generation Solar Cells

Third-generation solar cells comprise of solar technologies that use a variety of non-silicone materials, such as solar inks from conventional printing press technologies, solar dyes, conductive plastics, and solar cells that use plastic lenses. The most promising examples hereof are concentrating PV (CPV)[409] and organic PV cells.[410] CPV technologies use mirrors or lenses made from inexpensive materials such as glass, steel and plastic to concentrate sunlight 2–1,200 times onto a relatively small but highly-efficient semiconductor area consisting of silicon or multi-junction (MJ) PV cells. The benefits of such an approach are the minimization of expensive semiconductor material and the achievement of higher efficiencies.[411] Drawbacks of concentrating photovoltaics are the high costs, especially for MJ PV cells, which result from complex tracking devices, complicated manufacturing processes and expensive installation. Recent improvements to MJ PV cells have produced cell efficiencies of 43.5% in the laboratory.[412]

4.1.3 Solar Cell Efficiencies

Solar PV systems use sunlight to produce electricity. Sunlight is defined as *electromagnetic radiation* and constitutes only a small fraction of the electromagnetic spectrum that is visible to

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[408] U.S. Department of Energy. (2012). *SunShot Vision Study. Energy Efficiency & Renewable Energy (EERE)*. Golden, US: National Renewable Energy Laboratory (U.S.). http://doi.org/10.2172/1039075

[409] Concentrating photovoltaics (CPV) technologies use mirrors or lenses to concentrate sunlight 2–1,200 times onto high-efficiency silicon or multijunction (MJ) PV cells.

[410] An organic solar cell uses organic electronics, a branch of electronics that deals with conductive organic polymers or small organic molecules, for light absorption and charge transport to produce electricity from sunlight by the photovoltaic effect.

[411] This is particularly true for multi-junction (MJ) cells. MJ cells are capable of much higher efficiencies than single junction silicon or thin-film cells. This is because each junction of a MJ cell is designed to collect a different part of the solar spectrum. MJ cells are typically a stack of three different cells on top of one another.

[412] U.S. Department of Energy. (2012). *SunShot Vision Study. Energy Efficiency & Renewable Energy (EERE)*. Golden, US: National Renewable Energy Laboratory (U.S.). http://doi.org/10.2172/1039075

the human eye. The electromagnetic spectrum describes light as a wave that has a particular wavelength and a specific energy quantum (*photons*[413]). The energy of a photon of light is determined by its wavelength; shorter wavelength photons have higher energy than those with longer wavelengths.

Solar PV cells require a certain amount of energy (that is, sunlight of a particular wavelength) to move a semiconductor electron from its normal valence level (tightly bound to one atom) to its higher energy conduction level (free to move around). The amount of energy needed to boost it to the higher level is called the *band gap* energy. For solar PV cells, the band gap energy lies at a wavelength of 1,100 nanometres (nm), which corresponds to short wave infra-red light and which has just enough energy to promote an electron in a silicon atom, the most commonly used semiconductor material. Photons with a *longer wavelength* than 1,100 nm have insufficient energy to promote the electron. This part of the solar spectrum remains unused and either passes straight through the PV cell or is absorbed as heat. Photons with a shorter wavelength than 1,100 nm have more energy than is required to promote the electron, the excess of which is lost as heat[414]. Therefore, only photons with at least the band gap energy (that is at least 1,100 nm of wavelength) are able to free semiconductor electrons and produce electricity within PV cells. In general, all the photons in the visible spectrum are strong enough to cause electrons to jump the band gap.

These factors produce a theoretical upper limit to PV efficiency of around 33%, an effect that is also known as *Shockley Queisser Efficiency Limit.*[415] A solar cell's conversion efficiency thus describes the percentage of power converted from sunlight to electrical energy under "standard test conditions" (STC[416]). Hence, of the total amount of solar energy that hits a solar cell (100%), only 33% is theoretically convertible into electricity, whereas around 47 % of solar energy is converted into heat and around 18 % passes through the solar cells[417].

Since the 1970s, laboratory efficiencies of solar PV cells have nearly reached the theoretical maximum, as shown in Figure 9. Laboratory efficiencies are based on laboratory prototype cells and generally produce higher results than commercial efficiencies. In general, monocrystalline silicon (mSi) achieve the highest efficiencies, followed by polycrystalline silicon (pSi), thin-film and organic solar cells.

[413] A photon is an elementary particle, the quantum of all forms of electromagnetic radiation, including light.

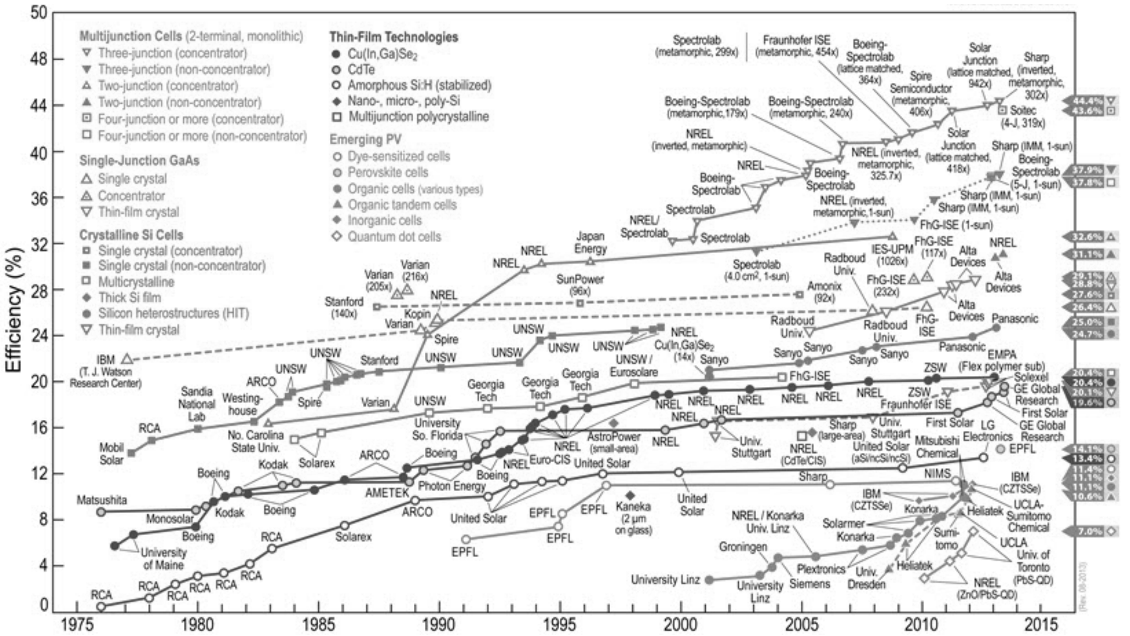
[414] It should be noted here that heat degrades solar cells more than any other environmental factor by far (for instance compared with hail, wind or flying debris).

[415] William Shockley and Hans Queisser were the first to calculate the efficiency limitations of solar cells in 1961.

[416] The STC conditions approximate solar noon at the spring and autumn equinoxes in the continental United States with the surface of the solar cell aimed directly at the sun

[417] One possibility to circumvent this limit is to produce a PV material made up of multiple layers, each layer tuned to a different wavelength. Efficiencies up to 44% have been achieved in the laboratory, but as yet none are commercially available.

Figure 11 Laboratory Best-Cell Efficiencies for Various PV Technologies



Source: NREL, www.nrel.org

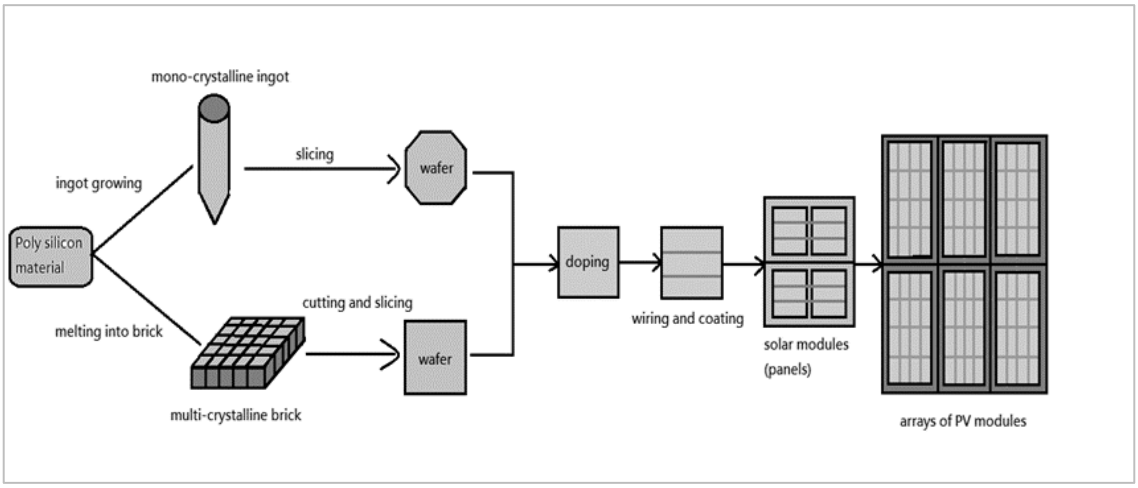
4.1.4 Solar PV Value Chain

In 2014, silicon-wafer based PV technologies (first generation solar cells) accounted for about 92% of the total production, of which in 2016 around 56% was attributed to multi-crystalline technology production[418]. Given that crystalline solar cells have already reached market maturity, they are subject to mass production with individual companies soon being able to produce them at the rate of several hundred MW a year and even at the Gigawatt scale[419]. The individual manufacturing steps that are involved in producing wafer-based crystalline solar cells (1[st] generation) are described in Figure 10 and Table 7 .

[418] Fraunhofer Institute for Solar Energy Systems (ISE). (2015). *Photovoltaics Report*. Freiburg, Germany.

[419] International Renewable Energy Agency (IRENA). (2014). *Renewable Energy Prospects: China REmap 2030 analysis.* Abu Dhabi, Arab Emirates: IRENA.

Figure 12 Difference between mono- and multi-crystalline solar cells



Source: http://www.prosun.org/en/sustainable-eu-solar/eu-solar-industry/solar-value-chain.html)

Table 5 Solar PV Value Chain, industry and environmental factors

Stage	Manufacturing Processes	Market and Economic Factors
Silicon (Si)	Silica (SiO_2) is the second most plentiful element on the Earth after oxygen. It is mainly found in sand and quartz in the form of silicon dioxide. Before metallurgical grade silicon can be used for solar cells, it must undergo a chemical purification process, called the *Siemens process*. The outcome of the purification process is polycrystalline[420] silicone, which can then be further processed into solar ingots and wafers.	This step is the costliest and most intricate process in the photovoltaic value chain. Around a 1/4 of the total cost for a crystalline module is just for the polysilicon material. Eight companies[421] currently dominate the global polysilicon market, producing nearly 70% of the output.
Solar Wafers	Polysilicon is processed into either *monocrystalline* or *multicrystalline* wafers. Wafers serve as the substrate for semiconductors and solar cells. They are typically 150 mm diameter and have a thickness of 200 microns. There are two common procedures for monocrystalline and multicrystalline wafers.	Despite low market barriers, the wafer market is dominated by 5 large companies[422] who share 93% of the wafer market, and 3 of which own 78% of wafer demand.[423] Wafer manufacturers typically locate their facilities close to wafer and solar cell manufacturers.

[420] Polycrystalline silicon is also called Polysilicon or poly-Si
[421] These companies are Hemlock, Wacker Chemie, OCI Company, GCL Solar, REC Silicon, LDK Solar MEMC
[422] Wafer manufacturers include GCL Poly, LDK, MEMC, Siltronic (Wacker Chemie) and SUMCO (Mitsubishi and Sumitomo, Solar, Renesola, Renewable Energy Corporation (REC), SolarWorld, Comtec Solar, GreenEnergy Technology, Nexolon, and Sino American Silicon
Other players include Solar, Renesola, Renewable Energy Corporation (REC), SolarWorld, Comtec Solar, GreenEnergy Technology, Nexolon, and Sino American Silicon (SAS).
[423] China Greentech Initiative. (2011). CGTI White Paper 2011: China's Solar PV Value China: Opportunities to improve profits. Greentech Networks Limited.

	When making *monocrystalline* wafers, silicon is molten at a temperature of more than 1,400 °C. Only one single monocrystalline silicon cylinder (called "rods" or "ingots") is drawn from the silicon melt (the most common procedure for this step is the *Czochralski method)*. When making *multi-crystalline* wafers, the liquid silicon melt solidifies and thousands of small crystals are formed into one block of cast multicrystalline silicon. The blocks are then broken up into columns with a square cross section from which the very thin wafers are cut with wire cutters or by laser. In the final step the wafers undergo a final cleaning and polishing prior to the quality assurance inspection.	
Solar Cells	Wafers are made into solar cells via cleaning, doping, etching, and deposition of the wafer surface. Here, two wafers are slightly altered (or "doped") with small amounts of different impurities to facilitate electron transfer (e.g. phosphorous in one wafer and boron in another). The wafers are sandwiched together between glass or layers of ethyl vinyl acetate and a polymer laminate to protect the cells. Metal grids and contacts conduct the electrical energy produced, and inverters change the direct current (DC) produced by solar cells to the alternating current (AC) used in power lines.	This procedure is an important step in the value chain and accounts for 14% of a module's cost. This procedure creates significant technical differentiations among manufacturers. The market is not dominated by a few big players but by an ever-growing number of cell manufacturers[424].
Solar Modules	In the final step, solar cells are interconnected and assembled into modules. This involves assembling the cells onto glass or another substrate and connecting the cells to form an electric circuit. Solar modules are the solar end product and are ready for solar power generation.	Given the low capital and energy requirements for this step, there are a large number of module manufacturers in this market segment (most of which are also solar cell producers)
Solar System	Solar modules combined with inverters, mounting systems and further components. Core elements are the solar cells which in turn are combined into modules. Solar module fabrication entails soldering cells together to create a string of cells to generate the necessary wattage. The next step involves laminating the	Panel manufacturing often takes place in smaller plants, located near end-markets, because of the bulky heavy nature of module components like the glass front sheet, and aluminum frame

[424] Some of the major players in the crystalline silicon segment include Sharp, SolarPower, Kyocera, BP Solar, Q-Cells, Mitsubishi, SolarWorld, Panasonic (Sanyo), Schott Solar and Isofoton.

cells between special glass on top and a polymeric backing sheet on bottom.

Source: Author based on Silicon Valley Toxics Coalition (SVTC) (2009). Toward a Just and Sustainable Solar Energy Industry. Report. Retrieved from: http://svtc.org/wp-content/uploads/Silicon_Valley_Toxics_Coalition_-_Toward_a_Just_and_Sust.pdf (accessed 01.03.2014)

4.1.5 Application and Utilization

In general, solar PV systems can be broadly distinguished into those PV systems that are connected to an electricity network (*on-grid*) or those that operate independently form the grid (*off-grid)*. Off- and on-grid PV systems operate similarly but have slight variations in their equipment. For instance, on-grid systems require an inverter[425] that converts electricity from direct current (DC) to alternating current (AC) before solar electricity is fed into the grid. Off-grid systems on the other hand, require a storage battery[426] to supply energy during low-light periods as well as a charge controller (or regulator) to protect the battery from deep discharge or overcharging. In general, there are six primary applications for PV power systems starting from small off-grid Pico systems of some watts to very-large-scale PV plants of hundreds of MW. The six application types are presented in Table 4.

[425] The typical weighted conversion efficiency – often stated as "European"' or "CEC" efficiency of inverters is in the range of 95% to 97%, with peak efficiencies reaching 98%. Most inverters incorporate a Maximum Power Point Tracker (MPPT), which continuously adjusts the load impedance to provide the maximum power from the PV array. One inverter can be used for the whole array or separate inverters may be used for each "string" of modules. PV modules with integrated inverters, usually referred to as "AC modules", can be directly connected to the electricity network (where approved by network operators) and play an increasing role in certain markets.

[426] Nearly all batteries used for PV systems are of the deep discharge lead-acid type. Other types of batteries (e.g. NiCad, NiMH, LiO) are also suitable and have the advantage that they cannot be over-charged or deep-discharged, but are considerably more expensive. The lifetime of a battery varies depending on the operating regime and conditions but is typically between 5 and 10 years.

Table 6 Overview of Categories of PV Applications

Off-Grid	Pico PV systems	Pico PV systems have developed rapidly in the past few years. They combine the use of very energy efficient lights (mostly LEDs) with sophisticated charge controllers and efficient batteries. The electricity that is needed to power such a small and efficient device is supplied through a small PV panel of only a few Watts. Therefore Pico PV systems can provide essential services such as lighting, phone charging and powering a radio or a small computer. Pico systems are becoming particularly popular in developing countries with limited access to electrical grids.
	Domestic PV systems	Off-grid domestic systems supply electricity to households or villages that are not connected to the grid (providing electricity for essential services such as lighting, refrigeration and other low power loads). They are typically around 5 kW in size. They are installed worldwide but are most commonly found in regions where grid extension to communities and homes is economically unfeasible (such as in mountainous or rural areas).
	Non-domestic PV systems	Examples of off-grid non-domestic installations are commercial PV applications that are used for satellites, telecommunication, street lighting, water pumping, navigational aids and so forth. These are often applications where small amounts of electricity have a high value, and therefore increase the cost competitiveness of PV systems towards other small generating sources.
Off-/On-grid	Hybrid PV systems	Hybrid systems combine solar PV systems with another power generating source (often diesel generators). Here, the diesel generator serves the purpose of constantly filling in the gap between the present load and the actual generated power by the PV system. Advantages of Hybrid PV systems are: a) mitigation of fuel price spikes; b) reduction in operating cost; c) higher service quality and flexibility than traditional single-source generation systems. Hybrid PV systems can be used for telecom base stations, rural electrification and even urban areas.
Grid-connected	Distributed PV systems	Grid-connected distributed PV systems provide electricity to a grid-connected customer (e.g. household) or directly to the electricity network. Distributed PV systems are decentralized, which means that energy supply is located close to the load it serves. Decentralized PV systems are therefore often modular and more flexible. In China, distributed renewable energy generation denotes power plants with less than 6 MW capacity.
	Centralized PV systems	Grid-connected centralized systems serve the purpose of centralized power stations. They are decoupled from a specific electricity demand and only serve the function of supplying a bulk of power. These systems are typically ground-mounted.

4.2 Policy Rationale: Opportunities, Challenges and Constraints of Solar PV in China

Discussion about benefits and usage of solar photovoltaic are often reduced to environmental facets, while neglecting that solar energy has far more complex and widespread merits to offer especially in terms of *energy security*, *land use*, *supply chains*, and *economic productivity*. Hermann Scheer[427], one of Germany's most well-known advocates for solar energy and facilitator of the German feed-in tariff, once argued:

> "Even where the individual characteristics of different resources are known – location of deposits, necessary extraction and refining techniques, applications, market participants, prices, achievable efficiencies, quantities and consequences of resultant emissions – these are almost always discussed in a *disconnected* and *fragmented* way. Fossil fuels are assumed to offer lower prices and greater potential, whereas solar energy is thought to have the edge solely in terms of reducing environmental impact. Very few people are aware that different resources types necessitate different *economic structures*, and promote different *development trends*." (Herman Sheer, The Solar Economy: Renewable Energy for a Sustainable Global Future, p.35)

The development of solar energy is therefore driven by a string of arguments that go far beyond the self-evident environmental impacts and that are likely to have profound effects on the *economic*, *political, environmental* and *social* development of a given country. And even if recognition about virtues of solar energy utilization exists, in practice, the exploitation of solar energies is inevitably bound to the limits of geographic, technical, economic, social and market factors that are distinct to individual countries. Therefore the potential of solar energies must be evaluated against economic and financial viability, potential to contribute to power supply, environmental impact and potential for large-scale commercialization. In doing so, this chapter explains the policy rationale behind government support in the solar energy sector.

4.2.1 Solar Resource Potential: Fuel Supply Chains and Energy Security

4.2.1.1 Solar Radiation Characteristics

The *theoretical potential* of photovoltaic systems describes the maximum of usable solar energy without consideration of technological, economic, market and social factors and is determined by the quantity of available solar irradiation. With an estimated 885 million terawatt hours (TWh) of solar radiation reaching the Earth's surface each year, solar resources are considered one the most abundant energy resources on earth.[428] In relative terms, its quantity equals 6200 times the commercial primary energy consumed by humankind in 2008, and 3500 times the energy that the

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[427] Hermann Scheer (April 29, 1944 – October 14, 2010) was a member of the German Social Democratic Party and member of the German Bundestag (Parliament), President of The European Association for Renewable Energy (Eurosolar) and General Chairman of the World Council for Renewable Energy. In 1999 Scheer received the Right Livelihood Award for his "indefatigable work for the promotion of solar energy worldwide".

[428] International Energy Agency (IEA), (2011). Technology Roadmap: Solar Photovoltaic Energy. Vienna, Austria: IEA/OECD.

International Energy Agency (IEA) expects humankind to consume in 2050.[429] The distribution of solar radiation intensity at the Earth's surface (hence solar resources) is subject to variation due to (i) *atmospheric effects* (such as absorption and scattering); (ii) *local variations* in the atmosphere (such as weather, water vaporization, clouds, air trace gases, and atmospheric particles); (iii) *geographic latitude* (which affects the inclination at which sun strikes the earth surface); and (iv) *season* of the year and *time* of the day.[430] This scattering effect of the atmosphere divides solar radiation reaching the Earth's surface into two categories: *direct*[431] and *diffuse*[432] irradiation. Although solar PV systems are able to convert both types solar radiation, diffuse radiation leads to significantly lower electrical output (which however can be to some extent counterbalanced by the tilting of PV panels).[433] The regions that are best suited for solar PV systems in terms of resource potential (that is high direct irradiation and low atmospheric scattering) are therefore typically located in arid and semi-arid areas close to the tropics but distant from the Equator.

4.2.1.2 Availability of Solar Resources in China

China possesses abundant resources of solar energy, as indicated by measures from the Chinese Meteorological Administration[434][435]. Favorable solar conditions are particularly found in western and northern parts of the country, such as shown in Figure 12. The provinces northern Ningxia, northern Gansu, southeastern Xinjiang, western Qinghai, and western Tibet exhibit annual solar radiation levels as high as 6.5-7.0 kWh/m^2 per day, compared to other regions with averages of 4.5-5.0 kWh/m^2 per day.

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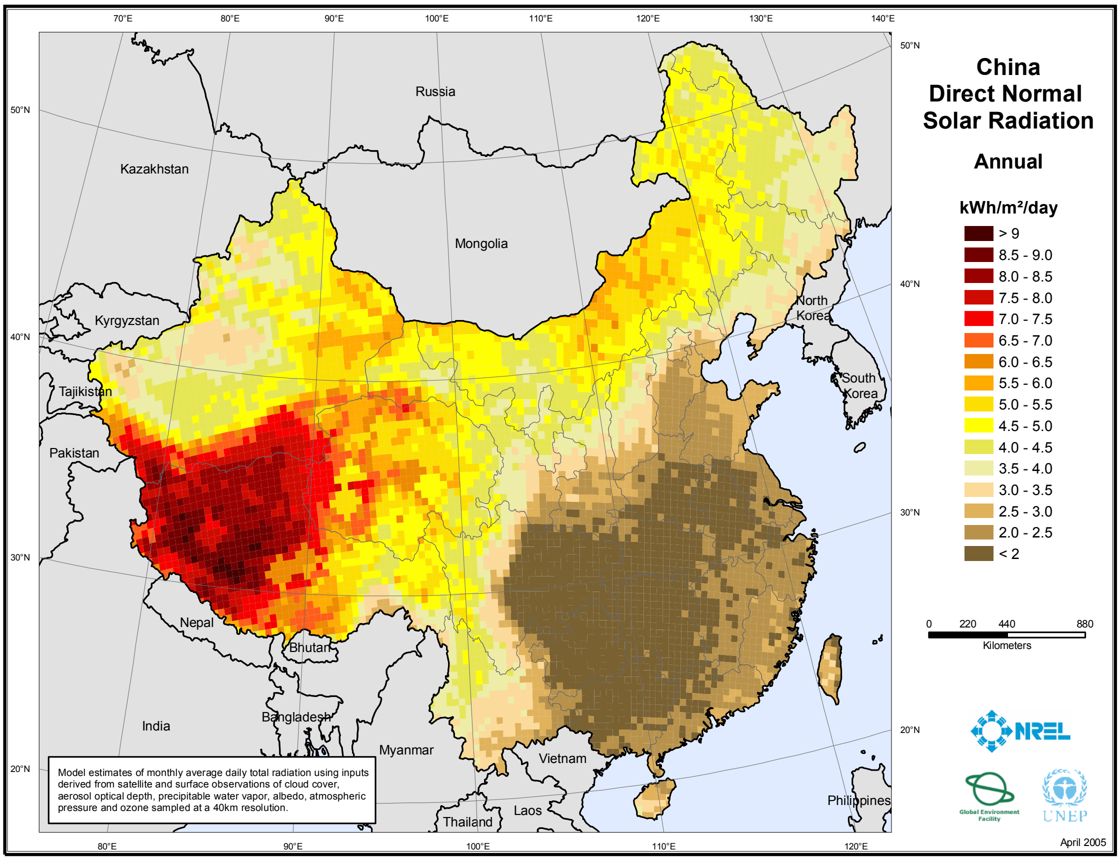
[429] Ibid.
[430] When the sun is lower in the sky, its energy is spread over a larger area, and more is also lost when passing through the atmosphere, because of increased air mass; it is therefore weaker per horizontal surface area
[431] Direct solar radiation is the radiation that comes directly from the sun, with minimal attenuation by the Earth's atmosphere or obstacles (also referred to as beam solar radiation).
[432] Diffuse solar irradiation is the part of the global solar radiation that is scattered by the atmosphere, mostly by clouds, particulate matter and gas molecules
[433] Diffuse radiation is generally equally distributed throughout the sky, the most diffuse radiation is gathered when your solar panels are laying down horizontally.
[434] Zhang, P., Yang, Y., Jin, S., Lisheng, W., & Li, X. (2009). Opportunities and challenges for renewable energy policy in China. *Renewable and Sustainable Energy Reviews, 13*(2), 439-449.
[435] Luo Y. J., He, X.N., & Wang, C. G. (2005). *Application technology of solar energy*. Beijing, China: Chemistry and Industry Press.

Figure 13 Distribution of Solar Resources in China



Source: NREL, http://www.nrel.gov/gis/pdfs/swera/china/china40kmdir.pdf)

Given the spatial distribution of solar resources and China's geographic extent, Chinese provinces are classified based on their solar resource potential, into the five categories (with Category I being the best), as shown in the Table 9. China also exhibits high potential in terms of sunshine hours per year, as more than two-thirds of the Chinese territory receives exceeds 2000 h of sunshine hours each year (compared with 1650h in Berlin,[436] Germany, and 2819h in Malaga, Spain). China's theoretical potential for utility PV and distributed PV is estimated at 2200 GW and 500 GW, respectively. Despite this considerable resource potential, China utilizes only 1% of utility and 1% of its distributed solar potential, as shown in Table 10.

[436] Climate data EU, see website: http://climatedata.eu/climate.php?loc=gmxx0007&lang=en

Table 7 Solar Energy Resources in different regions of China[437]

Category	Annual sunshine hours (h/a)	Total annual solar radiation (MJ/m^2 a)	Net annual solar energy per m^2 (kg of coal equivalents)	Provinces
I	3200–3300	6680–8400	225–285	Northern Ningxia, Northern Gansu, Southeastern Xinjiang, Western Qinghai, and Western Tibet
II	3000–3200	5852–6680	200–225	Northwestern Hebei, Northern Shanxi, Southern Inner Mongolia, Southern Ningxia, Central Gansu, Eastern Qinghai, Southeastern Tibet, and Southern Xinjiang
III	2200–3000	5016–5852	170–200	Southeastern Shandong, Southeastern Henan, Northwestern Hebei, Southern Shanxi, Northern Xinjiang, Jilin, Liaoning, Yunnan, Northern Shaanxi, Southeastern Gansu, Southern Guangdong, Southern Fujian, Northern Jiangsu, Northern Anhui, Tianjin, Beijing, and Southwestern Taiwan
IV	1400–2000	4190–5016	140–170	Hunan, Hubei, Guangxi, Jiangxi, Zhejiang, Northern Fujian, Northern Guangdong, Southern Shaanxi, Southern Anhui, Heilongjiang, and Northeastern Taiwan
V	1000–1400	3344–4190	115–140	Sichuan, Guizhou, and Chongqing

Source: Renewable Energy Development Project (REDP). (2008). Report on The Development of the Photovoltaic Industry in China (2006-2007).

Table 8 Theoretical Potential and Installed Capacity of solar PV in China

	Utility-scale PV systems in China	Distributed PV systems in China
Theoretical Potential	2200 GW	500 GW
Utilized Potential in 2014	23.38 GW	4.67 GW

437 Renewable Energy Development Project (REDP). (2008). Report on The Development of the Photovoltaic Industry In China (2006-2007).

Percentage share of theoretical potential	1,1 %	0,9 %

Sources: Statistics from The National Renewable Energy Centre (CNREC) (2012) and China's National Energy Administration (NEA)

4.2.1.3 Implications on Resource Depletion, Fuel Supply Chains and Energy Security

The seemingly endless *abundance* and *accessibility* of solar resources in China stands in stark contrast to the *finite nature* of most fossil fuels. The typical evolution of fossil fuel exploitation is often described as (i) extraction of fossil fuels, (ii) followed by production growth phase, (iii) leading to a peak and (iv) subsequent decline as the resource becomes more technically, energetically and economically challenging to extract and deliver to the market (e.g. peak oil[438])[439]. It is therefore predicted that most fossil fuels will reach the point of depletion in not-so-far future or will reach the point at which they are no longer economically feasible to exploit (either due to the availability of a substitute energy source or due to scarcity of the resource). This aspect is particularly important in the context of in China, as most primary fuel sources (such as oil, natural gas, coal) are limited and scarce when considered on a per-capita basis, as shown in Table 11[440].

Table 9 Comparison of China's Oil, Natural Gas and Coal Reserves on a per capita basis (based on proven reserves)

	China's total	% of world total	China's reserve-exploi-tation ratio	World's reserve-exploi-tation ratio	China's per capita possession	% of world per capita level
Oil (in 100 million barrels)	170.7	1.4	13.4	40.5	13.2	7.0
Natural gas (in trillion cubic meters)	2.2	1.2	54.7	66.7	0.2	6.1
Coal (in 100 million tons)	1145.0	12.6	59.0	164.0	88.8	61.5

Source: Xuan Xiaowei, 2006, http://en.drc.gov.cn/2006-09/11/content_23098706.htm

A prime example hereof is coal (*bituminous* coal but also *anthracite* and *lignite*), which supplies around three quarters of China's electricity generation. Coal is supplied through a monopoly of

[438] Peak oil refers to the absolute peak in global production and is assumed to correspond to the point at which half of the economically extractive cumulative reserves have already been depleted (Campbell, C. J., & Laherrère, J. H. (1998). The end of cheap oil. *Scientific American, 278*(3), 78-83).

[439] See for example Hubbert, M. K. (1949). Energy from Fossil Fuels. *Science, 109*(2823), 103-109. https://doi.org/10.1126/science.109.2823.103; Maggio, G., & Cacciola, G. (2012). When will oil, natural gas, and coal peak? *Fuel, 98*, 111-123. http://dx.doi.org/10.1016/j.fuel.2012.03.021.

[440] Xuan, X. (2006). *The Basic Situation in China's Primary Resources Supply and Demand and the Reform Direction of Resources Allocation Mechanism*. Development Research Center (DRC) of the State Council of the People's Republic of China. Beijing, China.

ten state-owned coal companies (such as Shenhua Company)[441], which dominates more than one third of domestic coal production. In 2011 the World Energy Council estimated that China holds 126 billion short tons of recoverable coal reserves,[442] which accounts for 13% of the world's total coal reserves and makes China the country with the third largest coal reserves (behind the United States and Russia). But in relative terms and divided by a population of 1.35 billion people, the per capita availability of coal reserves in China is far below the global average (61.5% of the world average per capita resource of coal). At coal consumption rates of 3 billion tons/year (which was the case in 2009), China's vast coal resources would likely reach depletion in around 42 years. Yet the point of depletion could be reached earlier than anticipated, as the *extraction* of coal reserves depends also on *accessibility*. Unlike the United States for example, half of China's coal deposits are *non-surface-minable* coal deposits (meaning that 53% of total coal deposits lie 1000m below surface),[443] which presents major engineering and cost challenges. Given the extensive coal exploration in past decades, China has nearly depleted all its *surface-minable* coal (average mining depths of 600 m), which means that most remaining coal resources in China are located at mining depths that are either non-feasible and technically impossible to explore. There are thus good reasons to assume that China has already passed its "peak coal" in 2013 and that the "the window of opportunity for high-carbon sources is closing".[444]

Equally important are also finite *supplementary resources* that are necessary to extract, transport and process fossil fuels. Coal-based electricity for instance, requires high levels of water resources for coal mining, extraction, washing, transportation, cooling of power plants and controlling of emissions and environmental waste. According to a 2016 Greenpeace Report, the world's 8,359 existing coal-fired power plants consume on average 19-23 billion cubic meters of fresh water each year, equaling the water demand of more than one billion people or one-seventh of the world's population[445]. This nexus between coal and water availability is particularly pronounced in China, where areas of rich coal reserves overlap with areas of water scarcity. In China's northern regions, coal power plants are believed to have contributed to a decade-long draught and chronic water shortages, widespread desertification, and the relocation of millions of people.[446]

Discussion about availability and accessibility of solar resources must also address the issues *supply chains*, *logistic challenges* and *externalities* of fossil fuels and implications that go far beyond China's borders. Here, Herman Scheer (2002)[447] denotes:

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[441] The largest coal company in China (and worldwide the largest) is Shenhua Group, which holds over 10 % of the domestic market in China.

[442] The World Energy Council estimated in 2011 that China holds 126 billion short tons of recoverable coal reserves, China's Ministry of Land and Resources however estimates the country's proven coal reserves to total 187 billion tons, which would make China the country with the second-largest reserves after the United states

[443] Xie, H., Liu, H., & Wu, G. (2013). China's Coal Industry Must Follow the Path of Sustainable Production Capacity. Retrieved January 28, 2014, from http://cornerstonemag.net/chinas-coal-industry-must-follow-the-path-of-sustainable-production-capacity/.

[444] International Energy Agency (IEA). (2015). Coal Medium-Term Market Report 2015: Market Analysis and Forecasts to 2020. Paris, France: IEA/OECD.

[445] Wong, E. (2016). *The Great Water Grab: How the Coal Industry is Deepening the Global Water Crisis*. Greenpeace Report. Retrieved on March 22, 2016, from http://www.greenpeace.org/international/en/publications/Campaign-reports/Climate-Reports/The-Great-Water-Grab/.

[446] Wong, E. (2016, March 22). Report Ties Coal Plants to Water Shortage in Northern China. *The New York Times*.

[447] Scheer, H. (2004). The Solar Economy: Renewable Energy for a Sustainable Global Future. London: Earthscan/James & James.

> "In order to comprehend the scope of the resource question, we must conduct a systematic analysis and evaluation of the differing supply chains, from the various primary resources through to the end-users. […] The fundamental economic reality of fossil fuels is that they are found in only a relatively small number of locations across the globe, yet are consumed everywhere. The economic reality of solar resources, by contrast, is that they are available, to varying degrees, all over the world." (Herman Scheer, The Solar Economy: Renewable Energy for a Sustainable Global Future, p.35-36)

Unlike solar resources that are dispersed and ubiquitous -albeit to differing degree- over the entire globe, raw materials available on the Earth's crust for fossil and nuclear energy are finite and concentrated in only a limited number of countries that are dominated by predestine, by geographical happenstance, oligopolistic and nepotistic regimes. This monopolistic nature of fossil fuels is particularly apparent in the case of oil resources, which are geographically concentrated in only few regions in the Middle East, Nigeria, Angola, Russia, Kazakhstan and Venezuela. The extraction of oil requires technically elaborate equipment and large investments and is often predestined to fall under the control of monopolies and rent-seeking regimes (see for instance theories on the "resource curse" and "poverty traps").[448] For oil-importing countries such as China, the geographic concentration of fossil fuels implies a "strategic vulnerability"[449] that entails greater foreign dependency and cutback of national sovereignty, vulnerability towards volatile fuel prices, national security risks and extensive diplomatic and military expenditures to ensure a steady and reliable supply of fossil fuels. For many decades China has pursued the doctrine of peaceful rise and has circumvented direct confrontations with western and U.S. interests (as in the case of the war on Iraq and the growing U.S. hegemony in the Middle East, which coincided with Chinese investments in the oil sectors of the Arab Gulf). Instead, China has upheld diplomatic ties and fuel trade with countries that the West considered pariahs, including Sudan, Angola, Iran or Uzbekistan. In recent years, however, the growing and sheer scale of China's energy needs has forced it more and more to intrude into what the United States regards as its own orbit of influence.[450] A recent example hereof are the escalating territorial disputes in the South China Sea and China's claims on the Paracel and Spratly islands, where significant deposits of oil and gas are assumed. This conflict has led to significant military armament[451] in the region and has inevitably strained China's ties with countries such as Vietnam, Malaysia, the Philippines, Brunei, Taiwan and the U.S.

There is thus much evidence that the window of opportunity for finite fossil fuels in China is slowly but steadily closing. China's thirst for oil and other fossil fuels and its growing dependence on fuel imports have altered the global energy markets and have created significant energy insecurities in China's energy supply. Conventional fuels such as coal, oil and natural gas reserves

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[448] The "Resource curse" mainly refers to an observation made by the U.S. economists Stern and Warner in 1995, that countries with higher resources, especially minerals and fuels, showed greater rates of poverty, corruption, political instability and risk of conflict than countries without resources wealth. In his theory on poverty traps, Paul Collier even goes as far as to argues that the risk of conflict rises from 0.5% to 23% if the country is endowed with plentiful natural resources, making natural resources a "crucial risk factor" impacting countries much more than historical, geographical and ethnical factors.

[449] Salameh, M. G. (2010). China's Global Oil Diplomacy: Benign or Hostile? In *International Association for Energy Economics (IAEE)* (pp. 21–25).

[450] Ibid.

[451] The U.S. has recently even prompted the White House to send Navy destroyers to patrol near the islands, see Watkins, D. (2015, October 27). What China Has Been Building in the South China Sea. *The New York Times*. New York, USA.

are moving towards depletion at an increasingly fast rate, not only in China but globally, highlighting the need and utilization of more infinite and domestic energy sources. Although China possesses vast amounts of fossil fuel reserves, its per-capita amount of coal, oil and natural gas resources are far below the world average. Solar resources, on the other hand, represent a viable alternative in terms of abundance and accessibility and are mostly still unexplored in China. The transition towards greater use of solar energy resources could therefore have far reaching merits in regard to China's energy diplomacy, an easing of political tensions between China and the West, stabilization of energy prices and greater energy security in the long run.

4.2.2 Technological Potential: Load Characteristics and Grid Integration

4.2.2.1 System Integration and Electric Load

Solar PV systems pose significant technical challenges to electricity grid operators in regard to transportation of electricity from energy production to demand centers and the variability of solar electricity generation. In general, the electricity grid, consisting of transmission and distribution networks, has the task to electricity from the point where it is produced (*power plants*) to the energy end-consumers (*load*). Since energy must be generated and supplied to residential, commercial and industrial energy users in extremely variable times and quantities, daily electric load patterns are generally distinguished into *base load*, *intermediate load* and *peak load*.[452] *Base load* (or *continuous* load) describes the minimum amount of electricity required over a period of 24 hours and is the amount of electricity necessary to power electrical assets that operate at all times (such as refrigerators and stand-by at household level). The *intermediate load* (or *middle load*) is the average load that is generally reached every day whereas *peak load* occurs during the time of the day when the electricity demand peaks (usually short-lived). In Germany, the average estimates of base load, intermediate load and peak load are 40 GW, 60GW and 80GW respectively.[453]

Given the timely variations in daily energy demand, grid operators require a mix of power generating technologies with unique operating characteristics. Each power-generating technology differs in its ability to ramp up power generation and their ability to switch on or off to meet demand peaks (this is called *dispatchability*[454]) and are therefore distinguished into *base*, *intermittent* and *peak load supply plants*. Typical *base load power plants* are those that are independent from daily variations and that are able to run continuously over extended periods of time and preferably at low cost. This includes nuclear power plant, coal power plant, hydroelectric plants, geothermal plants and so forth. By contrast, *peak supply power plants* require the flexibility to ramp up and down quickly to meet sharp increases and decreases in energy demand, but are only necessary to run for a few hours at a time. In reality, no single power generation technology meets all requirements to fulfill all three load types and therefore grid operators must resort to an *electricity mix* or *portfolio* consisting of various power sources and technologies to maintain grid stability.

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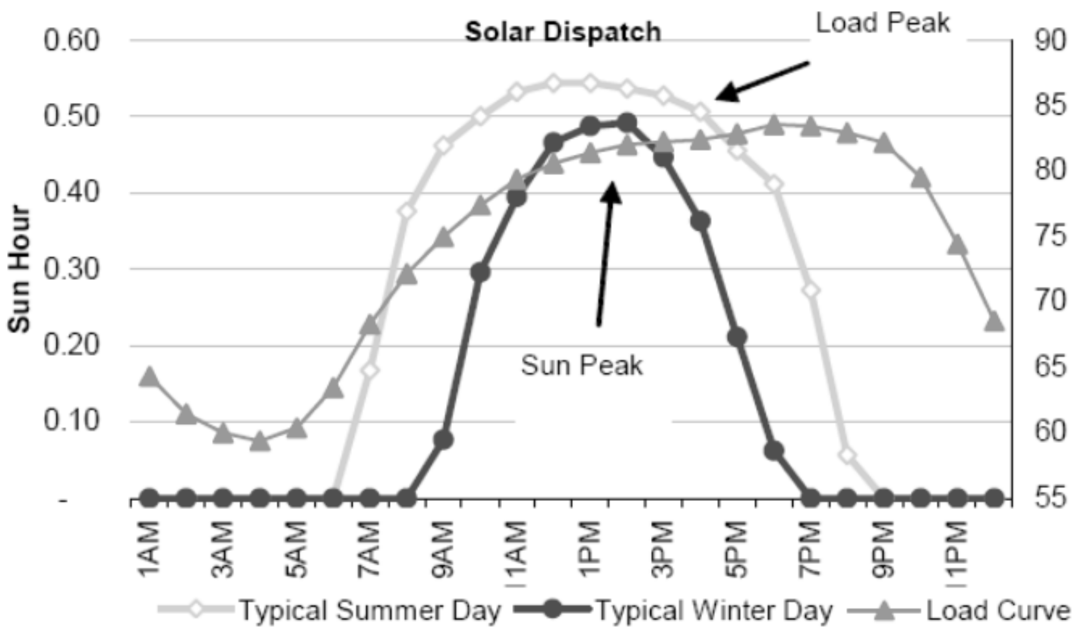
[452] Load, in electrical engineering, is the amount of current being drawn by all the components (appliances, motors, machines, etc.).

[453] Morris, C., & Pehnt, M. (2014). *Energy Transition: The German Energiewende*. Berlin, Deutschland: Heinrich Böll Foundation.

[454] Dispatchable electricity generation refers to power plants that can be dispatched at the request of power grid operators or of the plant owner; that is, generating plants that can be turned on or off, or can adjust their power output accordingly to an order

Solar PV systems’ load characteristics represent a technical challenge to most grid operators, as PV systems produce most electrical output during midday on sunny days but none during evenings or at night. Moreover, PV output can increase and fall rapidly with the appearance of clouds and the subsequent rise in diffuse irradiation, which makes it an *intermittent* or *variable* power source. In the absence of feasible storage alternatives to preserve solar electricity, the electrical output of PV systems is therefore *inconsistent* and *variable* and implies that solar plants cannot easily satisfy the steady requirements of base load power. Instead solar PV systems are suitable to serve peak loads, as their electrical output coincides with the peak demand, as shown in Figure 12. In some countries solar PV systems are contracted as ‘*must-take*’ generators, which implies that grid operators must purchase solar electricity supply whenever it is available. However in future, a growing number of ‘*must-take’* generators in the grid will necessitate the development of sophisticated grid-monitoring technologies (so-called *smart grids*) and more cost-effective electricity storage solutions that ensure grid stability. Another example of coping with the intermittency and variability of solar power is to combine energy sources with complementary intermittencies (such as in the case of onshore wind and solar photovoltaics)[455].

Figure 14 Example of Solar Dispatch



Source: NREL, www.nrel.org

[455] Kahn, E. (1979). The Reliability of Distributed Wind Generators. *Electric Power Systems Research,* 2, 1–14; Archer, C. L., & Jacobson, M. Z. (2003). Spatial and temporal distributions of US winds and wind power at 80 m derived from measurements. *Journal of Geophysical Research: Atmospheres*, 108(D9)4289. https://doi.org/10.1029/2002JD002076; Archer, C. L., & Jacobson, M. Z. (2007). Supplying baseload power and reducing transmission requirements by interconnecting wind farms. *Journal of Applied Meteorology and Climatology*, 46(11),1701-1717.

4.2.2.2 Curtailment and Grid Integration in China

Grid integration is of great significance for deploying solar energy in China, as the majority (98,9% in 2012) of installed solar PV systems are connected to the grid.[456] Given the sheer magnitude and rate at which new power generating capacity has been built and connected to the grid, *curtailment*[457] of wind and solar power generators has become a common reality and challenge in China. To date, China's national curtailment rate of solar power averages at 9% in 2015, with exceedingly high regional curtailment rates in the western and northern provinces Xinjiang (19%) and Gansu (28%).[458] Although the regulatory framework in China grants solar PV generators compensation for curtailment, in reality these are either delayed or simply not paid.[459]

***Excursus*: Wind curtailment in China**
Curtailment has become a serious issue for winds parks of more than 10 GW have become a serious issue. In recent years, grid curtailment of wind turbines received much international attention: in 2012 the China Electricity Council (CEC) estimated that around 20 TWh (17%) of wind-generated electricity was curtailed (equivalent to burning 9 million additional tons of coal), while wind power supplied only 2% of China's total electricity supply. The Chinese Wind Energy Association even estimates that curtailment rates for wind power reaches 40–50% of wind-generated electricity. In 2013 curtailment rates slightly declined to an average rate of 11% (with exceptions of 20% rate in some provinces). To date the installed capacity of grid-connected wind accounts for 129.34 GW in 2015.
Sources:

- National Wind Construction Outlook (2014, 2013). China National Renewable Energy Centre (CNREC)
- National Energy Administration/China Electricity Council (2013). Annual Wind Power Construction Assessment Report 2012.

There are many causes for curtailment, most of which are related to the high speed at which new power generating capacities has been built in regions far away from load centers, fueled by favorable policy regulations and financial incentives. In particular recent years have experiences a surge in new power generating capacity from wind and solar, which is planned to reach total power generating capacities of 100 GW for solar and 200 GW for wind by 2020.[460] Curtailment has become a serious concern, as new solar installations have grown at an unprecedented speed: 15 GW of additional solar PV capacity were added to China's total installed solar PV capacity

456 Lv, F., Xu, H., & Wang, S. (2013). National Survey Report on PV Power Application in China 2013.
457 Curtailment refers to an involuntary reduction in output of a generator from what it could otherwise produce with the given available resources (such as wind or sunlight) and is applied by grid operators to minimize transmission congestion.
458 National Energy Administration of China (NEA) (2015). *Nián shàng bànnián guāngfú fādiàn jiànshè xìnxī jiǎnkuàng*, Retrieved on 01 September 2015, from http://www.nea.gov.cn/2015-07/28/c_134455530.htm
459 International Renewable Energy Agency (IRENA). (2014). *Renewable Energy Prospects: China REmap 2030 Analysis.* Abu Dhabi, Arab Emirates: IRENA.
460 National Energy Administration of China (NEA) (2015). *Guowuyuan bangongting guanyu yin fa nengyuan fazhan zhanlüe xingdong jihua (2014-2020 nian) de tongzhi*. Retrieved on 7 September 2015, from https:// www.nea.gov.cn/2014-12/03/c_133830458.htm

(43 GW) in 2015, which marks a 40% increase of solar installed capacity in one year[461]. Given that the majority of these new power plants are constructed in remote and sparsely populated regions in western and northern China, additional grid and transmission capacities are necessary to transfer electricity to the highly populated load centers along the coast. Grid extension and construction, however, have lagged behind the massive expansion of renewable energy capacity, leading to transmission bottlenecks, grid congestion and eventually curtailment. According to the Energy Research Institute, the grid capacity would have to grow from currently 1,060 GW to 1,500 GW by 2020 to keep pace with the new power generating capacities and growing energy demand.[462] This has caused a situation in which solar and wind generators compete with coal-fired and other conventional power plants for the same transmission capacity. Until 2015 however, China's law granted coal-fired power plants a guaranteed amount of operating hours and thus preferential treatment for grid connection, which in turn left many intermittent power plants such as wind and solar generators running idle and struggling to compete[463]. Starting in 2007 however, the State Electricity Regulatory Commission (SERC, *Guojia Dianli Jianguan Weiyuanhui*) began to tackle this issue by strengthened measures to prioritize renewable energy in the dispatch order and obligating grid companies to purchase all available renewable electricity (except cases that could lead to grid instability) in order to avoid penalties.[464] In the same year, the NDRC piloted an "energy efficient dispatch" scheme (or "energy-saving dispatch")[465], which prioritized renewables and nuclear in the dispatch order, and continues with coal units in decreasing order of efficiency.

In reality, however, grid curtailments are also the result of more deeply entrenched structural and institutional issues. These include competing interests due to incomplete power deregulation, fragmented transmission authorities, lack of centralized dispatch and transmission mechanisms, non-market and semi-transparent transmission pricing, limited coordination between project developers and grid planners, inflexibility of the system, lack of a real-time electricity market to trade electricity, lack of incentives for inter-company cooperation and trade among grid operators.[466] Such institutional barriers and structural flaws of solar curtailment are attributed to the fact that China's energy sector is still in the process of transitioning from a centralized and planned economy to a market-oriented and competitive energy market. The considerable overlap between traditional vertically integrated state-run utilities and the partial liberalization in which wholesale and retail markets are unbundled from regulated transmission and distribution monopolies, has led to complicated shake-ups of ownership and regulatory authority.[467]

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[461] National Energy Administration of China (NEA) (2014). *Nian guang fu fadian tongji xinxi 2015*. International Association for Energy Economics. Retrieved on 1 May, 2016, from http://www.nea.gov.cn/2015-03/09/c_134049519.htm.

[462] Li, J., Cai, F., Qiao, L., Xie, H., Gao, H., Yang, X., Tang, W., Wang, W., & Li, X. (2012). *2012 China Wind Energy Outlook*. Beijing, China: Global Wind Energy Council (GWEC).

[463] During the heating season (roughly October until April)

[464] Schuman, S., & Lin, A. (2012). China's Renewable Energy Law and its impact on renewable power in China: Progress, challenges and recommendations for improving implementation. *Energy Policy*, 51, 89-109.

[465] Wang, Z., H. Qin, & J. I. Lewis (2012). China's wind power industry: Policy support, technological achievements, and emerging challenges. *Energy Policy*, 51, 80-88.

[466] For more information, see for example Li, C., Shi, H., Cao, Y., Wang, J., Kuang, Y., Tan, Y., & Wei, J. (2015). Comprehensive review of renewable energy curtailment and avoidance: a specific example in China. *Renewable and Sustainable Energy Reviews*, *41*, 1067-1079; Davidson, M. M. R. (2014). *Regulatory and technical barriers to wind energy integration in northeast China* (Doctoral dissertation, Massachusetts Institute of Technology).

[467] Davidson, M. (2014). Renewable Energy Momentum in China. In *The Energy Collective*. Retrived 25 September 2013, from http://theenergycollective.com/michael-davidson/279091/transforming-china-s-

In view of the institutional and structural deficits, regulators and grid operators have mobilized massive efforts to tackle the issue of grid curtailment by strengthening the regulatory framework of renewables and heavily investing into grid extension. Most important efforts in this direction are grid improvement and grid extension and the onset of China's "golden era"[468] of ultra-high-voltage (UHV) development. Since 2006, grid companies and policymakers have embarked on a massive installation of UHV transmission lines that are able to carry AC and DC electricity over thousands of kilometers at around 800,000 to 1,000,000 volts.[469] The country's UHV era began with the operation of the 654 km long '*Jingdongnan-Nanyang-Jingmen 1000kV UHV alternating current (AC) power line'*, which was completed in 2009 and connects southeast Shanxi province and Jingmen in Hunan province. In 2010, China launched its first DC UHV line, the 1,373 km long '*Yunnan-Guangdong 800kV UHV DC line'*, which connects Chuxiong in southwestern Yunan province and Guangzhou. The NEA plans to install altogether 12 inter-regional UHV transmission corridors with a total capacity of 300 GW by 2020,[470] which will be backed by at least 2 trillion CNY (315 billion USD) of investments that will be channeled to power grid infrastructure for the timeframe 2015-2020[471].

The massive extension of grid capacity through UHV lines takes place within the broader context of structural reforms, known as China's "Coal-to-Electricity" Program, which promotes a greater shift towards electric heating and replacement of inefficient coal- and oil-fired boilers in northern China with centralized and more efficient electric boilers. Another government effort includes the planned quota systems, known as the Renewable Energy Portfolio Standard (RPS). It mandates each province to cover a certain percentage (currently 2-10%) of their electricity mix through non-hydro renewable energy sources, primarily wind, solar and biomass.[472] Provinces that are unable to meet their quotas will face penalties and will be forced to suspend or reduce fossil fuel-based power plants fuels. Once put into play, the renewable energy quota system will likely improve the grid-connection of renewables and grant renewables such as solar priority grid access to the grid. Similarly, the National Development and Reform Commission (NDRC) has recently launched an initiative to overcome grid curtailment by means of pilot projects and incentivized relocation of energy-intensive industries to the northwestern provinces Gansu and Inner Mongolia to increase the local absorption rate of renewable electricity and to omit the need for additional electricity transmission.

In conclusion, grid curtailment remains the most significant technical limitation in the deployment of solar PV in China. Government initiatives to tackle this issue are already in place and efforts are particularly channeled towards the massive extension of UHV lines. Whether or not such regulatory and technical efforts will suffice to absorb the sheer magnitude of new solar and wind

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grid-sustaining-renewable-energy-push; Davidson, M. M. R. (2014). *Regulatory and technical barriers to wind energy integration in northeast China* (Doctoral dissertation, Massachusetts Institute of Technology).

468 Kemp, K. (2014). Article: Super-grid: China masters long-distance power transmission, *Reuters News*, retrieved 1 July 2016, from http://www.reuters.com/article/us-china-electricity-grid-kemp-idUSKBN0EU19B20140619.

469 Davidson, M. (2013). Politics of Power in China: Institutional Bottlenecks to Reducing Wind Curtailment Through Improved Transmission. In *International Association for Energy Economics (IAEE) Energy Forum* (4 ed., pp. 41-43).

470 Xu, Z., Xue, Y., & Wong, K. P. (2014). Recent advancements on smart grids in China. *Electric Power Components and Systems*, 42(3-4), 251-261. https://doi.org10.1080/15325008.2013.862327.

471 Stanway, D. (2015, September 1). China targets $300 bln power grid spend over 2015-20 - Report. *Reuters*.

472 Although the RPS was expected to be introduced in 2014, the law was delayed due to negotiations among provincial governments and grid companies.

capacity in coming years remains uncertain. Yet with China's ambitious goals of scaling up solar capacities from 43 GW in 2015 to 100 GW by 2020, Chinese regulators are left with little choice but to overcome the technological barriers that impede solar energy deployment in China.

4.2.3 Geographic Potential: Land utilization and building integration

4.2.3.1 Solar PV and Impact on Land

The land requirements for solar systems are higher than those for conventional systems by 2-3 orders of magnitude.[473] Technical advances in this area are unlikely to lead to a substantially reduction of land requirements for solar plants because irradiation is, in essence, a natural location-specific parameter. On the other hand, the unavailability of land is rarely a restriction.[474] Discussions about land requirements must also address the type of *technology* and *utilization* (*distributed* or *utility-scale* systems) as land requirements depend predominantly on geographic location, the efficiency of modules, the slope of the site and the type of mounting used. The land requirements of individual photovoltaic systems depend on *efficiencies;* for instance, crystalline solar systems have different land requirements than thin-film systems for the same electrical output. The type of *utilization* plays also a role as *distributed* solar systems produce small amounts of electricity near the point where it is consumed and are flexibly integrated into rooftops, buildings' envelope (for instance as PV facades or roof tiles) or ground-mounted in gardens. This omits the need for and occupation of additional land. *Distributed* photovoltaic systems in China refers to all rooftop-integrated PV systems installed on residential and commercial buildings as well as ground-mounted solar systems on abandoned lands, unused slopes, canopy for agricultural uses, and fish ponds[475]. The benefits of requiring no additional land makes distributed solar systems particularly compelling for China's urban areas, where population densities have been soaring and different types of land-use compete heavily over limited land resources.
Utility-scale PV systems on the other hand, refer to large-scale power generation that is fed directly into the electricity grid. They are decoupled from a specific demand and end-consumer and produce large amounts of solar electricity that is sold to wholesale utility buyers. Characteristic features of utility-scale systems are that they are predominantly location in remote but resource rich regions, require access to the grid and occupy contiguous parcels of land in order to operate most efficient and cost-effective way. Utility-scale PV systems may therefore lead to undesirable impacts on land use, landscape, and biodiversity.[476] This downside of utility-scale systems can be minimized by installing such systems on unused, low productivity agricultural lands, pastures, grasslands or scrublands (such as marginal lands that need to be reused).[477]

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[473] Winter, C. J., Sizmann, R. L., & Vant-Hull, L. L. (Eds.). (2012). *Solar power plants: fundamentals, technology, systems, economics*. Berlin, Germany and New York, USA: Springer Science & Business Media.
[474] Ibid.
[475] Liang, X. (2014). *Lost in Transmission: Distributed Solar Generation in China*. Washington D.C., USA: Wilson Center China Forum.
[476] Graebig, M., Bringezu, S., & Fenner, R. (2010). Comparative analysis of environmental impacts of maize–biogas and photovoltaics on a land use basis. *Solar Energy*, *84*(7), 1255-1263.
[477] IPCC (2011). Summary for Policymakers. In O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, C. von Stechow (Eds.), *IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation*. Cambridge, UK and New York, USA: Cambridge University Press.

4.2.3.2 Spatial distribution of energy demand and supply in China

The attribute of *decentralized energy supply* via distributed solar power generation makes for a particularly compelling argument in the case of China. Chinas geographical mismatch between energy supply and demand applies also to the case for utility-scale photovoltaic systems. *Utility-scale PV* systems are located in areas where the solar radiation is highest (western and northern regions) and therefore require extensive transmission and grid infrastructure to transport solar electricity to load centers in eastern and southern China. As discussed in *Chapter 'Curtailment and Grid Integration in China'*, power transmission and dispatch infrastructure are the major obstacles in making use of geographically dispersed solar resources. This challenge, however does not apply to *distributed* PV, which produces electricity close to where it is consumed and thus preempts the need for additional power transmission and dispatch infrastructure. The geographic qualities of distributed solar PV thus provide compelling arguments that could solve the issue of curtailment and bridge the geographic discrepancy between energy supply and demand.

Last but not least, distributed PV has also distinct geographic benefits in regard to poverty alleviation and electrification of remote areas. According to statistics form the World Bank, 0.3% of China's total population (around 4 million people) live without access to the electricity grid and are therefore deprived from access to modern energy services and basic electricity infrastructure.[478] Lack of access often entails lack of modern telecommunications, clean water and other basic services. The fact that these remote communities live at very large distances from the existing grid and feature very low populations densities, a grid extension in foreseeable future seems unlikely. Therefore, distributed off-grid photovoltaics in such remote areas could result in environmentally benign access to electricity at a lower cost than conventional technologies.

4.2.4 Environmental Potential: Environmental Footprint and Displaced Emissions

4.2.4.1 Environmental benefits of Solar PV

A distinct environmental feature of solar energy is, that it describes an *environmentally closed cycle*[479] because solar radiation from the sun- after end use- is returned to space in the form of heat and ambient temperature. It is a ubiquitous energy '*resource'* that does not require additional raw materials. By contrast, coal, minerals, oil, natural gas and nuclear fusions are *environmentally open systems,*[480] as they take irreplaceable raw materials from the Earth's crust and return it elsewhere to the geosphere in a chemically and isotopically altered from (such as in the case of radioactive waste or greenhouse gas emissions).[481] Such fossil fuels and nuclear fission are therefore inevitably tied to conversion processes of raw materials, the removal of oxygen from and release of CO2 into the atmosphere, the production of radioactive and poisonous waste and heat transfer to the environment. Solar energy on the other hand, is fundamentally different as it does not require any raw materials nor does it release any pollutants during its operational lifetime. In the absence of combustion processes involving toxicity and radioactivity, photovoltaic systems are therefore considered as *inherently safe.*[482] Despite hazardous elements during manufacturing

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[478] World Bank Statistics. Retrieved on 3 April 2014, from http://data.worldbank.org/country/china.
[479] Winter, C. J., Sizmann, R. L., & Vant-Hull, L. L. (Eds.). (2012). Solar power plants: fundamentals, technology, systems, economics. Springer Science & Business Media.
[480] Ibid.
[481] Ibid.
[482] Ibid.

and processing, solar power plants exhibit fewer long-term impacts and no need for '*solar containment'* (as in case of nuclear waste).

Nevertheless it should be noted that solar PV systems themselves are not entirely free from hazardous materials, as they exhibit minor amounts of *Lead* (Pb), which is contained in the cell metallization layer (around 2 grams of lead per 60-cell module) and in the solder (approximately 10 grams of lead per 60-cell module) of silicon modules. Moreover, thin-film solar cells based on *Cadmium telluride* (CdTe) contain the substance *Cadmium* (Cd),[483] which is associated with lung and kidney diseases if exposed or inhaled. Moreover, solar cells that use Copper Indium Selenide (CIS) contain *Selenium (Se)*, which is classified as toxic and particularly poisonous element when oxidized (such as in the case of fire). Hazardous and toxic materials are also found in solar batteries, which contain lead, cadmium, antimony and sulphuric acid.[484]

The most harmful substances and environmental pollution associated with photovoltaic technologies occur during the stage of mining and processing raw materials, in particular polysilicon. Polysilicon production has become an issue of growing concern in China where environmental standards, laws and penalties are often neglected. As explained in *Chapter 3.1.4 Solar PV Value China*, the manufacturing of crystalline solar cells begins with the polysilicon production, which requires large amounts of *Silica (SiO2)* that is mined in countries such as China. This extraction of *Silica (SiO2)* is associated with health-related risk, the most common of which is the lung disease *Silicosis*.[485] Further downstream the value chain and at the stage of *polysilicon* production arises the issue of discharging the extremely hazardous by-product *Silicon Tetrachloride* (SiCl4).[486] Each ton of polysilicon generally leads to at least four tons of *Silicon Tetrachloride* (SiCl4) liquid waste. *Silicon Tetrachloride* (SiCl4) is an extremely toxic substance that reacts violently with water and leads to skin burns and respiratory, skin, and eye irritation. Although it is easily recovered and often recycled as an input for *Silane* (H_4Si) production, in places with little or no environmental regulation such as China, *Silicon Tetrachloride (*SiCl4) can constitute an extreme environmental hazard. Moreover, the burgeoning growth of new polysilicon factories in China has occurred at such an unprecedented speed that recycling facilities for by-products and hazardous chemicals are unable to keep pace.[487] A 2008 report from the Washington Post disclosed cases of careless and uncontrolled disposal of *Silicon Tetrachloride* (SiCl4) near villages in China, leaving behind a trail of toxic pollution and infertile agricultural land.[488] A second equally harmful by-product of polysilicon production is the extremely potent greenhouse gas *Sulfur Hexafluoride (SF6),* which is used to clean reactors of silicon production. The Intergovernmental Panel of Climate Change (IPCC) considers *Sulfur Hexafluoride (SF6)* to be the most potent greenhouse gas per molecule as one ton of *Sulfur Hexafluoride (SF6)* has a

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483 Cadmium exposure and inhalation can affect the lung and kidneys and lead to health effects, such as lung cancer, pulmonary irritation, kidney diseases, fetal malformations (as tested in rats but not in humans) and so forth. The United States Environmental Protection Agency (EPA) has classified cadmium as a Group B1, probable human carcinogen.

484 Yang, H., Huang, X., & Thompson, J. R. (2014). Tackle pollution from solar panels. *Nature*, *509*, 563.

485 Eunjung, A. (2008, March 9). Solar Energy Firms Leave Waste Behind in China. *Washington Post Foreign Service*. Retrieved on 1 September, 2016, from: http://www.washingtonpost.com/wp-dyn/content/article/2008/03/08/AR2008030802595.html?referrer=emailarticle.

486 When silicon tetrachloride is exposed to humid air it transforms into acids and poisonous hydrogen chloride gas, which lead to dizziness and respiratory difficulties

487 Eunjung, A. (2008, March 9). Solar Energy Firms Leave Waste Behind in China. *Washington Post Foreign Service*. Retrieved on 1 September, 2016, from: http://www.washingtonpost.com/wp-dyn/content/article/2008/03/08/AR2008030802595.html?referrer=emailarticle.

488 Ibid.

greenhouse effect equivalent to that of 25,000 tons of CO_2.[489] In the absence of environmental regulatory enforcement or comparably low environmental standards in China, these hazardous greenhouse cases are often emitted into the atmosphere without adequate filtering and treatment. A third issue relates to the enormous amount of energy needed to purify silicon for crystalline solar cells. For this process and also for the crystal growing and casting, extremely high temperatures are required. In countries such as China where conventional energy is traditionally supplied through coal and other fossil fuels, this translates into an increased amount of greenhouse gases and coal-associated pollution to the environment. The magnitude of environmental pollution associated with polysilicon factories in China was highlighted in a 2012 Greenpeace report, which found that only 20 out of 70 upstream polysilicon producers in China were able to pass the 'National Polysilicon Industry Entry Requirements' published by the Chinese Ministry of Industry and Information Technology in 2010.[490] Less than one third of Chinese polysilicon producers were therefore able to meet the country's environmental and energy standard of clean production.[491] Further downstream the manufacturing process, China has around 700-800 module and system manufacturers of which only few publicly listed companies release regular reports on *Corporate Social Responsibility (CSR),*[492] which are the only reference point for environmental pollution in China's industries.
Environmental pollution and hazardous waste are not invariable concomitants of solar manufacturing, processing and polysilicon production, as has been demonstrated by many developed countries such as the US, where *Silicon Tetrachloride* ($SiCl_4$) and other toxic by-products are safely returned to the recycling process or carefully disposed. The Waste Electrical and Electronic Equipment (WEEE) legislation is another succinct example of how the disposal of electronic equipment can be governed more transparently and how manufacturers can be held accountable for eventual disposal or recycling. Moreover, several solar companies around the world have launched voluntary take-back schemes for photovoltaic equipment and materials to improve recycling and environmentally sound disposal of photovoltaic waste.

4.2.4.2 Displaced Emissions and Water Resources

There are two distinct advantages inherent to solar PV solar systems that are especially pertinent to the Chinese environmental context: Greenhouse gas (GHG) emissions and water requirements. Coal-based electricity and the accompanying emission of nitrogen oxides, sulfur dioxides, particulates, and carbon dioxide, has led to alarmingly high levels of air pollution and has raised serious concerns within and beyond China's borders. Most of these airborne pollutants that result from coal combustion present serious health hazards, either *directly* as in the case of particulates or *indirectly,* as in the case of ground-level ozone formed from high levels of nitrogen oxides and other chemicals. In China, an extensive amount of coal is burned directly by domestic and residential consumers by means of inefficient combustion facilities that result in high levels of indoor air pollution. This is also the case in the industrial sectors, where boilers and power plants

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489 Alsema, E.A., Baumann, A.E., Hill, R., & Patterson, M.H. (1997). *Health, safety and environmental issues in thin film manufacturing*. Utrecht, Netherlands: Utrecht University Repository.
490 These 20 enterprises vary in size, with some reaching the capacity of 10,000 tons, while others with much smaller capacity. Some are under construction or not in production, with the number of enterprises who can continue their production being at less than 10.
491 Greenpeace East Asia Report (2012). *Unraveling the puzzle that is solar PV pollution - Clean production of solar PV manufacture in China*. Retrieved on 1 December 2014, from http://www.greenpeace.org/eastasia/publications/reports/climate-energy/2012/solar-pv-pollution-report/.
492 Ibid.

exhibit low levels of thermal efficiencies and lack of modern pollution control equipment, which in turn has the same aforementioned effect.[493] The situation is aggravated by the fact that most of the consumed coal is unwashed,[494] which leads to higher SO2 and particulate emissions. It is estimated that the environmental pollution associated with the combustion of coal and other fossil fuels contributes to 1.6 million premature deaths each year and accounts for roughly 17% of all deaths in China.[495] It is interesting to note here that by comparison solar PV leads to only 5% of the amount of energy consumption and carbon dioxide emissions that coal-fired power plant require for the same amount of electricity.[496] Similarly the GHG emissions that occur over the lifecycle of solar PV systems are estimated to lie somewhere between 1 g CO2-eq/kWh to 218 g CO2-eq/kWh (mean value is 49.9 g CO2-eq/kWh).[497] The 2014 IPCC report concludes that the lifecycle CO2 equivalent emissions associated with utility solar PV (48 gCO2-eq/kWh) and solar rooftop PV (41 gCO2-eq/kWh)[498] are only 5,8% and 5% respectively, compared to those of coal (820 gCO2-eq/kWh on average), as shown in Table 20. A larger deployment of solar PV would therefore imply a noticeable reduction of greenhouse gas emissions, air pollution and health hazards.

Table 10 Comparison of GHG emissions between Coal and Solar Power Plants (global average)

	Coal Power Plant	Utility solar PV	Rooftop Solar PV
Average lifecycle CO2 equivalent emissions (measured in gCO2-eq/kWh)	820	48	41
Percentage of coal	100%	5,8%	5%

Source: by Author, based on 2014 IPCC report

Another important environmental aspect pertains to water requirements of solar power plants. Coal power plants have a significant impact on water resources at every stage of their life cycle from coal *mining*, *washing*, *burning* and *treatment* of combustion waste. In fact, in many countries the coal industry is one of the largest consumers of freshwater resources. The same goes for China where coal-fired power plants consume on average 7.4 billion cubic meters of water each year, equivalent to the water needs of 406 million people or 30% of the country's population.[499] This

493 International Energy Agency (IEA) Statistics.
494 Coal washing describes a process during which water is used to remove the stone, sulphur and ash from the desired coal ore. The undesired products are then discharged as a toxic slurry.
495 Rohde, R. A., & Muller, R. A. (2015). Air pollution in China: Mapping of concentrations and sources. *PloS one*, 10(8), e0135749. https://doi.org/10.1371/journal.pone.0135749
496 De Groot, R. A. F., Van der Veen, V. G., & Sebitosi, A. B. (2013). Comparing solar PV (photovoltaic) with coal-fired electricity production in the centralized network of South Africa. *Energy*, *55*, 823-837.
497 Nugent, D., & Sovacool B. K. (2014). Assessing the lifecycle greenhouse gas emissions from solar PV and wind energy: a critical meta-survey. *Energy Policy, 65*, 229-244.
498 Schlömer S., T. Bruckner, L. Fulton, E. Hertwich, A. McKinnon, D. Perczyk, J. Roy, R. Schaeffer, R. Sims, P. Smith, & R. Wiser (2014). Annex III: Technology-specific cost and performance parameters. In Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (Eds.), *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, UK and New York, USA: Cambridge University Press.
499 Cheng, I., & Lammi, H. (2013). The great water grab: how the coal industry is deepening the global water crisis. Greenpeace.

has induced a serious "resource dilemma"[500] as regions with large coal reserves coincide with regions that have scare water resources and fragile ecosystems. This resource dilemma has given rise to a series of environmental degradations, such as a decade-long drought and desertification in northern China, low groundwater levels and the relocation of millions of people. One of the large rivers under threat is the Kuye River, a class I tributary of China's iconic Yellow River that extends to a river basin and population of 878,000 people.[501] The magnitude of the water crisis in northern China is so severe that a series of canals have been built to transport water hundreds of miles from the Yangtze River to the North, known as the *South-North Water Diversion Project.* Contrary to this, renewable energy sources such as solar photovoltaic systems require freshwater resources only during the manufacturing stage and only little to no water resources for operation. Therefore, solar PV can have an important role in reducing water usage in the electricity sector. Moreover, it highlights the importance of PV deployment in reducing national and regional levels of water withdrawal and consumption and emphasizes the environmental opportunities in regard to water stress, sustainable water management and avoided water costs.

4.2.5 Economic Potential: Feasibility and Cost-recovery

4.2.5.1 Costs characteristics of solar PV and Levelized Cost of Energy

Compared with conventional power generators, solar PV systems have distinct cost characteristics. Costs for PV systems are composed of *hard costs* and *soft costs*. *Hard costs* refer to the PV systems hardware (such as solar panels, power inverters, cables, Balance of Systems (BOS)) whereas *soft costs* include all other expenditures (such as financing, customer acquisition, permits, installation, labor, inspection). Hard costs and in particular the purchase of solar modules, are the most expensive part across all PV systems (i.e. residential, commercial, utility scale systems) and can take up to 45% of the total investment costs.[502] In contrast, *soft costs* tend to range more widely than those of cells and modules, which are global commodities and subject to global prices. Given that the bulk of costs for solar PV systems are spent on hardware and solar modules, most of the investment costs for PV systems accumulate prior to installation, as maintenance and repair costs are relatively low and no additional fuels are required throughout the operational lifetime.

The initial investment costs for solar plants is therefore comparatively high, but a number of compensating advantages must also be considered. Solar plant construction times are short (around 12-18 months for plants around 30-80MWe).[503] Moreover, almost the entire capital outlay is due over the period of plant construction whereas the follow-up costs for maintenance and repair are relatively negligible. There are no expenses for purchasing energy raw materials or

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[500] Wong, E. (2016). *The Great Water Grab: How the Coal Industry is Deepening the Global Water Crisis*. Greenpeace Report. Retrieved on March 22, 2016, from http://www.greenpeace.org/international/en/publications/Campaign-reports/Climate-Reports/The-Great-Water-Grab/.

[501] Yellow River Water Research Institute (YRWRRI) (2014*). The environmental impact assessment of the integrated planning of the Kuye river basin* (Chinese). Retrieved on 2 February, 2016, from http://www.ordossl.gov.cn/xxgk/tzgg/201403/ P020140328626819245237.pdf.

[502] Goodrich, A., James, T., & Woodhouse, M. (2012). Residential, Commercial, and Utility-Scale Photovoltaic (PV) System Prices in the United States: Current Drivers and Cost Reduction Opportunities. Golden, USA: National Renewable Energy Laboratory (NREL).

[503] Winter, C. J., Sizmann, R. L., & Vant-Hull, L. L. (Eds.). (2012). *Solar power plants: fundamentals, technology, systems, economics*. Berlin, Germany and New York, USA: Springer Science & Business Media.

for dealing with pollutants and safe disposal. The non-contaminating construction materials of solar module design (mostly steel, concrete, aluminum, glass or silicon) are materials that are commonly used in machine-building and electrical industry and are therefore easy to recycle. Consequently, the pre-financing needs of a plant prior to its first power delivery consume the bulk of total investment but are moderate compared to conventional power plants. By contrast, conventional power plants accumulate ongoing costs that go far beyond their operational lifetime (as in the case of safely disposing nuclear waste, which remains radioactive for up to billions of years).[504]

Another cost characteristic of solar PV systems is that *size matters* in reducing the overall costs for solar electricity. According to the installation size, the total costs for solar PV systems can vary substantially*:* *Distributed* or *residential-scale* PV systems (< 6kW capacity) are the most expensive (US$6/Watt in 2010) owing to their small installation size, low electrical output, fragmented distribution channels and high installation costs. *Commercial-scale systems* (6kW–5MW capacity) cost on average 20% less than residential systems (US$5/Watt in 2010)[505] due to higher outputs and direct distribution channels. *Utility-scale PV systems* (>5MW capacity) are the least expensive (US$4/Watt in 2010) as that they are able to realize significant economies of scale in component purchasing and installation labor, which in turn lowers the installed system price[506]. National feed-in tariffs and incentives schemes in individual countries determine if and to which extent costs between residential, commercial and utility-scale PV systems vary.

Table 11 Typical PV System Prices in 2013 in selected countries (USD) [507]

USD/W	Australia	China	France	Germany	Italy	Japan	United Kingdom	United States
Residential	1.8	1.5	4.1	2.4	2.8	4.2	2.8	4.9
Commercial	1.7	1.4	2.7	1.8	1.9	3.6	2.4	4.5
Utility-scale	2.0	1.4	2.2	1.4	1.5	2.9	1.9	3.3

Sources: Friedman et al. (2014), *Comparing PV Costs and Deployment Drivers in the Japanese and U.S. Residential and Commercial Markets*, February, NREL/TP-6A20-60360; PV-PS IA (2014a), *PV Cost Data for the IEA*, personal communication, January.

Source: International Renewable Energy Agency (IRENA) Statistics.

A common reference to assess the economic *feasibility* and *cost-competitiveness* of solar electricity is the *Levelized Cost of Energy* (LCOE), indicated in US dollars per kilowatthour (US$/kWh). LCOEs are derived by summing up all costs that are necessary to purchase, operate and maintain an energy generating asset divided by its estimated total energy output over the

[504] Nuclear waste describes a cocktail that consists of radioactive waste from elements with differing half-lives. The half-life of Uranium (238U) is 4,468 billion years whereas that of Caesium (137Cs) is only 30.2 years.

[505] Although commercial-scale systems are usually more expensive than utility-scale systems, many commercial systems are being developed by third-party installers using power purchase agreements (PPAs). These third-party installers are frequently able to achieve significant economies of scale in component purchasing and can finance, permit, and build commercial projects more quickly than larger utility projects.

[506] U.S. Department of Energy. (2012). *SunShot Vision Study. Energy Efficiency & Renewable Energy (EERE)*. Golden, US: National Renewable Energy Laboratory (U.S.). http://doi.org/10.2172/1039075

[507] International Renewable Energy Agency (IRENA) Statistics.

course of its lifetime, as indicated in the equation below. LCOEs provides an important estimate of the economic feasibility and competitiveness of a power source, as it is sensitive to a) the purchase investments to construct and install the plant; b) financing conditions (return on investment, interest, plant lifetime); c) operating costs over the course of a power plant's lifetime (transmission and distribution costs, insurance, maintenance, operator margins, taxation, repairs); d) irradiance availability; and e) projected utilization rates (lifetime and the annual degradation of the power plant).

$$LCOE\ (\frac{\$}{kWh}) = \frac{Sum\ of\ costs\ over\ lifetime\ (\$)}{Sum\ of\ electrical\ output\ over\ lifetime\ (kWh)}$$

In countries where deployment of PV systems is still at a nascent stage, LCOEs for PV systems tend to be significantly higher and ergo less competitive than conventional energies.[508] When solar PV systems generate electricity at LCOEs that are less or equal to the price of purchasing power from the electricity grid, this situation is known as *grid parity* or *socket parity*. *Grid parity* depends on many factors, such as whether or not environmental costs are internalized or whether carbon/coal taxes are levied. Fossil and nuclear plants have incurred a number of social and environmental costs, which are not or not fully reflected in the electricity bill.[509] Therefore prices for fossil and nuclear electricity are held artificially low because related external costs are borne by the national economy, cloaked through subsidies and paid public tax money. A conservative estimate by Winter et al. (2012) shows that full accounting of environmental penalties and costs for damages to the environment would typically double the price for electricity delivered by fossil fuel power plants[510].
LCOEs also give an estimation of the price that a solar PV system must earn per MWh to break even on total investment (known as *energy payback time*). The *energy payback time* describes the time span over which an energy conversion system must operate in order to 'pay back' the energy, which was invested in its construction, its lifelong operation and its eventual recycling[511]. Solar power plants usually have payback times up to one order of magnitude higher than those of conventional plants[512]. While solar plats are materials intensive, the fast energy payback assures that the environmental costs of constructing a solar plant is quickly recovered.[513] Solar plants could even compete with conventional power plants today is social costs of fossil fuels and nuclear plants were accounted for. Moreover, it is likely that given the depletion and growing scarcity and limited access of fossil fuels and nuclear energy, the costs of social and nuclear power plants are destined to go up[514].

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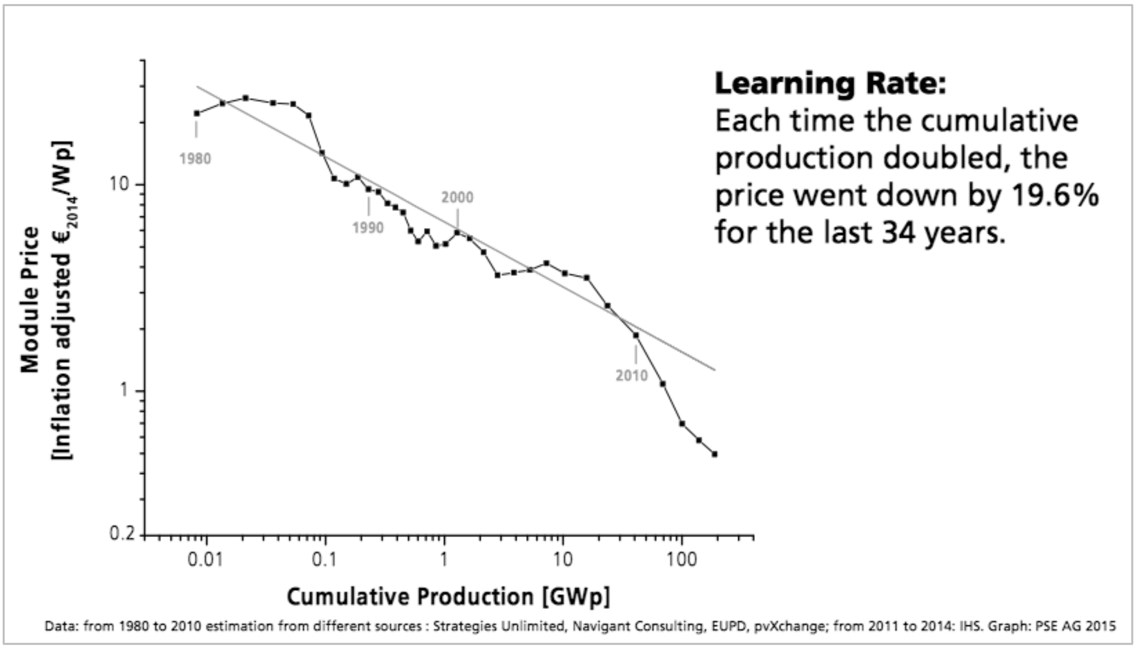
508 International Energy Agency (IEA) Statistics.
509 Winter, C. J., Sizmann, R. L., & Vant-Hull, L. (Eds.). (1991). *Solar Power Plants: Fundamentals, Technology, Systems, Economics*. Berlin & Heidelberg, Germany: Springer-Verlag. http://doi.org/10.1007/978-3-642-61245-9.
510 Ibid.
511 Ibid.
512 The Energy Payback Time of PV systems is dependent on the geographical location: PV systems in Northern Europe need around 2.5 years to balance the input energy, while PV systems in the South equal their energy input after 1.5 years and less, depending on the technology installed.
513 Winter, C. J., Sizmann, R. L., & Vant-Hull, L. (Eds.). (1991). *Solar Power Plants: Fundamentals, Technology, Systems, Economics*. Berlin & Heidelberg, Germany: Springer-Verlag. http://doi.org/10.1007/978-3-642-61245-9.
514 Ibid.

Many countries around the world have seen a continuous decline in LCOEs for solar electricity. Price declines and lower LCOEs for solar electricity have been the result of *long-term trends*, such as improved technology and manufacturing processes; extensive research, development, and demonstration; technological innovation; greater cell efficiencies; industry maturing; and economies of scale. *Short-term trends* have also contributed to this trend and include supply and demand dynamics, market stimulation, and accumulated experience of manufacturers and developers. The combination of long-term and short-term trends have driven down the total investment costs for solar PV technologies to a minimum, particularly the manufacturing costs of solar modules. Between 1976 and 2010, prices for solar modules fell from 60 US$/W to 2 US$/W, respectively.[515] In other words, since 1976 global module prices have declined by around 20% on average for every doubling of cumulative global production, a phenomenon known as *Swanson's law.*[516] The Swanson Law is based on the *learning curve* or *experience curve* and assumes that for every doubling of cumulative shipped volume, the costs for photovoltaic cells fall by around 20%.

The learning curve and the concept of LCOEs provide important arguments in favor of political intervention and incentives schemes for solar energy technologies. Renewable energies such as solar technologies are still at an early development stage of the learning curve, hence associated costs with such innovations are much higher than those of matured technologies. Based on the learning curve, it can also be expected that, given sufficient government support and market support and market incentives in the short-run, the industry will experience important cost reductions through learning-by-doing and accumulation of experience which will leapfrog solar electricity to the level where it is competitive with long established fossil fuels.

Figure 15 The Learning Curve of Photovoltaics



(Source: https://www.ise.fraunhofer.de/de/downloads/pdf-files/aktuelles/photovoltaics-report-in-englischer-sprache.pdf)

515 U.S. Department of Energy. (2012). *SunShot Vision Study. Energy Efficiency & Renewable Energy (EERE)*. Golden, US: National Renewable Energy Laboratory (U.S.). http://doi.org/10.2172/1039075.

516 The Swanson's Law is named after Richard Swanson, the founder of the American solar-cell manufacturer SunPower.

4.2.5.2 Energy Cost Considerations

Estimates on LCOEs for solar electricity in China vary considerably, as shown in Table 14. Projections for 2030 estimate the LCOEs for rooftop solar and utility-scale solar at 90-120 USD/MWh and 60-75 USD/MWh respectively, which still considerably higher than those LCOEs for coal electricity (43-57 USD/MWh). Moreover, LCOEs for residential PV systems are generally much higher and ergo less competitive than those of utility-scale PV systems. The reason for this relates first and foremost to the distinct pricing scheme for electricity and low feed-tariffs that are granted to small-scale solar plants. In 2013, the Chinese government introduced its first nationwide feed-in scheme for solar energy, establishing remuneration for three different categories based on regional variation for utility-scale PV power plants (the tariff categories were 0.9 CNY/kWh, 0.95 CNY/kWh and 1 CNY/kWh).[517] Distributed solar systems were, however, excluded from this tariff scheme and granted only the local and comparably low desulphurization rate of coal-fired plants (between 0.4 to 0.5 CNY/kWh). Therefore the current remuneration scheme for solar power plants in China clearly favors utility-scale power plants over distributed solar generation. Theoretically China would need to introduce a nationwide price of about USD 50 per ton of carbon dioxide (CO2) to raise the cost of coal power generation to a level where distributed solar PV could become cost-competitive. Prices of USD 25-30 per ton of CO2 would allow for utility-scale wind and solar PV plants to compete with coal electricity.[518]

In regard to grid parity, some forecasts project China's PV industry to achieve grid parity on the consumption side by 2015 and on the generation side by 2020[519]. Higher LCOEs also translate into longer payback times, which -according to estimates by the Chinese Renewable Industry Association (CREIA)- takes residential rooftop PV systems around 17 years (with 6.11% annual return rate) and utility scale PV systems around 7 to 9 years (with 8% annual return rate).[520] By comparison, conventional fuels such as coal, gas, nuclear, and wind generators achieved annual return rates above 10% in 2013.[521]

517 The Notice of the National Development and Reform Commission on Improving the Development of Solar PV Industry by Utilizing the Price Leverage Effect

518 International Renewable Energy Agency (IRENA). (2014). *Renewable Energy Prospects: China REmap 2030 analysis.* Abu Dhabi, Arab Emirates.

519 Sun, H., Zhi, Q., Wang, Y., & Su, J. (2014). China's solar photovoltaic industry development: The Status Quo, Problems and Approaches. *Applied Energy, 118*, 221-230, https://doi.org/10.1016/j.apenergy.2013.12.032.

520 Li, J. (2014). Studies on investment and financing mechanism that support the development of China's distributed solar PV industry. Beijing, China: Chinese Renewable Energy Industries Association (CREIA).

521 Liang, X. (2014). *Lost in Transmission: Distributed Solar Generation in China*. Washington D.C., USA: Wilson Center China Forum.

Table 12 Estimates of LCOEs for solar electricity in China

Table 17: Comparison of LCOE for power sector technologies

	BNEF 2012 (USD/MWh)	IRENA 2013 (USD/MWh)	IEA/NEA 2010 (USD/MWh)	GlobalData 2013 (USD/MWh)	REmap 2030 (USD/MWh)
Discount rate (%):	N/A	10	10	5-8	8
Renewables:					
Wind onshore	46-124	79	72-125	53-67	78-95
Wind onshore (remote)					70-88
Wind offshore	91-240			95-120	125-160
Solar PV (utility)	99-257	191	186-282	70-86	60-75
Solar PV (rooftop)					90-120
Solar CSP					145-200
Landfill gas ICE					42-57
Biomass	28-132	53-67		27-31	
Conventional:					
Coal (new)					43-57
Coal (existing)					15-21

Source: Based on Asia-Pacific Renewable Energy Assessment, BREE 2014, summary of data from BNEF, IRENA, IEA/NEA, GlobalData.

Source: Fraunhofer Institute, https://www.ise.fraunhofer.de/en/publications/veroeffentlichungen-pdf-dateien-en/studien-und-konzeptpapiere/study-levelized-cost-of-electricity-renewable-energies.pdf

LCOEs for distributed solar systems in China are also exceptionally high as a result of various administrative risks and challenges. These challenges include administrative uncertainties, complicated and time-consuming procedures, issues of ownership, and payment defaults. For commercial enterprises that are interested in rooftop PV systems, *recuperation period* and *operating lifespan* of solar PV systems are major risks, as the operational lifespan of a solar power plants (around 25 years) exceeds by far the average lifespan of a Chinese company and the frequent relocation of Chinese businesses. The building space beneath the rooftop-installed solar systems is therefore subject to a frequent change of tenants and owners, which leaves potential solar investors with a high uncertainty and risk that contractual obligations are met for the entire operational lifespan of a solar system.[522] Secondly, *ownership* is also a challenge for multiple-family dwellings, where up to hundreds and thousands of residents share the property rights of the apartment roof.[523] In the absence of clear laws on collective leasing, the installation of distributed solar PV systems on such shared roof space requires therefore the consensus from all the residents of the respective building. A third risk factor of distributed solar PV is the lack of regulations, procedures and penalties for fee collection. Solar companies who install distributed solar PV panels are generally responsible for collecting fees but lack, however, the authority to penalize in case of non-compliance. In the absence of authority and the possibility of sanctions, distributed solar PV systems therefor exhibit high financial risk.[524] Last but not least there are also significant administrative hurdles, as all distributed power generations require permits from local authorities that are obtained during opaque and cumbersome procedures. Some large cities, such as Beijing, Shanghai and Shenzhen have taken progressive steps to streamline the permitting and

[522] Interview in Beijing, China 2013.
[523] Interview Beijing, China 2013.
[524] Liang, X. (2014). *Lost in Transmission: Distributed Solar Generation in China*. Washington D.C., USA: Wilson Center China Forum.

reporting procedures of distributed power generation, but this has been more the exception than the rule. These high uncertainties and risks are reflected in the high interest rates and commercial loans that banks grant distributed solar power projects, which in turn affects LCOEs of distributed solar plants.[525] Distorted LCOEs for distributed solar power plants are currently subject to various government efforts as distributed solar generation is projected to become a strong component of China's future electricity portfolio. In late June 2014, the NEA circulated a draft plan, *The Notice on Further Implement the Related Policies of Distributed Solar Generation* among governmental agencies, major solar enterprises, grid companies and China Development Bank, in which it proposed a set of clear principles to bolster distributed solar generation in 11 critical aspects: project planning, non-residential market support, coordination of roof space, electricity rates and subsidy adjustment, permits application, and so on.[526] Moreover in 2014, the Chinese government also laid out an ambitious goal for distributed solar generation, aiming for 14 GW of additional solar capacity over the course of the year, 60% of which is to be derived specifically from distributed solar generation capacity.

Excursus: Electricity Pricing in China

Electricity pricing in China remains heavily regulated due to their macro-economic implication (inflation and development policy) and their role as an essential commodity for everyday life and industrial activities. China's electricity pricing scheme is a distinct amalgamation in that it allows liberalization of prices in some sectors (for instance in the coal sector) while highly regulating electricity prices in others. Electricity pricing has remained under government control. Prices are set by a number of state authorities at central and provincial level, such as provincial governments, the energy sector regulator (formerly SERC and now NEA), the State Council, the National Energy Bureau (NEB), the State-Owned Assets and Supervision and Administration Commission (SASAC), the State Environmental Protection Bureau (SEPB) and the pricing department of the NDRC. A significant diversity of rates and rate structure exist in China. China's government controls prices in three segments of the electricity value chain: (i) prices between fuel suppliers and power producers (e.g. coal prices), (ii) prices between power producers and grid-companies (*wholesale generation prices* or *on-grid benchmark tariffs*) and (iii) prices between grid companies and electricity consumers (*retail prices*).

Wholesale generation prices/ On-grid benchmark tariffs*:* China has unbundled power generation from transmission and distribution/retail, therefore wholesale generation rates have existed since the mid 1980s. Since early 2000, wholesale rates for most power generation is based on "benchmarks" (*biaogan dianjia*).

[525] Strikingly, even China's national distributed solar demonstration pilots are facing difficulties in obtaining funds from the China Development Bank for the same reasons.
[526] Liang, X. (2014). *Lost in Transmission: Distributed Solar Generation in China*. Washington D.C., USA: Wilson Center China Forum.

Benchmark tariffs are estimated based on what it would take to build and operate different types of plants (which does not reflect the actual cost of running the power plant) and vary by geographic region (e.g., the province-specific thermal power benchmark price system), by type of resource (coal, wind, biomass, solar, hydro) and threshold setting (e.g. for nuclear, adopting the thermal power price if beyond a level of 0.43 CNY/kWh). *On-grid benchmark* prices are normally levied with a value-added tax (VAT) rate of 17%, which makes the tariff level highly sensitive to the variation in coal price (as coal dominates the electricity mix).

- Benchmark tariffs = Unit of fixed costs /operating hours + Unit of variable costs

Transmission and Distribution (T&D) prices: T&D prices were never subject to market and there was little cost accounting as Chinese grid companies were allowed to charge their customers the difference between average retail price and average generation costs, which led to massive profit margins. In 2015, China's government introduced a system of "approved costs plus reasonable profit" and differentiated T&D prices based on voltage levels. This new policy breaks up China's traditional model of integrating transmission, distribution, and retail in a single entity and sets a cap to profits made by grid operators. The new policy also enforces that the grid is considered no longer an electricity trading body but instead an electricity transmission provider, which implies that the grid will earn profits through a "toll" in exchange for services.

- T&D price = Average retail price- average generation costs

Retail prices: China's electricity retail pricing scheme for energy consumers was designed in a way that it supports key industries and maintains social stability. Prices depend on voltage levels and user category (residential, light/heavy industry, commercial, agricultural, social/public). In general, heavy industry, agriculture, and residents pay lower, heavily subsidized prices. The commercial and industry electricity price can reach 1 Yuan/kWh; the household tariff is about 0.5 Yuan/ kWh; and the price for agriculture in a poor area can be as low as 0.2–0.3 Yuan/kWh. In Oct 2010, a tiered electricity pricing (TEP) was introduced, which allocates electricity consumers a pre-defined block of electricity at low rate and any consumption that exceeds the block is charged at higher rates. Previously, consumer groups were charged a flat rate based on the "electricity end-use tariff catalogue", which varied by province but ignored the amount of electricity actually consumed. The system was therefore unable to ensure cost recovery, incentivize energy efficiency and disproportionately benefited higher income groups (who consume more power). With the introduction of the TEP system, pricing regulators aim (a) to balance the recovery of the generating cost and the affordable burden of the residents and (b) to capture the heterogeneity across regions, while keeping the general principle on volume and pricing. Provincial governments are appointed to set the specific electricity-use pricing (price ladders) and associated volume blocks (e.g., kilowatt hours [kWh] per month or per year).

Retail price = Tiered electricity pricing (TEP)

The current pricing mechanism is anchored on administrative measures of checks and balances, which fails to capture market realities and real prices and sets distorted incentives to potential investors and operators. Since part of the electricity value chain is subject to market-set prices (e.g. coal) while others are heavily regulated, price distortions and conflicts are predestined to occur. This was the case in 2011, when liberalized coal prices surged and coincided with low, capped retail price, which led to a detriment of power producers, who were forced to generate electricity at levels below cost recovery. Moreover the system lacks a robust link between prices and costs. The dispatching of power plants (i.e., turning generators on and off as the requirement for power changes) is not based on cost calculations but rather on the assigned number of operating hours (*lìyong xiaoshí*), which means that the least efficient power plants may run just as much as the most efficient ones.

Sources:

- China Energy Storage Alliance (CNESA). (2015). *China's New Electric System Reforms*.
- Lv, F., Xu, H., & Wang, S. (2013). *National Survey Report of PV Power Applications in China*. Paris, France: International Energy Agency (IEA).
- Zhang, S., & Qin, X. (2015). *Lessons Learned from China's Residential Tiered Electricity Pricing Reform*.
- Ma, J. (2011). On-grid electricity tariffs in China: Development, reform and prospects. *Energy Policy* 39(5), 2633-2645. https://doi.org/10.1016/j.enpol.2011.02.032.
- Zhang, S. & Qin, X. (2015). *Lessons Learned from China's Residential Tiered Electricity Pricing Reform*.

4.2.6 Market Potential: Energy demand and Solar Industry

4.2.6.1 China's Growing Electricity Demand and Future Electricity Mix

The development of solar energy technologies in China depends also on the market potential, which includes the overall electricity demand and solar supply chains in China. It is, however, not the *quantity* but the *quality* of China's future electricity mix that creates unique opportunities for solar energy. China is in the midst of decarbonizing its economy and paving the way for an increased share of renewables in the overall electricity mix. To this end, China has already taken concrete steps to restructure its economic growth model by deemphasizing energy-intensive sectors such as manufacturing and moving instead towards cleaner and higher-paying industries such as financial services and web-based start-ups. The restructuring of energy supply will be part of this reform process, as indicated by recent policy documents and strategic guidelines which suggest that a significant share of this new power generating capacity will come from renewables such as solar and wind. This stands in stark contrast to previous trends, as historically China's power supply has been predominantly based on a cheap and domestic supply of fossil fuels, as shown in Table 14. Although coal currently supplies more than half of China's electricity mix, there are several indications that coal will be substituted by renewable energy sources in foreseeable future. China's 12th Five-year plan (2011-2015), for instance, sets the following goals:

- By 2017 and the share of non-fossil energies will rise to 15% by 2020 and 20% by 2030;
- By 2017, the share of coal in the total primary energy consumption will fall below 65%; and
- Carbon dioxide emissions will be reduced to 17 % by 2015 (compared to 2010 levels)

Table 13 China's Primary Electricity Supply in 2012

Fuel	Coal	Hydro	Nuclear	Wind	Natural gas	Biofuels	Waste	Oil	Solar
Share	75,0%	17,5%	2,0%	1,9%	1,7%	0,7%	0,2%	0,1%	0,1%
Amount in GWh	3784	872	97	95	85	33	10	7	6

Source: EIA statistics, www.eia.gov

Similarly, in March 2015, China's State Council issued a reform plan, which aims to optimize the country's energy mix and improve the share of renewable energy in electricity generation.[527] Decarbonization trends, diversification of electricity supply and an overall shift towards cleaner and environmentally friendly energy sources thus create unique market opportunities for solar photovoltaic deployment in China.

4.2.6.2 Overcapacities and Pressures from China's Solar Manufacturers

China possesses favorable market conditions also because of its solar industry, existing supply chains and manufacturing capacities. Although China's solar manufacturing industry dates back to the 1980s with the introduction of two single crystalline silicon solar cell production lines, it was not until the beginning of the 20th century that China's solar industry began to grow as a result of increasing global demand in Germany, Italy, Japan, Spain and the USA. Within only 12 years starting in 2000, the manufacturing capacity of Chinese PV modules increased 1000-fold, from 3MW to 23GW respectively. In 2008, China ranked the world's largest solar cell and solar module manufacturer, dominating 30% of the worldwide PV module production and shipping 26,000 MW peak of PV panels (equivalent to roughly one-third of worldwide total cell shipments) to markets in Europe and North America[528]. Among the world's top 15 PV cell industries in 2006, there were four Chinese Mainland enterprises while, by 2012, six Chinese enterprises were listed among the world's top 10 enterprises. Today the industry is dominated by several major manufacturers, such as CHINT Group Corporation, JA Solar Holdings, Jinniu Energy, Suntech Power, Yingli, China Sunergy and Hanwha SolarOne.

China's remarkable solar industry development owes itself to the unique ability of Chinese manufacturers to develop across the entire spectrum of the solar value chain (as opposed to country-specific advantages such as low labor and tax)[529]. As discussed in *Chapter Solar PV Value Chain*, the manufacturing processes of solar PV modules entails *upstream production* (polysilicon, ingot and wafer production), *downstream production* (solar cells and modules) and *PV installation* (PV system integrators). By 2009, China's manufacturers expanded to all solar upstream and downstream stages of the solar PV value chain, ranging from polysilicon production to wafers, cells and modules. This vertically integrated operation patterns across the entire value chain spectrum allowed Chinese solar manufacturers to develop strong international market competitiveness within a relatively short period of time.

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[527] China Electricity Council (CEC). (2015). *2015 Nián 1-2 yuèfèn diànlì gōngyè yùnxíng jiǎnkuàng*. Beijing, China. Retrieved on 4 June, 2015, from http://www.cec.org.cn/guihuayutongji/gongxufenxi/dianliyunxingjiankuang/2015-03-20/135495.html.
[528] Zhang, S., & He, Y. (2013). Analysis on the development and policy of solar PV power in China. *Renewable and Sustainable Energy Reviews*, 21, 393-401.
[529] Goodrich, A. C., Powell, D. M., James, T. L., Woodhouse, M., & Buonassisi, T. (2013). Assessing the drivers of regional trends in solar photovoltaic manufacturing. *Energy & Environmental Science*, *6*(10), 2811-2821.

Yet in some markets segments, such as in the case of polysilicon production, the intensity and rate of growth has also led to massive overcapacities and overinvestment. Polysilicon manufacturing requires sophisticated technologies, which is why this segment is traditionally dominated by few companies such as Hemlock, Wacker, Tokuyama, REC Silicon ASA, SunEdison Inc. (formerly known as MEMC Electronic Material), Misubishi, Sumitomo and other international corporations. For China's solar industry, this meant that almost 100% of the high-purity polycrystalline silicon required by the industry was imported from abroad. In 2008 the exceedingly high demand for solar cells in Europe and North America outpaced polysilicon production, leading to extreme bottlenecks in global polysilicon supply and skyrocketing prices for polysilicon to as high as US$500 per kilogram.[530] This bottleneck drove Chinese manufacturers such as GCL-Poly Energy Holdings Limited and LDK Solar to heavily ramp up their domestic polysilicon production and to supply nearly half of the silicon material required by China's PV industry. This trend was also spurred by local governments who offered polysilicon investors preferential tax rebates and exemptions, in an attempt to spur their local economies. Within only four years, polysilicon production in China grew by a factor of 2833, from 60 tons in 2005 to 170,000 tons in 2009. In 2009, some 50 new companies were building, expanding, and designing polysilicon production lines in more than 20 provinces throughout China.[531]

A positive side-effect of this polysilicon production boom was that solar manufacturers were able to drive down the costs for solar PV systems: Between 2000 and 2012, the average manufacturer-sale price of PV modules in China declined by over a factor of 10 (from 45 CNY/WP in 2000 to 4.5 CNY/WP respectively),[532] which in turn has made a considerable contribution to the extent and rate of solar energy utilization worldwide.[533] Conversely, the perils of such rapid escalation in solar manufacturing capacity combined with a strong export-orientation began to surface in 2011, when Chinese solar manufacturers saw themselves confronted with serious price dumping allegations and export sanctions from the European Union (EU) and US. Within the broader context of the global financial downturn and trade protectionism, the US and EU implemented a series of "anti-dumping and anti-subsidy"[534] penalties that led to international trade barriers for Chinese PV products. Moreover, Germany and other countries began to lower their PV subsidies for solar photovoltaic, which in turn led to a sharp decline in foreign demand. As a result, nearly all the solar manufacturers in China fell into significant loss status, followed by mergers, acquisitions, loan withdrawals, bankruptcies and excessive overcapacities.

China's solar PV manufacturing industry has therefore reached a historical turning point, at which it is strongly dependent on the development of a domestic solar market. Compared with the burgeoning of new manufacturers and the magnitude of growth, the domestic solar market in China has remained at a rather nascent development stage. This untapped market potential makes Chinese consumers an attractive target group for Chinese solar manufacturers. A re-orientation towards domestic markets and domestic consumers could alleviate some of the existing pressures,

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[530] Liu, Y. (2016). *China's "Silicon Bubble" Deflates at Early Stage*. Worldwatch Institute. Retrieved January 29, 2015, from http://www.worldwatch.org/node/6276

[531] Ibid.

[532] Goodrich, A. C., Powell, D. M., James, T. L., Woodhouse, M., & Buonassisi, T. (2013). Assessing the drivers of regional trends in solar photovoltaic manufacturing. *Energy & Environmental Science*, *6*(10), 2811-2821.

[533] SEMI (2013). *Report on development of solar PV industry in China*. China Solar PV Advisory Committee and China PV Industry Alliance.

[534] In 2014, the United States Commerce Department found that Chinese solar companies had benefits from unfair government subsidies and had thus dumped their solar products on the American market at below cost. Penalty duties declared by the United States Commerce Department ranged from 10,74% to 55.49% (see for example http://www.nytimes.com/2014/07/26/business/energy-environment/solar-industry-is-rebalanced-by-us-pressure-on-china.html?_r=0)

overcapacities and mal-investments that have accumulated in China's solar industry over the past years and could serve as a stabilizing factor to ward off socio-economic tensions in times of faltering economic performance and growing social discontent.

4.3 China's Energy Sector, Institutions and Actors

4.3.1 Primary Energy Consumption

China's growth in GDP has been the principal driver of energy demand in China. According to the International Monetary Fund (IMF), China's annual real gross domestic product (GDP) growth slowed to a reported 7.4% in 2014, which was the lowest since 1990, after registering an average growth rate of 10% per year between 2000 and 2011.[535] In 2011, China became the world's largest global energy consumer, accounting for one fifth of all global energy consumption. Energy consumption in China has grown more than six-fold within the past 30 years, from 5714 million tons of SCE in 1978 to 37500 million tons of SCE in 2013. In 2013, energy consumption was mainly supplied through coal (66%), crude oil (18%), natural gas (5,4%) and hydropower, nuclear and wind power (9,8%). By 2030, China's energy consumption is expected to increase by 60%.[536] China's energy demand growth is also among the world's highest,[537] which could lead to a shortage of own energy resources and call for a greater demand in imported fuels, leading to questions of energy security and volatile energy prices.

Table 14 Overall Energy Balance in China (indicated in Mio tons of Standard Coal Equivalent (SCE))

Item	1990	1995	2000	2005	2010	2011	2012	Growth factor 1990 - 2012
Total Energy Available for Consumption	9613	1295	1426	232 2	339 7	362 8	3787	3,9
Primary Energy Output	1039	1290	1350	2162	2969	3178	3318	3,2
Imports	13	55	143	270	557	623	666	50,8
Exports (-)	- 59	-68	-96	-114	-88	-84	-74	0,0

Source: Author, based on China's National Bureau of Statistics (2014). China's Statistical Yearbook, see http://www.stats.gov.cn

[535] International Monetary Fund (IMF). (2015). *Slower Growth in Emerging Markets, a Gradual Pickup in Advanced Economies*. In Washington D.C, USA. Retrieved on 1 February 2016, from https://www.imf.org/external/pubs/ft/weo/2015/update/02/.
[536] International Renewable Energy Agency (IRENA). (2014). *Renewable Energy Prospects: China REmap 2030 analysis.* Abu Dhabi, Arab Emirates.
[537] World Bank Statistics.

4.3.2 China's Electricity Supply, Demand and Transmission

China's electricity sector is the largest in the world. Within the past 20 years, demand in electricity has grown almost eight-fold, from 6230 billion kWh in 1990 to 49767 billion kWh in 2012. Yet in recent years and given the economic slowdown, electricity demand has slowed down from 7,5% in former years to only 3.8% in 2014.[538] Yet China's power transmission system remains fragmented and largely under-developed. The national grid consists of six regional grids, of which five are managed by the state-owned State Grid Corporation (north, north-east, east, central and north-west grids) and one is managed by the South China State Grid Corp (covering the light manufacturing hub around Guangzhou-Shenzhen and the inland areas of Guangdong, Guangxi and Guizhou). Electricity grid assets are controlled by three state-owned companies: The State Grid Corporation of China (SGCC, hereinafter referred to as State Grid),[539] the China Southern Power Grid Company Limited (CSG, hereinafter referred to as Southern Grid)[540] and the Inner Mongolia Electric Power Group. Additionally, China has 39 transmission companies (5 regional and 32 are provincial companies) as well as 3171 distribution companies (of which 431 are municipal and 2740 county companies).

Future electricity demand will likely slow down due to several factors, most importantly (i) China's new macroeconomic trajectory that builds on slower growth and greater efficiencies and (ii) the restructuring of China's industry away from energy-intensive industries such as steel, coal, and construction and towards clean and higher value-added industries, such as computer technology, quality manufacturing, agricultural modernization, and healthcare.[541] That being said, China will likely expand its Demand-Side Management (DSM) in the industry, transport and buildings sectors.[542] The decelerated energy demand will be met through an electricity mix that includes a range of energy sources, such as coal (below 62% by 2020), oil, renewable energy as well as cleaner or advanced conventional energy such as gas and nuclear. According to China's 12 Five-Year-Plan (FYP) non-fossil fuels will supply 15% of the primary energy consumption and constitute 438 GW of the installed power generating capacity by 2015 (consisting of 200 GW installed wind capacity, 100 GW installed solar capacity, 50 tons of SCE geothermal energy).

Central features of China's energy sector are (i) the geographic mismatch between energy resources and energy consumption which is amplified by the absence of an unified, national grid and low interregional cooperation; (ii) an unfavorable economic structure with a strong focus on energy-intensive (heavy) industries; (iii) an unfavorable traditional energy use that is mainly based on coal resources, (iv) seasonal peak loads; and (v) logistic and weather-induced delays in coal transport due to natural disasters. The most important challenge, however, pertains to the

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538 National Energy Administration of China (NEA). *Guójiā néngyuán jú fābù 2014 nián quán shèhuì yòng diàn liàng* (2015). Beijing, China: National Energy Administration (NEA). Retrieved on 30 March, 2015 from http://www.nea.gov.cn/2015-01/16/c_133923477.htm.

539 The State Grid covers 26 of China's 31 provinces, extends to 88 % of China's territory and connects over one billion people to the grid. It has 1.5 million employees and belongs to the largest utility in the world, ranking in position seven of the Fortune Global 500 List in 2013.539 The State Grid consists of five regional power grid companies, and 26 provincial electric power companies, five scientific research institutes and 22 affiliates.

540 The Southern Grid on the other hand, operates only in five provinces, namely Guangzhou, Guangxi, Yunnan, Guizhou and Hainan. For more information, see official website: http://eng.csg.cn

541 Meidan, M., Sen, A., & Campbell, R. (2015). China: the 'new normal' *The Oxford Institute for Energy Studies*, 1–13.

542 For this the National Development and Reform Commission (NDRC) and the Ministry of Finance (MoF) have amended the DSM guideline in 2011 and have decided on a Energy saving quota of 0.3% on the demand side. Additionally, China has started some pilot projects such as in Suzhuo, Beijing, Foshan und Tangshan, Shanghai

geographic mismatch between electricity demand and supply. China's *electricity demand* is highest in the fast-growing energy consumption centers in the east (Shanghai and Zhejiang) and south (Guangdong, Guangxi and Guizhou), where high population densities coincide with energy-intensive industrial activities. Electricity demand has shifted towards central and coastal regions and has correlated strongly with *urbanization* trends. Today more than half of the Chinese population lives in cities, as urbanization rates rose from 19.39% in 1980 to 51.27% in 2011.[543] China's central and coastal regions are therefore responsible for around 70% of China's total energy demand compared with sparsely populated western regions.[544] *Electricity supply* through coal-based power plants and hydropower, on the other hand, is mostly distributed in areas far away from coast. Coalmines and coal-based power plants, for instance, are mostly situated in the Northeast (Heilongjiang, Jilin and Liaoning Province), northern (Shanxi, Shaanxi and Henan Province) and West (Xinjiang Province). This results in a geographic mismatch, as both the highest quality and highest concentration of coal reserves (91%) are therefore found in northern parts of the country, whereas the energy-hungry and economically dynamic areas of south-central and eastern China have only about 9% of national coal reserves.[545] Electricity supply through coal is therefore inevitably bound to logistical challenges as coal transportation from the mines to power stations ties up more than 60% of China's rail capacity.[546] In many cases this leads to heavy traffic congestion and supply bottlenecks, which in turn adversely impacts coal electricity prices and competitiveness. Similarly, hydropower dams are mainly situated the Southwest (Sichuan, Yunnan, and Tibet), and the fast-growing industrial load centers of the east (Shanghai-Zhejiang) and South (Guangdong, Fujian).

These challenges have led to localized electricity shortages. Northern regions for instance, experience shortages especially during winter months, when there is increased demand for heating and when logistical difficulties arise due to weather-related traffic congestion. Contrary, southern regions encounter bottlenecks in late spring until July/August when large parts of the population resort to air-conditioning and when hydropower reservoir levels are low (this situation endures continues until July/August when summer rains arrive). Southern Provinces such as Guangdong have therefore started to bridge this power gap by importing substantial quantities of expensive oil and diesel to run additional generation capacity. The Chinese government is responding to these existing energy challenges by massively expanding its generating capacity (clean) by means of coal and hydropower. Renewable energy also plays an important role, albeit to much lesser degree. In future, China's government will likely deal with the following energy policy priorities: (1) transitioning the country's economic and industrial growth and composition and adjusting its industrial structure in the long-term, (2) expanding the renewable energies while simultaneously capping coal consumption in the medium- to long-term and (3) increase of energy efficiency in the medium- to short-term.

4.3.3 Energy Resources, Production and Trade

Although energy policies are considered an independent policy field in their own right, they are inevitably shaped by and compete with a multitude of other policy fields, such as fossil fuels and other renewable energies. In the context of China, this includes predominantly fossil fuels, such as coal, natural gas, oil, petroleum but also hydropower and wind energy. The following sections

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543 Wang, Q. (2014). Effects of urbanization on energy consumption in China. *Energy Policy*, 65, 332-339.

544 China's total population is estimated at 1.3 billion people.

545 Lu, Y. (2003). Fueling One Billion: An Insider's Story of Chinese Energy Policy Development. Washington, D.C., USA: Washington Institute Press.

546 Zhu, C. (2012, November 21). China's power grid plans: a $250 billion white elephant? *Reuters.*

provide a brief description and overview of the differing and competing policy fields and resources that are available in China.

4.3.3.1 Coal Resources

One of the most distinguishable attributes of China's energy sectors is its heavy reliance on coal. Coal has been traditionally the main source for electricity, heating and development of energy-intensive heavy industries. China is the world's largest coal consumer and producers, as shown in Table 16. China became a coal importer in 2009, importing around 6,1% of its consumed coal. The process of mining, transporting and burning coal causes severe harm to the environment and public health, including land and water impacts from mining, and air, water and coal ash pollution from combustion. The IEA predicts that China's future coal demand will peak in around 2030, at levels around 10% higher than today. With approximately 2,800 Megaton Of Coal Equivalent (Mtce) by 2040, China will likely remain by far the largest coal producer and requiring 8% of its domestic demand to be covered by imports.[547]

Table 15 China's Coal Balances in 2012

Sectors	Amount	Details
Coal Consumption	3.8 Gtce	Total World Coal Consumption is 7.7 Gt, therefore China accounts for 49% of world's coal consumption followed by the US (11%)
Coal Domestic Production	4160 Mtce	Inner Mongolia (25%), Shanxi (22%) and Shaanxi (11%)
Coal Export	9.26 Mtce	Japan (44%), South Korea (40%) and other Asian states (14%)
Coal Import	234.28 Mtce	Indonesia (29%), Australia (25%), Mongolia (9%), and Russia (9%)

Source: The Lawrence Berkeley National Laboratory China Energy Group (2015) Key China Energy Statistics 2014, retrieved from http://eetd.lbl.gov/sites/all/files/key_china_energy_stattistics_2014_online.final_.pdf

4.3.3.2 Crude Oil and Petroleum Resources

The heavy demand for coal has also driven up diesel consumption, as roughly two thirds of diesel is used for coal transportation via trucks and trains.[548] Moreover, China has the world's largest car market that covers more than 300 million transit and private motor vehicles.[549] That being said, China ranks as the world's second-largest oil consumer, predicted to overtake the US in oil consumption in 2030.[550] Some of China's demand is met through domestic oil sources, as China is the largest oil producing country in the Asia-Pacific region (excluding Russia). China's estimated oil reserves amount to 24.6 billion barrels of proved oil reserves mostly in the, but also

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547 International Energy Agency (IEA). (2014). *World Energy Outlook 2014*. Paris, France: IEA.

548 Since the mid-2000s, when the Chinese government mandated that all trucks should run on diesel. This has led to a substantial surge in diesel demand, as more than 700,000 trucking operators found employment in transporting goods, particularly coal which was shifting from overburdened rail systems to trucks. For more, see The Economist. (2014, July 12). Logistics The flow of things. *The Economist.* Shanghai and Suzhou, China.

549 U.S. Energy Information Administration (EIA) Statistics.

550 International Energy Agency (IEA). (2014). *World Energy Outlook 2014*. Paris, France: IEA.

in western interior regions and offshore. In 2014, China produced nearly 4.6 million barrels per day (bbl/d) of petroleum and other liquids, of which 92% was crude oil and the remainder was non-refining liquids and refining gain. China's largest oil fields are mature, and production has peaked, causing companies to invest in techniques to sustain oil flows at the mature fields, while also focusing on developing largely untapped reserves in the western interior provinces and offshore fields (involving deep-water and tight oil extraction).[551] China also relies to a large extent on crude oil imports, which have increased dramatically over the past decade but which have been diversified to mitigate geopolitical uncertainties. In this context, China is heavily expanding its domestic and transnational pipeline network with Kazakhstan, Russia, and Myanmar.[552] Since the 1980s, China's oil sector has been controlled by three powerful national oil companies (NOCs), namely China National Petroleum Corporation (CNPC), the China Petroleum and Chemical Corporation (Sinopec), and China National Offshore Oil Corporation (CNOOC). In recent years, diesel demand has declined due to slower economic growth, decreased need for coal and mining products, greater efficiency in heavy-duty vehicles, and increased use of natural gas-fired vehicles.

Table 16 China's Petroleum Balances in 2012[553]

Sectors	Amount	Details
Petroleum Consumption	3,751 million barrels	Total World Petroleum Consumption is 32,642 million barrels. China ranks second as the world's largest petroleum consumer (11%) behind the U.S. (21%)
Crude Oil Production	207 Mt	Heilongjiang (19%), Shaanxi (16%), Tianjin (14%), Shandong (13%)
Crude Oil Export	2.4 Mt	Japan (55%), North Korea (21%), USA (8%)
Crude Oil Import	271 Mt	Saudi Arabia (20%), Angola (15%), Russia (9%), Iran (8%), Oman (7%), Iraq (6%)

Source: Based on China Energy Group. (2015). Key China Energy Statistics 2014. Berkeley, USA: Lawrence Berkeley National Laboratory. Retrieved on 1 March, 2016, from http://eetd.lbl.gov/sites/all/files/key_china_energy_stattistics_2014_online.final_.pdf

4.3.3.3 Natural Gas Resources

Natural gas production rose in China in the 1960s and 1970s, after large gas deposits were discovered in Sichuan province. Until 2007, China was traditionally a net gas exporter after which it became a natural gas importer. Since then, gas imports have increased dramatically in tandem with rapidly developing pipeline and natural gas processing infrastructure. Natural gas has been mainly used in the chemical industry, fertilizer production, for residential use and for gas-fired vehicles. Natural gas plays a minor role in primary energy consumption and therefore China is still able to cover most of its demand through domestic production from onshore and offshore reserves, as shown in Table 18. Natural gas is also imported via transnational pipelines from Russia and Central Asia. By 2020, China plans to boost its share of natural gas to 10% of the primary energy mix, as natural gas is considered a cleaner-burning fossil fuel than coal or oil,

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[551] U.S. Energy Information Administration (EIA) Statistics.
[552] China's first transnational pipeline started operating in 2006, when China began importing Kazakh and Russian oil via Kazakhstan. Similarly, Russia's new East Siberian oil fields have become another source for Chinese crude oil imports.
[553] Lawrence Berkeley National Laboratory. (2015). Key China Energy Statistics 2014. *China Energy Group*, 1–66.

with about half the CO2 emissions from combustion as coal and far lower emissions of SO2 and other air pollutants.[554] Similar to oil, China's natural gas sector is dominated by the three principal state-owned oil and gas companies: CNPC, Sinopec, and CNOOC. In May 2014, Russian state-controlled entities Gazprom and China National Petroleum Corp (CNPC) signed a $400-billion and 30-year gas supply deal in Shanghai. Under this biggest energy contract that it has ever signed Russia will begin delivering gas from 2018, gradually increasing to 38 billion cubic meters a year and totaling over 1 trillion cubic meters for a whole contractual period.

Table 17 China's Natural Gas Balances in 2012[555]

Sectors	Amount	Details
Natural Gas Consumption	147 billion m3	The world's natural gas consumption is 3,399 billion m3. China globally ranks 4th (4%) in natural gas consumption, after the US (21%), Russia (13%), Iran (5%)
Natural Gas Production	107 billion m3	Shaanxi (22%), Inner Mongolia (18%), Xinjiang (18%), Sichuan (12%)
Liquefied Natural Gas Import	14.68 Mt	Qatar (34%), Australia (24%), Indonesia (16%), Malaysia (13%)

4.3.3.4 Nuclear Energy Resources

After placing its first nuclear power plant into operation in 1991, China is currently undertaking a rapid expansion of its nuclear power capacity from the current 12.5 GW to approximately 40 GW by 2015 and an estimated 70 GW by 2020. China's nuclear plants utilize mostly pressurized water reactors (PWR) generation II technology. There are currently three nuclear power plants clusters in operation: The Guangdong Daya Bay Nuclear Power Plants Base, the Zhejiang Qinshan Nuclear Power Base and the Jiangsu Tianwan Nuclear Power Plant Base. All are located in coastal areas with high economic activities and energy demand, but few natural resources. Nuclear power is considered one of the few options available to reduce carbon-dioxide emissions at scale and is therefore considered an important means to achieve 15% of its energy from non-fossil sources by 2020. Following the Fukushima nuclear disaster in March 2011, the Chinese government temporarily suspended approvals of new projects until it could prepare a new nuclear safety plan and strengthen the approval process. Since then the government has renewed its focus on the safety of nuclear power plants, undertaking a safety inspection of operating plants and plants under construction and halting approval of new plant applications, strengthening safety standards and designs for nuclear power plants. The IEA predicts that China alone will account for 46% of incremental world nuclear generation in 2040, surpassing the US and the largest producers just after 2030.[556] By the year 2020, China seeks to rapidly expand its nuclear power capacity to 70 GW.

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554 Ögütcu, M. (2009). Energiewirtschaft. In B. Staiger, S. Friedrich, H. W. Schütte, & R. Emmerich (Eds.), *Das große China-Lexikon: Geschichte, Geographie, Gesellschaft, Politik, Wirtschaft, Bildung, Wissenschaft, Kultur* (2nd ed., pp. 1–974). Darmstadt, Germany: Wissenschaftliche Buchgesellschaft (WBG).
555 Lawrence Berkeley National Laboratory. (2015). Key China Energy Statistics 2014. *China Energy Group*, 1–66.
556 International Energy Agency (IEA). (2014). *World Energy Outlook 2014*. Paris, France.

4.3.3.5 Hydropower and other Renewable Energies

Hydropower constitutes the largest share of non-fossil energy in China and has been developed and exploited in China for many decades. China has the world's largest hydropower installed capacity totaling 319 GW in 2015 (including 1.2 GW of pumped storage) and reaching approximately 420 GW by 2020 (350 GW of regular hydro and 70 GW of pumped hydro). Two thirds of China's hydropower capacity are large hydropower (more than 50MW)[557] whereas one third is small hydropower (less than 50 MW) and pumped hydro storage stations. The majority of China's hydropower resources lie in the southwestern part of the county including Hubei province (home to the largest hydropower project, the Three Gorges Dam, on the Yangtze River), Sichuan, Chongqing, Yunnan, Guizhou and Qinghai. Despite concerns about ecological, environmental and social impacts[558] of hydropower, China plans to expand its hydropower capacities in the coming decades, including the construction of 25 large hydropower projects on the Jinsha river in Yunnan Province and its expansion of pumped storage capacity to better integrate intermittent, renewable energy sources.

Wind electricity has also become an increasingly important energy source and has been the fastest growing renewable energy source in China. China experienced a rapid increase in wind power beginning in the Eleventh Five Year Plan (2006-2010), with wind increasing from a mere 1.3 GW at the end of 2005 to 65 GW of installed capacity by the end of 2011 (45 GW of which was connected to the grid), making China the world leader in terms of installed capacity. Regions with the highest wind capacity are located in the deserts of West China in remote areas in the North and Inner Mongolia. This rapid expansion was made possible through the Renewable Energy Law (REL), passed in 2005, which helped establish renewable energy targets, a mandatory connection and purchase policy requiring grid companies to connect renewable power generators, a national feed-in tariff system that establishes fixed prices for renewable power generation, and a cost-sharing mechanism to pay for the feed-in tariffs. After several years of developing wind power projects using an auction mechanism, China in August 2009 established national on-shore wind power feed-in tariffs of 0.51-0.61 CNY per kWh, depending on the location of the wind farm. China's wind resources are particularly plentiful in the north, with wind farm development most notable in Inner Mongolia (28% of China's installed capacity as of 2011), Gansu, Hebei and Liaoning provinces. China is currently developing seven large-scale wind power bases with at least 10 GW of installed capacity, in east and west Inner Mongolia, Xinjiang, Jiuquan in Gansu, Hebei, Jilin and the shallow seas off of Jiangsu. China has also begun to develop its offshore wind resources. Key tasks to increase the utilization of wind power in the future will be: improving wind turbine technology, grid-connection standards and wind forecasting to improve integration of wind power with the grid, completing construction of transmission lines to bring wind-generated electricity to eastern demand centers, improving coordination of wind farm and grid planning, and establishing renewable energy generation and consumption quotas for generators, grid companies and provinces. Wind will continue to be a key and growing source of renewable electricity in China in the next decade, with capacity expected to expand to 100 GW by 2015 and 200 GW by 2020. The construction of large-scale wind farms and off-shore wind farms, and improvements in wind turbine technology, grid integration and transmission, will help to ensure that wind continues to expand rapidly in China. In terms of modern renewable energies, China will see a six-fold expansion led by further significant wind power output.[559]

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557 An example hereof is the Three Gorges Dam with 22.5 GW of capacity.

558 Drawbacks and Risks associated with hydropower stations include an increased potential for droughts, silt build-up, the displacement/resettlement of local populations, the increased risk of methane emissions, and the increased risk of landslides.

559 International Energy Agency (IEA). (2014). *World Energy Outlook 2014*. Paris, France.

Solar Photovoltaic electricity has also become an important source of electricity (see 4.3 Policy Rationale: Opportunities, Challenges and Constraints of Solar PV in China). Solar PV is currently in applied in the following areas: (i) government demonstration projects; (ii) civilian projects (*Minxin xiangmu*); (iii) international cooperation program; (iv) power source for communications and satellite signals in rural areas; and (v) street lighting, advertising signs, garden lamps (*Keji shifan xiaoying*).[560]
Last but not least, China has also a range of other renewable energy sources ranging from geothermal energy, biomass energy and tidal energy, all of which will likely gain importance in China's in the medium to long-term to diversity China's energy mix. Most of these energy sources are, however, located in remote areas, such as geothermal resources, which are highest in the Himalaya region and to some extent in the southern coast. Therefore, exploitation of these resources will also depend on accessibility, technological advances and economic feasibility.

4.3.4 Institutional Landscape, Energy Actors and Processes

Especially in China the energy sector has been proclaimed a strategic industry ever since the inception of the People's Republic of China (PRC) in 1949, which makes it a highly political issue that is naturally consistent with the Communist party's ideological and strategic inclinations. Although reforms and liberalization have gradually found their way into the energy sector, policymaking in China persists to being a lengthy, opaque and fragmented process that is characterized by heavy bureaucratic traditions and a distinct consensual form of decision-making. Therefore, energy policy choices are contingent on a number of factors that mostly pertain to Communist ideology and vision, institutional settings, formal decision-making bodies and power hierarchies, along with domestic and external factors that shape, drive or constrain energy policy choices. The aim of this section is therefore to shed light on the inherently complex and oftentimes opaque processes and context of initiating, approving, formulating and implementing energy policies in China and to shed light on the different factors and constraints that come into play when policy choices are made. More specifically, this chapter examines the political and institutional framework of China, the key drivers of energy policy, the energy actors and institutions involved, policy processes and decision-making as well as domestic and external factors that shape energy choices. China's heavy bureaucratic tradition and the consensual form of decision-making render policy making a lengthy process that, in order to gain the support of all the related ministries, is translated into watered down regulations that are often outdated by the time of their final approval. Furthermore, there are a growing number of actors involved in the Chinese energy sector, each introducing new ideas and initiatives into the existing system that then shape the decision-making process and policy implementation.

4.3.4.1 The Overall Political Structure

In the early days of the Communist regime, the Communist Party of China (CPC) and the Chinese government operated as one single entity under slogan "the Party's absolute and unified leadership". Since the late 1970s, however, the CPC and the government have gone separate ways. Today the state is mainly responsible for the management of the country's economy whereas the CPC controls all political matters such as propaganda, ideology and security.

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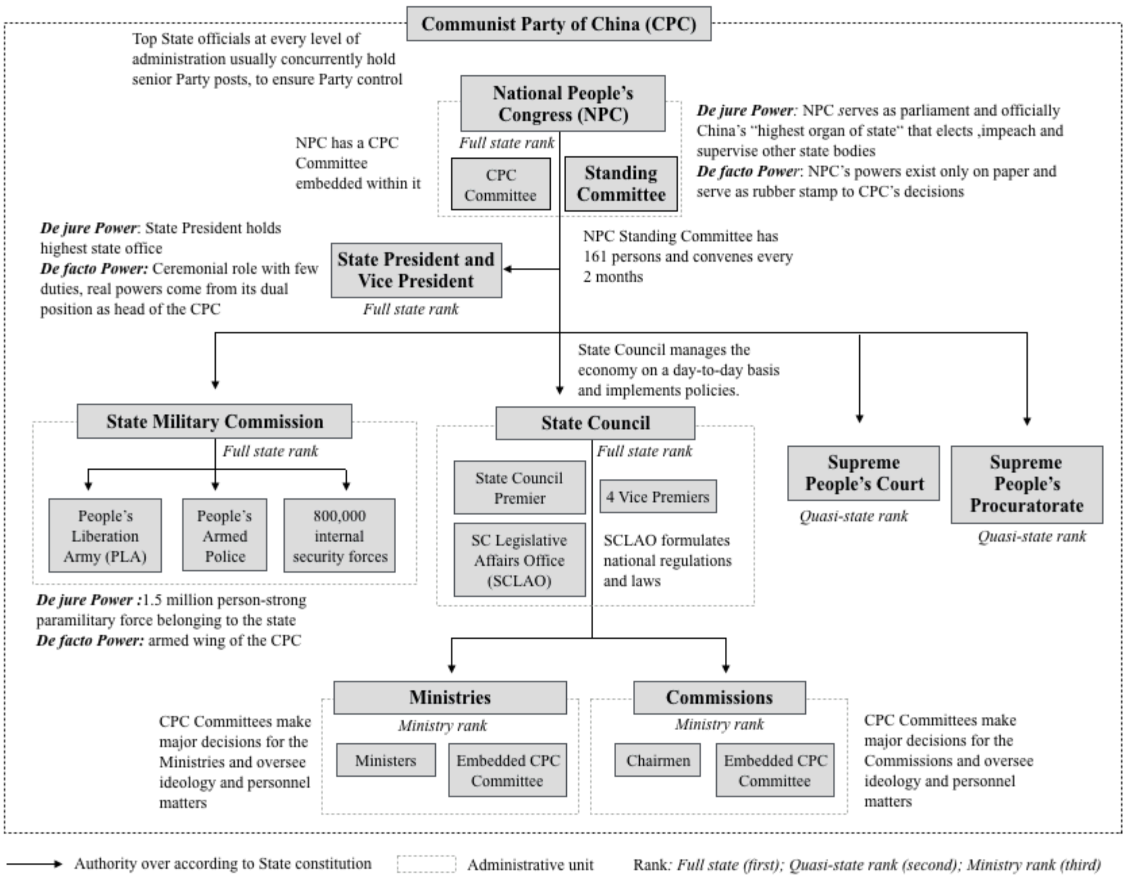
[560] Yu, J. (2007). Woguo Taiyangneng Fadian Xianzhuang Fazhan Zhang`Ai Ji Cujin Cuoshi. Huatong Jishu, 3.

Figure 16 Approximate Illustration of China's State



Source: Author

According to China's constitution (Chapter "Structure of the State"), political authority in China is *de jure* distributed among the following state institutions, as shown in Figure 16:

1. China's unicameral legislature, the *National People's Congress*, which serves as the country's "highest organ of state power" supervising the work of four other political bodies, namely
2. *The State Council*, which serves as the highest organ of state administration;
3. The State Central Military Commission, which comprises mostly of the People's Liberation Army (PLA)[561] and the People's Armed Police;
4. *The Supreme People's Court*, which is the highest judicial organ; and
5. *The Supreme People's Procuratorate* (the main prosecutor authority).

[561] China's military, the People's Liberation Army (PLA), is considered an armed wing of the Communist Party, as the CPC exercises "absolute leadership" over the military to stay in power. The PLA's willingness to put the Communist Party's interests first was tested in 1989, when the Party ordered tanks into the streets of Beijing to clear unarmed protestors from Tiananmen Square. A heavy emphasis on political indoctrination—and particularly on the need for the PLA to be unswervingly loyal to the Communist Party—has been a hallmark of the PLA from its earliest days. Among the five "core values" for the military outlined by China's most recent Party and military chief, Hu Jintao, "loyalty to the Party" came first, ahead of "ardent love for the people," and "service to the country". For more see James Mulvenon, "Hu Jintao and the 'Core Values of Military Personnel'", China Leadership Monitor, no. 28 (May 8, 2009).

These five institutions constitute the Chinese government and are officially separated from the Communist Party. Although there is only a sideline mentioning of the Communist Party in the preamble of the state constitution,[562] the CPC is indisputably the most powerful institution in China that practically controls all of the six abovementioned state institution by means of (i) authority over personnel decisions in line with the Soviet *Nomenklatura System;*[563] (ii) operating parallel party committees within all important state and non-state organizations;[564] and (iii) applying a system of *democratic centralism* to discipline subordinate state organs.[565] That being said, the CPC effectively retains full control over the country's legislature, judiciary, military, media, mass organizations and strategic enterprises by means of informal influences, hidden power hierarchies and unlimited *de facto* decision-making power.[566] The CPC stands therefore above the state constitution, which implies that "the CPC is the sovereign, and not the people".[567] The ubiquitous role and influence of the CPC has also inevitably contradicted political and administrative decision-making authorities and has eroded formal institutions, which in turn has rendered policy choices a blurred and sometimes arbitrary process that is sometimes more understandable from the viewpoint of ideology, tradition and vision of the CPC than from a purely rationale perspective.

The salience of weak institutional structures is rooted in China's history absence of organized institutions (such as religious or church spheres) to separate and delineate state power[568]. Until

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[562] The clearest statement of Party leadership in the state constitution's preamble is, "Under the leadership of the Communist Party of China and the guidance of Marxism-Leninism, Mao Zedong Thought, Deng Xiaoping Theory and the Important Thought of the 'Three Represents,' the Chinese people of all ethnic groups will continue to adhere to the people's democratic dictatorship and the socialist road, persevere in reform and opening to the outside world, steadily improve socialist institutions, develop the socialist market economy, develop socialist democracy, improve the socialist legal system, work hard and self-reliantly to modernize the country's industry, agriculture, national defense and science and technology step by step, and promote a coordinated development of material, political and spiritual civilizations to turn China into a socialist country that is prosperous, powerful, democratic, and culturally advanced."

[563] The *Nomenclatura* were a category of people within the Soviet Union and Eastern Bloc countries who applies a system by which various key administrative positions in all spheres of government, industry, agriculture, education, etc., were granted and approved by the ruling communist party. It enables the CPC to appoint nearly all key positions of the government to its leading Party cadres, such as positions within the State Council, ministries, legislature, courts, state-owned enterprises, universities, hospitals, most private companies and major non-governmental organizations.

[564] Communist Party units exist in all official and semi-official organizations and institutions, including state- owned enterprises and universities. As of the end of 2011, they also existed in nearly 1 million private businesses and foreign-owned enterprises and in nearly every officially registered civil society organization. For more see Lawrence, S., & Martin, M. F. (2012). *Understanding China's political system. CRS Report for Congress*. Congressional Research Service.

[565] One example here is that the State Military Commission is identical with the CPC's Party Central Military Commission, which is believed to exist in name only. In the Party constitution, Party leadership of the legislature, the State Council, the courts, and the prosecutor's office is not explicitly stated, but is implied. Source: Lawrence, S., & Martin, M. F. (2012). *Understanding China's political system*. CRS Report for Congress. Congressional Research Service.

[566] Burns, J.P. (1999). The People's Republic of China at 50: National political reform. *The China Quarterly 159*, 580-594; Emmerich, R., Cabestan, J. P., Heilmann, S., & Schubert, G. (2009). Stichwort Politisches System. In B. Staiger, S. Friedrich, H. W. Schütte, & R. Emmerich (Eds.), *Das große China-Lexikon: Geschichte, Geographie, Gesellschaft, Politik, Wirtschaft, Bildung, Wissenschaft, Kultur* (2nd ed., pp. 573–581). Darmstadt, Germany: Wissenschaftliche Buchgesellschaft (WBG).

[567] Emmerich, R., Cabestan, J. P., Heilmann, S., & Schubert, G. (2009). Stichwort Politisches System. In B. Staiger, S. Friedrich, H. W. Schütte, & R. Emmerich (Eds.), *Das große China-Lexikon: Geschichte, Geographie, Gesellschaft, Politik, Wirtschaft, Bildung, Wissenschaft, Kultur* (2nd ed., pp. 573–581). Darmstadt, Germany: Wissenschaftliche Buchgesellschaft (WBG).

[568] Ibid.

the establishment of the Republic in 1912, China had traditionally been under the rule of absolute monarchy and all state institutions were under absolute rule and direction of the Imperial Court. Moreover, during the People's Republic of China (PRC), institutional structures were further eroded by the informal decision-making practices during the Mao Zedong and Deng Xiaoping eras[569]. Although the Jiang Zemin and Li Peng regime and leadership generations since then have put much effort into strengthening and reinforcing the formal institutional structures of power, informal power structures have persisted to this day.

Hence political power does not necessarily correspond to formal position and organizational rank, but rather to personal prestige, length of service, loyalty from protégés, and clever concealed manipulation tactics[570]. Personalized networks of influence (*guanxi*), backdoor negotiations and rigorous repression of political opposition remain therefore preeminent features of the governance system[571]. Nonetheless, China features a high degree of factionalism, Although China is effectively a one-party state, multiple coalitions, factions, and constituencies exist within the political system. Political mentorship, place of birth, the affiliations of one's parents, and common educational or work history may lead individuals to form political alliances.[572]

4.3.4.2 Key Actors in China's Energy Arena

Despite the CPC's prevalent role and its implicit influence on all spheres of energy policymaking, energy policy choices are the outcome of the interaction between an ever growing number of new and emerging energy actors, who introduce new ideas and initiatives and seek to shape decision-making processes and policy implementation.[573] Despite that China's energy sector is mostly state controlled, recent reforms and market liberalizations have led to a burgeoning of new and emerging actors and institutions that are highly heterogeneous in their responsibilities, administrative tasks, influential powers and composition. Given such pluralization trends, scholars have contended that an increasing number of policy actors are able to influence the policy debate,[574] which can be broadly distinguished into three categories: (i) the agenda setters and decisionmakers; (ii) the technocrats and policy initiators; and (iv) the social elite.[575] This section provides an overview of the individual actors, their profiles, structures and the modes of interaction among them, as shown in Figure 16.

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569 Ibid.

570 Ibid.

571 China's legal system developed only after the demise of Mao Zedong's Cultural Revolution in the late 1970s, consequently, the country's legal system is still relatively young and underdeveloped

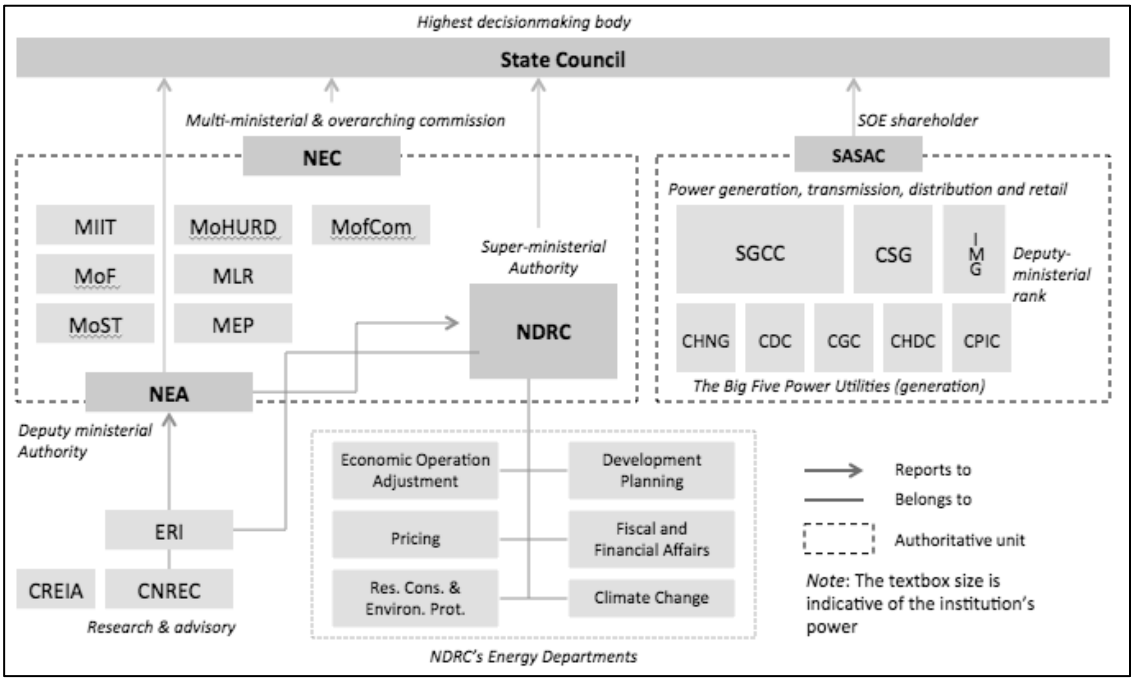
572 Lawrence, S., & Martin, M. F. (2012). *Understanding China's political system. CRS Report for Congress*. Congressional Research Service.

573 Meidan, M., Andrews-Speed, P., & Xin, M. (2009). Shaping China's Energy Policy: actors and processes. *Journal of Contemporary China*, *18*(61), 591–616. http://doi.org/10.1080/10670560903033885.

574 See for instance Mertha, A. (2009). "Fragmented Authoritarianism 2.0": Political Pluralization in the Chinese Policy Process. *The China Quarterly*, *200*, 995–1012. http://doi.org/10.1017/S0305741009990592.

575 This classification is borrowed and modified from Chen, who defines political authorities, technological bureaucrats and the social elite. See Chen, L. (2008). Bureaucratic System and Negotiation Network: A Theoretical Framework for China's Industrial Policy. In *OECD Reviews of Innovation Policy: China* (pp. 597-612). Paris, France: Organization for Economic Co-operation and Development (OECD)..

Figure 17 Stakeholders Constellation and Interaction in China's Electricity Sector[576]



Source: Author

Table 18 Names and Abbreviations of Electricity Sector Actors

Abbreviation	Institution Name
CDC	China Datang Corporation (Zhōngguó dà táng jítuán gōngsī)
CGC	China Guodian Corporation (Zhōngguó Guódiàn Jítuán Gōngsī)
CHDC	China Huadian Corporation (Zhōngguó Huadian Jítuán Gōngsī)
CHNG	China Huaneng Corporation (Zhōngguó Huaneng Jítuán Gōngsī)
CNREC	China National Renewable Energy Centre (*Zhongguo kezai shengnengyuan zhongxin*)
CPIC	China Power Investment Corporation (*Guójiā diànlì tóuzī jítuán)*
CREIA	China Renewable Energy Industries Association (Zhongguo Ziyuan Zongheliyong Xiehui kezaishengnengyuan Zhuanye Weiyuanhui)
CSG	China Southern Power Grid Cooperation (*Zhongguo Nanfang Diangwang*)
ERI	Energy Research Institute (Guojia fazhan he gaige weiyuanhui nengyuan yanjiu suo)
IMG	Inner Mongolia Power Group Co. Ltd. (Neimenggu dianli (jítuan) youxian zeren gongsi)
MEP	Ministry of Environmental Protection (*Huanjing Baohubu*)
MIIT	Ministry of Industry & Information Technology (*Gongye He Xinxihuabu)*
MLR	Ministry of Land and Resources (*Guotuziyuanbu*)
MoF	Ministry of Finance (*Caizhengbu)*

[576] Based on interviews with stakeholders, most important of which wa the German Agency for International Cooperation (GIZ) in Beijing

MofCom	Ministry of Commerce (*Shangwubu*)
MWR	Ministry of Water Resources *(Shuilibu)*
MoHURD	Ministry of Housing, Urban & Rural Development (*Zhufang Chengxiang Jianshebu*), (formerly known as Ministry of Construction)
MOT	Ministry of Transport (*Jiaotong Yunshubu*) (formerly known as Ministry of Railways)
MoST	Ministry of Science and Technology (*Kexue Jjishubu*)
MOFA/MFA	Ministry of Foreign Affairs (*Waijiaobu*)
NDRC	National Development and Reform Commission *(Guojia Fazhan he Gaige Weiyuanhui)*
NEA	National Energy Administration (*Guojia Nengyuanju)*
NEC	National Energy Commission (Guojia nengyuan weiyuanhui)
SASAC	State-owned Assets Supervision and Administration Commission *(Guowuyuan Guoyou Zichan Jiandu Guanli Weiyuanhui)*
SGCC	State Grid Cooperation of China *(Guojiadianwanggongsi)*

Source: Author

4.4.2.1 Agenda Setters and Decisionmakers

The omnipotent rulemakers describes the political elite that has a final say in energy decision due to their ubiquitous role and all-encompassing powers in policymaking in China. Although China's state constitutions officially assign these responsibilities to the National People's Congress (NPC), this role is unofficially and de facto subjugated by the Communist Party (CPC). This group, however, also includes high-level institutions that have a significant influence over the country's energy agenda and strategic energy development. The support from agenda setters and decisionmakers can provide "exceptional momentum" to the policy process as they have the final say in the developing the national agenda and reaching energy choices.[577] Other distinguishable attributes are that agenda setters and decisionmakers reach political decision on the basis of *consensus* during platforms such as circle-reading and high-level meetings.

The Communist Party

The energy sector and all of China's leading government positions within the energy sector are dominated by China's Communist Party. Energy choices in China are therefore very much dependent on the agenda and priorities that the Communist Party sets. The Communist Party of China (CPC, *Zhongguo Gongchangdang*) was founded in Shanghai in 1921 and assumed power in 1949 after civil war victory over the forces of Chiang Kai-shek's Nationalists, who moved their Republic government seat to the island of Taiwan. After coming to power, the CPC named their new regime the People's Republic of China (PRC). The CPC has currently 85 million dues-paying members, equivalent to roughly 6% of China's population, which makes it the largest political

[577] Chen, L. (2008). Bureaucratic System and Negotiation Network: A Theoretical Framework for China's Industrial Policy. In *OECD Reviews of Innovation Policy: China* (pp. 597-612). Paris, France: Organization for Economic Co-operation and Development (OECD).

party in the world.[578] Although the CPC was originally composed of the '*three revolutionary classes'* (i.e. workers, farmers, and soldiers), the CPC's target group has recently shifted to members of the young, highly educated and urban elite as well as the new social stratum of young entrepreneurs and professionals, whose motives to join the CPC are self-interest and career incentives.[579] A membership with the CPC is therefore still popular, although it is officially no longer a prerequisite to work for Chinese state organizations and ministries.[580]

The leadership and organizational structure of the CPC is shaped in the form of a power pyramid, which is composed of five levels of hierarchy, as shown in Figure 17. Personnel decisions take place every 5 years with the assembly of the *National Party Congress* (1st and lowest level of hierarchy) in China's capital Beijing.[581] During a moderately competitive selection procedure,[582] the 2,270 delegates of the *National Party Congress*[583] appoint members for the new *Central Committee* (2nd level of hierarchy), consisting of 205 full members and 171 alternate members. During their first plenary session and through a non-competitive selection procedure, the newly established Central Committee (2nd level of hierarchy) appoints from its members a 25-person *Politburo* (3rd level of hierarchy), a seven-person *Politburo Standing Committee* (4th level of hierarchy) and one *General Secretary* (5th level of hierarchy). Although the *Politburo Standing Committee* is officially chosen by vote from the *Central Committee* (376 members), their candidates are unofficially determined in backroom negotiations among outgoing members and selected party elders and based on attributes such as personal ties with preeminent leaders, respect and influence among senior colleagues, or their network of personal ties (*Guanxi*).[584] The General Secretary serves as China's top leader and is concurrently a member of the Politburo Standing Committee. In a final procedure, the Politburo Standing Committee and the Central Committee select 7 Members of the *Politburo Party Secretariat,* which manages the daily operations of the Politburo and its Standing Committee and oversees Party Central Committee departments and commissions. At the sub-national level, the power hierarchy is replicated for each geographic unit as provinces, counties and townships all have Party committees and a parallel people's government, with the Party Secretary of the Party committee serving as the geographic unit's top leader. Memberships of all leadership positions are elected and endorsed for a five-year term, until the assembly of the next National Party Congress.

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578 Xinhua Daily Telegraph. (2013, July 1). *By the End of 2012, National Party Members Reached 85.127 Million*. Retrieved on 30, August 2014, from http://news.xinhuanet.com/mrdx/2013-07/01/c_132499421.htm.

579 Dickson, B. J. (2014). Who Wants to Be a Communist? Career Incentives and Mobilized Loyalty in China." *The China Quarterly*, *217*, 42-68.

580 Any Chinese citizen over the age of 18 who is willing to accept and abide by the Party's constitution and policies and fulfills the membership requirements (for instance being an atheists) can apply for Party membership. CPC members are predominantly male, with less than 25% being female. The majority of members (85%) work for the CPC Party or the State. Party membership is considered prestigious, although not to the degree that it was in earlier eras.

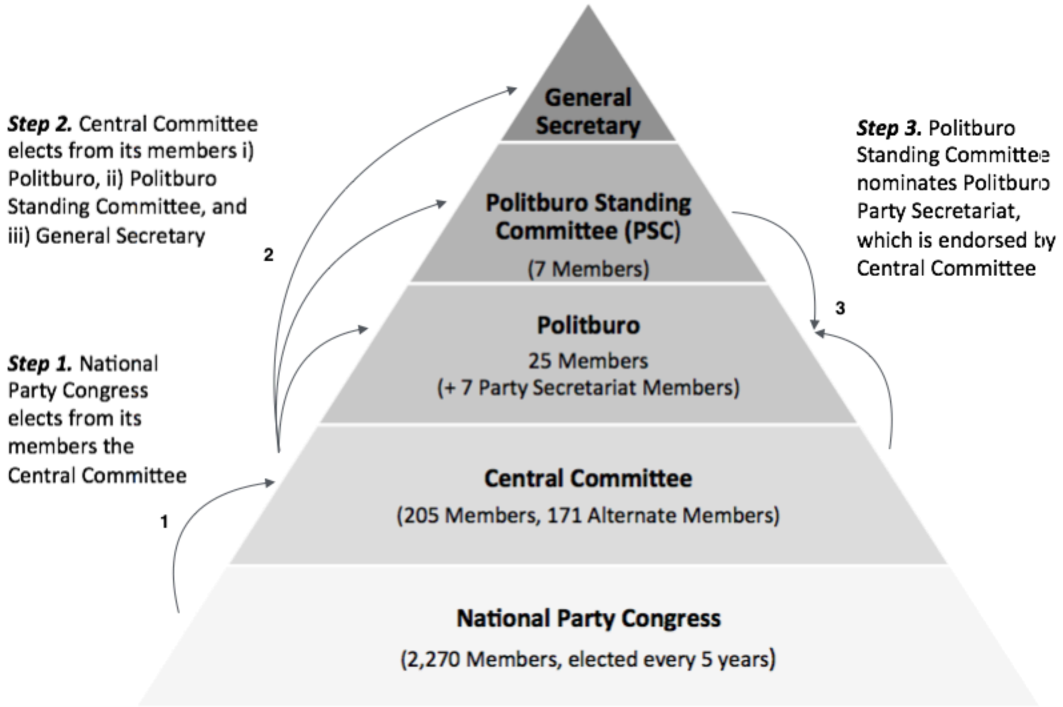
581 The most recent National Party Congress (18th) took place on November 18th, 2012. For more information see: http://en.people.cn/206235/index.html

582 It is moderately competitive as there are approximately 10% more nominees than available positions.

583 In Chinese language the Congress's names are usually abbreviated as the number of the Conference followed by the character da (大), short for dahui (大会 "conference"). For example, the 18th Conference would be translated as Zhōnguó Gòngchăndăng Dìshíbacì Quánguó Dàibiǎo Dàhuì (中国共产党第十八次全国代表大会) and shorted to Shíba Dà (十八大).

584 Lieberthal, K., & Oksenberg, M. (1988). *Policy Making in China: Leaders, Structures, and Processes*. Princeton, USA: Princeton University Press; Lawrence, S., & Martin, M. F. (2012). Understanding China's political system. CRS Report for Congress. Congressional Research Service.

Figure 18 Hierarchy of Communist Party of China (CPC)



Source: Author

The seven members of the CPC's Politburo Standing Committee (including the Party General Secretary*),* inarguably constitute the apex of power in Figure 18. Although the power hierarchy may seem monolithic, homogenous and highly centralized at first sight, competing interests, consensus-seeking and sometimes fierce competition among even the highest-ranking officials are common to CPC (such as between the Politburo Standing Committee and the Politburo or between ministries or provincial governments).[585] Consensus seeking is particularly prevalent in the seven-member *Politburo Standing Committee* as "the No. 1 leader (*General Secretary)* has some initiative and power […] but he is a first among equals and has a lot of restraints".[586] The Politburo Standing Committee assembles once every week in the *Zhongnanhai Leadership Compound* near Tiananmen Square in the capital Beijing to reach consensus on and approve all of the cou.ntry's major policies.

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[585] Lawrence, S., & Martin, M. F. (2012). *Understanding China's political system. CRS Report for Congress*. Congressional Research Service.
[586] Quote from Cheng Li (senior fellow at the Brookings Institution), cited by Roberts, D. (2012, September 28). China's Leaders: Who Holds the Real Power? *Bloomberg Businessweek.*

Figure 19 China’s Power Apex: The CPC's Politburo Standing Committee (2012-2017)

Source: Susan V. Lawrence, 2013, China’s Political Institutions and Leaders in Charts, see also https://www.fas.org/sgp/crs/row/R43303.pdf

The National People’s Congress

The *National People’s Congress* (NPC, *Quanguo Renmin Daibiao Dahui)* amalgamates all functions of a parliament and serves as China’s “highest organ of state power” for the approval of energy legislation.[587] It is the country’s highest legislative body (as oppose to administrative) with the power to establish energy laws and ratify energy policies. The NPC consists of 3000 delegates[588] that are elected in five-years intervals by indirectly assigned assemblies on provincial level. The NPC is structured as a unicameral legislature and has the power to establish laws, ratify policies, and delegate its authority.[589] Each year traditionally in the month of March, the NPC holds one to two-week plenary sessions in the Great Hall of the People in the capital Beijing to review past policies and present future plans to the nation. For practical reasons and given the NPC’s large membership base, the NPC Standing Committee, which holds only 175 members, acts as a surrogate parliament that meets every two months to adopt and review new laws.[590] In

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[587] China State constitutions, for an English-language version of the Party constitution, as revised and adopted on November 14, 2012 at the Party’s 18th National Congress. See China Internet Information Center (2012). *Explanation of the revisions to the Constitution of CPC*. Retrieved June 9, 2013, from http://www.china.org.cn/china/18th_cpc_congress/2012-11/16/content_27138338.htm

[588] NPC delegates comprise of party chiefs, government officials, company executives and military commanders hailing from 35 constituencies, including provinces, regions, municipalities and the semi-autonomous former colonies of Hong Kong and Macau. Members include everyone from so-called model workers to President Xi Jinping.

[589] National People’s Congress of the People’s Republic of China. (n.d.). Retrieved March 2, 2014, from http://www.npc.gov.cn/englishnpc/news/index.htm

[590] Emmerich, R., Cabestan, J. P., Heilmann, S., & Schubert, G. (2009). Stichwort Politisches System. In B. Staiger, S. Friedrich, H. W. Schütte, & R. Emmerich (Eds.), *Das große China-Lexikon: Geschichte, Geographie, Gesellschaft, Politik, Wirtschaft, Bildung, Wissenschaft, Kultur* (2nd ed., pp. 573–581). Darmstadt, Germany: Wissenschaftliche Buchgesellschaft (WBG).

practice, however, both the NPC and its Standing Committee are believed to serve as the extended arm of the CPC serves that only serves as a "rubber stamp"[591] to ratify the CPC's decisions.[592] It is telltale fact that the head of China's top legislature is also third-ranked Member of the Politburo Standing Committee (currently Zhang Dejiang) and that two-thirds of the NPC members are concurrently members of the Communist Party.[593] Therefore China's legislature is "strong on paper [*yet*] weak in practice" (p.7).[594]

The State Council and SCLAO

The *State Council* (*Zhonghua Renmin Gongheguo Guowuyuan)* is officially described as the highest organ of state administration and is the country's highest administrative body. It is the highest decision-making authority and the highest-level administrative body to formally oversee all policymaking. It is also responsible for implementing policies formulated by the CPC Party and laws passed by the NPC, along with overseeing the day-to-day work of the State bureaucracy.[595] The highest position is that of the Premier State Councils' *(Premier Li Keqiang*), which is automatically assigned to the second-ranked member of the CPC's Politburo Standing Committee. Under the Premier's leadership, several Vice Premiers are in charge of industry, economics and trade, science and technology, respectively. Other positions are formally divided into *inner* and *outer cabinet*, the former of which consists of ten members appointed through the State Council Premier and NPC.[596] The 'Outer Cabinet' consists of 29 ministers from various departments, 50 chairs of major agencies below ministry level (working bodies, national authorities, etc.) as well as 20 temporary coordination bodies at the State Council. The role of the Vice Premiers in the State Council is confined to serving as support and not as equal partners to the State Council Premier.[597] Therefore the State Council has a clear hierarchical structure that stands in stark contrast to the collective leadership of the CPC Politburo Standing Committee.
The State Council is automatically assigned the task of registering, examining and approving projects that exceed a certain budget threshhold (lower budget projects are handled by the Ministries and Commissions). The State Council has the power to formulate, enact and promulgate administrative decisions, measures and orders (*Xingzheng fagui*). Main tasks include oversight of the state bureaucracy, managing administrative issues of the state, reporting to the NPC and its standing committee and supervising the various subordinate government authorities at provincial level. The State Council is also empowered to issue its own administrative

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591 Lawrence, S., & Martin, M. F. (2012). *Understanding China's political system. CRS Report for Congress*. Congressional Research Service.
592 According to research by the late China University of Political Science and Law Professor Cai Dingjian, the full session of the NPC has never turned down a bill put to it for a final vote by government agencies (Source: Caixin News. (2015, October 9). *Réndà zhǔdǎo lìfǎ: Bǎituō "bùmén bǎngjià.*" *Caixin News*; Lawrence, S., & Martin, M. F. (2012). *Understanding China's political system. CRS Report for Congress*. Congressional Research Service.
593 Emmerich, R., Cabestan, J. P., Heilmann, S., & Schubert, G. (2009). Stichwort Politisches System. In B. Staiger, S. Friedrich, H. W. Schütte, & R. Emmerich (Eds.), *Das große China-Lexikon: Geschichte, Geographie, Gesellschaft, Politik, Wirtschaft, Bildung, Wissenschaft, Kultur* (2nd ed., pp. 573–581). Darmstadt, Germany: Wissenschaftliche Buchgesellschaft (WBG).
594 Lawrence, S., & Martin, M. F. (2012). *Understanding China's political system. CRS Report for Congress*. Congressional Research Service.
595 Ibid.
596 The ten members of the State Council's Inner Cabinet are the Premier, four Vice Premiers from various political departments, and five interdepartmental State Councilors.
597 Xie, Q. G. (1991). *Dengdai Zhongguo Zhengfu (The Contemporary Chinese Government)*. Shenyang, China: The People's Publisher of Liaoning.

regulations without NPC approval, as it has done for most science and technology legislation.[598] The State Council and its ministries communicate their decisions through decrees (*Tiaoli*), policies (*Guiding*) or methods/measures (*Banfa*). The *State Council* instructs other organs of the centralized power structure or executive bodies through so called announcements (*Tongzhi*). Departments of the *State Council* can independently issue implementation regulations (*Shishi xize*) for the laws that were issued by the NPC.[599]
The State Council takes decisions through various conferences, such as the Standing Conference of the State Council, the Assembly Conference of the State Council, and the Premier Working Conference. The Premier, Vice Premiers, State Councilors and Secretary-General constitute the Standing Conference of the State Council, and the Premier convenes and chairs the Premier Working Conference, the Standing Conference of the State Council and the Assembly Conference of the State Council to discuss policies and take decisions. However, these conferences, unlike the committees, do not work on the basis of a majority vote, in which the minority accepts the view of the majority. In these conferences, each person airs his/her opinion in the discussions, and for issues requiring a decision, the Premier has the final say. The decision-making process of the State Council thus aims to integrate opinions with a view to achieving consensus.

4.4.2.2 Technocrats and Policy Initiators

Technocrats, technological bureaucrats or policy initiators describe a group of ministries, provincial governments and commissions from various fields, ranging from actors with super-ministerial status (such as NDRC or NEC) to authorities of ministerial rank (such as provincial governments, ministries). This group of policy actors is mostly responsible for preparing and submitting policy schemes as well as executing policy and providing feedback on the effect of policy. What distinguishes them most is their ability to rapidly place issues on the national agenda of the central government (State Council, NPC or CPC). Unlike the agenda setters and decisionmakers, technocrats act according to their departmental interests and disciplinary knowledge. They are able to influence the policymaking process by writing letters, conducting research reports and communicating their views and expectations via informal communication and through personal relations (*guanxi*). Occasionally, members of this group are also invited to participate directly in the formulation, discussion, revision and decision of energy policies, for instance, through temporary platforms such as Leading Small Groups or ad-hoc working groups on specific issues for a limited period of time.[600]

The National Development and Reform Commission (NDRC)

The most powerful actor in energy policymaking is arguably the *National Development and Reform Commission* (NDRC**,** *Guojia fazhan he gaige weiyuanhui)*. It was established from the former State Development and Planning Commission (SDPC) in 2003 and functions as a 'super ministry'[601] responsible for policy coordination macroeconomic level and drafting the overall

[598] Ahrens, N. (2013). China's Industrial Policymaking Process. *Center for Strategic and International Studies (CSIS)*, 1–40.
[599] Pissler, K. (2005). *Gesetzgebungsgesetz der VR China*. Retrieved February 20, 2013, from http://www.chinas-recht.de/000315b.htm.
[600] Chen, L. (2008). Bureaucratic System and Negotiation Network: A Theoretical Framework for China's Industrial Policy. In *OECD Reviews of Innovation Policy: China* (pp. 597-612). Paris, France: Organization for Economic Co-operation and Development (OECD).
[601] It is also considered a 'super ministry' due to its prominent leadership. Currently headed by Xu Shaoshi, former Minister of Land Resources (2007-2013), and six other minister level seniors

national economic development plan.[602] It is currently led by Mr. Xu Shaoshi, 63 years, member of the CPC Standing Committee. Although the NDRC is *de jure* ranked below the State Council, it is *de facto* claimed to be “the biggest, most powerful Chinese bureaucracy”[603] with authoritative power that sometimes rivals that of State Council. The predecessor of the NDRC is the Soviet-inspired State Planning Commission (SPC),[604] which was formerly the most powerful economic institution for setting production targets and developing the Five-Year Plans for economic growth. NDRC’s origins are therefore still relics from the “command-and-control economic past” and its primary mandate has remained that of developing the country’s macroeconomic and social strategies and translating these into annual, mid-, and long-term plans, sector specific plans and national support programs.[605] Since 2008, however, the NDRC has moved away from the level of micro-managing and detailed project approvals towards the more general level of macro-economic management, such as drafting national economic programs, establishing industrial and investment policies, spearheading reforms, controlling price levels, and participating in fiscal and monetary policy. The NDRC has an important stake in the development of energy policy and direct access to China’s leadership, as it has the sole authority to set ad adjust energy prices[606] and to govern energy conservation.[607] It is authorized to approve large-scale investment projects within the energy sector. Within NDRC, responsibilities are scattered among 26 departments and bureaus with over 3,000 staff. The most important departments that deal specifically with energy issues are the Energy Department (*Nengyuanju*), which covers issues such as renewable energy, as well as NDRC’s Research Institute for Energy (*Nengyuan Yanjiusuo*), which specifically deals with the formulation and evaluation of renewable energy policy (the latter operates the Centre for Renewable Energy (CRED) that deals with renewable energy and other sectoral programs, medium and long-term planning). Another important department within the NDRC is the Department of Price (*Jiagesi*), which is responsible for instance for solar energy feed-in tariffs and energy prices in general.

The National Energy Commission (NEC) and National Energy Administration (NEA)

The second most powerful institution endowed with the mandate of strategic planning within the energy sector is the *National Energy Commission* (NEC, *Guojia nengyuan weiyuanhui*). NEC is a relatively nascent institution that was established in 2008 and that serves as an “overarching government agency”.[608] Nevertheless it is an extremely potent institution as it brings together 23 of the countries highest ranked officials and senior ministers from all energy-relevant agencies.[609]

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[602] Saich, T. (2011). Governance and Politics of China. In *Governance and Politics of China (review)* (3rd ed., pp. 1–448). New York, USA: Palgrave Macmillan.
[603] Roberts, D. (2013, June 21). China’s Economic Policy Factory: The NDRC. *Bloomberg Businessweek*.
[604] Ibid.
[605] Emmerich, R., Cabestan, J. P., Heilmann, S., & Schubert, G. (2009). Das Politische System der VR China. In B. Staiger, S. Friedrich, H. W. Schütte, & R. Emmerich (Eds.), *Das große China-Lexikon: Geschichte, Geographie, Gesellschaft, Politik, Wirtschaft, Bildung, Wissenschaft, Kultur* (2nd ed., pp. 573–581). Darmstadt, Germany: Wissenschaftliche Buchgesellschaft (WBG).
[606] Erica Downs argues that the NDRC has been one of the strongest opponents of creating a Ministry of Energy (MOE), as this would deprive the NDRC of a substantial powers and macroeconomic control. For more on this, see Downs, E. S. (2008). *China’s Energy Policymaking Structure and Reforms (Panel II). China’s Energy Policies and Their Environmental Impacts*. Washington D.C., USA: United State Congress.
[607] Xu, Y. C. (2008). China’s struggle for power. *Lowy Institute*.
[608] For more information, see Wan, Z. (2010). Wen heads 'super ministry' for energy. *China Daily*.
[609] For more information, see China Council for International Cooperation on Environment and Development (CCICED). (n.d.). Retrieved March 4, 2015, from http://www.cciced.net/cciceden/.

Given the prominence of its members, NEC tends to be more a senior strategic body with ministerial rank that is not involved in day-to-day activities of the energy sector. Its mandate is to strengthen the overall energy decision-making procedure and coordination efforts among relevant energy actors in formulating national energy strategies and deliberating on key questions pertaining to energy security and energy sector development.

In 2008 a third institution titled *National Energy Administration* (NEA, *Guojia nengyuanju*) was established, which received responsibilities from NDRC's former Energy Bureau of the NDRC and State *Electricity Regulatory Commission* (SERC). Its official mandate is to implement the day-to-day policies of NEC, which include drafting and developing policy instruments, standards, laws and regulations, coordinating energy development and energy reforms, approving foreign energy investments as well as monitoring and regulating the energy sector. Since 2014, it is headed by Mr. Nur Bekri, 53 years, former governor of the Uighur Autonomous Region Xinjiang. NEA's role in the government hierarchy has become a point of major contention among industry experts, as it is officially ranked a vice/deputy ministry, but is lead by an official with full ministerial rank,[610] which gives it significant additional clout.[611] NEA is intrinsically connected to NDRC and NEC, as its highest position (director of NEA) is automatically assumed by the vice director of NEC and NDRC.[612] Another indication that NEA is ranked below NDRC is the fact that specific policies of renewable energy development are still under the framework of NDRC's national Five-year plan, which is the national highest level economic and social planning in China..

The State Grid Corporation of China (SGCC)

SGCC was established in 2000 and took over responsibilities from the former State Power Cooperation. It is currently led by Mr. Liu Zhenya, a member of the CPC Central Committee. The SGCC is primarily responsible for ensuring and securing a reliable supply of electricity by means of grid operation, grid development and extension, and supply of end-consumers. SGCC belongs to the ten largest companies in the world, with more than 1,8 million employees and Sales of USD 307 billion, total assets of USD 383 billion.[613] It is also a major global player that is becoming increasingly active in foreign electricity markets aiming to transfer 10% of its activities to foreign countries.[614] Given its economic status, the SGCC enjoys a ministerial rank directly below the State Council, and not the NDRC. Recently, the SGCC has become a topic of major contention, with opponents criticizing its monopolistic structure and demanding that it be dissolved into smaller or regional distribution units. The SGCC itself will probably undergo

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[610] The Head of the NEA is Zhang Guobao, who holds a ministerial position, is a very prominent government official and a well-recognized energy expert. He is still the vice-minister of the NDRC and was previously responsible for the Commission's Energy Department.

[611] Downs, E. S. (2008). China's Energy Policymaking Structure and Reforms (Panel II). China's Energy Policies and Their Environmental Impacts. Washington D.C., USA: United State Congress.

[612] Downs, E. S. (2008). China's "New" energy administration. *China Business Review*, *35*, 42–45.

[613] SGCC belongs to the ten largest companies in the world, with more than 1,8 million employees, sales of 307 billion US-dollar and total assets of USD 383 billion US-dollar.

[614] For instance, SGCC owns 25% of the Portuguese power company's REN shares since 2012. In July 2014 SGCC also expanded to the Italian market and purchased 35% shares ofthe Italian company CDP Reti, which itself owns 30% shares of the gas network Snam and is involved in a similar amount in the electricity grid operator Terna. In August 2014, SGCC had made a bid for a stake in Greek operator ADMIE, and has also shown interest in further investments in Spain. The end of 2013 SGCC announced that it will no longer participate in the bidding process for Berlin's electricity and gas network. An entry into the German energy market is therefore seems unlikely, although SGCC has established a European office in Frankfurt. Source: SGCC Official Website, http://www.sgcc.com.cn/ywlm/gsgk-e/gsgk-e/gsgk-e1.shtml (accessed 05.2016)

significant changes during the electricity market reforms in 2015 and will likely transition into an energy service company (ESCO) than merely a energy supplier.

State-owned Assets Supervision and Administration Commission (SASAC)

The State-owned Assets Supervision and Administration Commission (SASAC) was established in June 2003 and is the technical owner of all China's State-owned Enterprises (SOEs).[615] On behalf of the central government, SASAC has investor responsibility for state-owned assets. It was established to speed up the restructuring of these and to push forward reform of SOEs. SASAC is charged with managing the assets of the SOEs, improving corporate governance, participating and guiding the direct financing of enterprises, and promoting the strategic adjustment of the state-owned economic structure and layout. As the majority shareholder, the institution currently oversees more than 150 SOEs including CNPC, Sinopec and CNOOC. Despite SASAC's importance as the owner of all SOEs, the institution's power is extremely limited. SASAC does for example not have representatives on the ground in the offshore operations of the SOEs[616] as it does not have control over budgets and it does not have the authority to collect earnings from the SOEs. This is instead the responsibility of the Ministry of Finance.[617] Despite SASAC's importance as the owner of all SOEs, the institution's power is extremely limited. SASAC does for example not have representatives on the ground in the offshore operations of the SOEs[618] as it does not have control over budgets and it does not have the authority to collect earnings from the SOEs. This is instead the responsibility of the Ministry of Finance.[619]

Provincial Governments

Local governments are also are important actors in the energy governance structure and are especially powerful in shaping policies at national level. The government structure at the provincial/municipal level resembles that of the central government. There are provincial counterparts of all central government ministries and agencies in each province, minority, autonomous region and municipality. Local Party Committee Secretaries (*Dangwei shuji),* similar to the position of Party General Secretary at national level, share the same bureaucratic rank as central government ministers. They often hold dual positions in the CPC Politburo and are therefore among the 25 most powerful officials in the country. Provincial governments are also powerful to their fiscal liberties and control over own revenue streams and their responsibility for most of the country's public spending on education, health, unemployment insurance, social security, and welfare.[620] In order to stimulate economic growth, experimentation and innovation at regional level, provincial governments enjoy considerable free rein in passing their own laws and regulations that may deviate from the official Party line but not stand in conflict with it. In terms of policymaking and implementation, local governments have considerable autonomy. Because economic, social, geographic and climate conditions differ widely across China, the

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615 Naughton, B. (2007). *The Chinese Economy: Transitions and Growth*. Cambridge, USA: Massachusetts Institute of Technology.
616 Burke, C., Jansson, J., & Jiang, W. (2009). Formulation of Energy Policy in China: Key Actors and Recent Developments. *University of Stellenbosch.*
617 Xu, Y. C. (2008). China's struggle for power. *Lowy Institute*.
618 Burke, C., Jansson, J., & Jiang, W. (2009). Formulation of Energy Policy in China: Key Actors and Recent Developments. *University of Stellenbosch.*
619 Xu, Y. C. (2008). China's struggle for power. *Lowy Institute*.
620 Saich, T. (2011). Governance and Politics of China. In *Governance and Politics of China (review)* (3rd ed., pp. 1–448). New York, USA: Palgrave Macmillan.

decentralized governance system allows local governments to design local policies for implementing central government policies effectively under local conditions. For local affairs, which are not regulated by central government policy, local governments can enact and enforce local regulations.

Ministries

There are also several government ministries and departments are also involved in energy policy (see Annex III for a complete list of Ministries. Different ministries have their own priorities and agendas and their role in the policy processes depends much on the issue at stake.[621] Ministries and commissions take decisions on policy issues that are considered less important and that fall under their jurisdiction. However, for investment projects that exceed a certain funding threshold or for cross-sectoral policy issues decision-making power is transferred to the State Council. Ministries also play an important role in policy implementation and at the stage of drafting concrete policies and regulations (*zhengce*).[622] Not all ministries and commissions are created equal. MIIT, NDRC, NEC and NEA are considered "super-ministries"[623] with more authority powers than regular ministries.

Table 19 Overview of energy-relevant ministries

Abbr.	Official Name	Description
MIIT	Ministry of Industry and Information Technology *(Gongye He Xinxihuabu)*[624]	Established in 2008 mandated with the responsibility (i) to determine China's industrial planning, policies and standards; (ii) to monitor the daily operation of industrial branches; (iii) to promote the development of major technological equipment and innovation concerning the communication sector; (iv) to guide the construction of information system and (v) to safeguard China's information security.
MOF	Ministry of Finance *(Caizhengbu)*	MOF administers macro-economic policies, the national annual budget, fiscal policy, economic regulations and state expenditure and records macroeconomic data on China's economy. MOF plays a key role in the solar energy sector as it decides upon and allocates solar energy subsidies[625].

[621] Chen, L. (2008). Bureaucratic System and Negotiation Network: A Theoretical Framework for China's Industrial Policy. In *OECD Reviews of Innovation Policy: China* (pp. 597-612). Paris, France: Organization for Economic Co-operation and Development (OECD).
[622] Meidan, M., Andrews-Speed, P., & Xin, M. (2009). Shaping China's Energy Policy: actors and processes. *Journal of Contemporary China*, *18*(61), 591–616. http://doi.org/10.1080/10670560903033885.
[623] Lawrence, S., & Martin, M. F. (2012). *Understanding China's political system. CRS Report for Congress*. Congressional Research Service.
[624] For the sake of clarity, the references to ministries and other state authorities omit the title "of the People's Republic of China" (*Zhonghua Renmin Gongheguo*).
[625] Chinese Ministry of Finance, http://www.mof.gov.cn/index.htm.

MOST	Ministry of Science and Technology (*Kexue Jjishubu*)	MOST formulates and implements laws that pertain to science and technology[626] and is considered the backbone of China's technology innovation and the central planning body for China's technology sector.[627] MOST is especially important to the solar energy sector because it is responsible for Research and Development (R&D) of solar PV technology.
MOHURD	Ministry of Housing, Urban & Rural Development (*Zhufang Chengxiang Jianshebu*)	MOHURD is responsible for housing policy, distribution of housing space and plays a key role in solar energies, particularly for building-integrated PV (BIPV) and building attached PV (BAPV). MOHURD is mandated to increase the energy efficiency of buildings and lower the overall emissions of the housing sector; to which ends solar energy technologies could contribute significantly.[628]
MLR	Ministry of Land and Resources (*Guotuziyuanbu*)	MLR is responsible for the planning, administration, management, preservation and exploitation of natural resources, including land, mineral and marine resources.[629]
MEP	Ministry of Environmental Protection (*Huanjing Baohubu*)	MEP (established in 2008 and formerly known as State Environment Protection Administration (SEPA, *Guojia huanbaozongju*) has become increasingly important for the energy sector due to environmental pollution associated with fossil fuels.[630]
MOFCOM	Ministry of Commerce (*Shangwubu*)	Formerly known as Ministry of Foreign Economic Relations and Trade (MOFERT, 1982-1993) and Ministry of Foreign Trade and Economic Cooperation (MOFTEC, 1993-2003). MOFCOM is responsible for formulating policy on foreign trade, export and import regulations, foreign direct investments, consumer protection, market competition and negotiating bilateral and multilateral trade agreements, monitoring and analyzing market performance and commodity supply and demand; organizing international economic cooperation; coordinating anti-dumping and anti-subsidiary issues and arranging industry damage survey. MOFCOM also include the State Economic and Trade Commission (SETC), which deals with investment in important technology renovation projects.

[626] Chinese Ministry of Science and Technology, http://www.most.gov.cn/index.htm.
[627] Hofem, A. (2009). Staatliche Förderung von Umwelttechnologie in der VR China. *China Analysis*, 71.
[628] Chinese Ministry of Housing and Urban and Rural Development, http://www.mohurd.gov.cn/
[629] International Crisis Group. (2008). *China's Thirst for Oil (Report No. 135)*. Seoul, South Korea and Brussels, Belgium.
[630] Chinese Ministry of Environmental Protection, http://english.mep.gov.cn/.

4.4.2.3 The Social Elite and Policy Entrepreneurs

The social elite and *policy entrepreneurs*[631] describe a highly heterogeneous group of mostly government-sponsored actors as well as non-government actors, who are not directly and necessarily but often indirectly involved in energy decision-making. This group includes for instance official and quasi-official research institutes and universities as well as members from state-owned companies. Non-government affiliated actors such as members from the media, non-government organizations (NGOs) and micro-bloggers are also part of this group.[632] The boundaries of this group are often blurred and the composition varies according to the specific issue at stake.

Research Institutes and Think Tanks

China has currently 429 think tanks, the second-largest number in the world after the United States, with 6 Chinese think tanks ranked among the top 100 globally.[633] Representatives of this group include among others the State Council Development Research Center, the Chinese Academy of Sciences, the Chinese Academy of Engineering, the Chinese Academy of Social Science, the China National Renewable Energy Centre (CNREC), the Tsinghua University and the China University of Petroleum.[634] Unlike their western counterparts, most think tanks, research institutes and universities in China are to some degree affiliated with the government or state enterprises. Nevertheless, they provide policymakers with important input such as research reports (*keti*), cutting edge knowledge, skills and ideas. Especially since the third and fourth generation of leaders (Jiang Zemin Administration and Hu-Wen Administration) it has become a common practice for high-level decisionmakers to seek informed advice from research groups and institutions, non-government organizations, business associations and influential entrepreneurs.[635] During the Hu-Wen Administration (2002-2012) for instance, the most notable think tanks were the Development Research Center of the State Council (*Guowuyuan fazhan yanjiu zhongxin*) and the NDRC Energy Research Institute (ERI, *Fagaiwei nengyuan yanjiusuo*), who decisively influenced China's Renewable Energy Law in 2005.[636] Aside from that, China has also seen a burgeoning of independent think tanks and foreign-financed research institutes in recent years (such as Greenpeace).

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[631] Mertha, A. (2009). "Fragmented Authoritarianism 2.0": Political Pluralization in the Chinese Policy Process. *The China Quarterly*, *200*, 995–1012. http://doi.org/10.1017/S0305741009990592

[632] Lawrence, S., & Martin, M. F. (2012). *Understanding China's political system. CRS Report for Congress*. Congressional Research Service.

[633] McGann, J. G. (2012). *2012 Global Go to Think Tanks Report and Policy Advice, Think Tanks and Civil Societies Program*. University of Pennsylvania. Retrieved on 4 March 2015, from http://www.gotothinktank.com/wp-content/uploads/2013/01/ 2012-Global-Go-To-Think-Tank-Report.pdf.

[634] CNREC is a joint non-profit think tank established with support from the Danish government to develop and advocate the RE technology and capacities in China.

[635] See Ma, C. (2007, October 11). A survey of China's official research centres. *Nanfang Zhoumo*.

[636] China Development Research Center. (2004). *National Energy Strategy and Policy Report*; National Development and Reform Commission (NDRC). (2004). *Medium and Long Term Energy Conservation Plan*.

SOEs and Financial Institutions

State-owned enterprises (SOEs, *Yangqi*) belong to "one of the most powerful special interest groups in present-day China".[637] Since the 1990s, many former state-owned production units were corporatized and converted into joint stock companies and registered under the Company Law. SOEs play a very important role in China's policy processes as they can influence policy decision-making and agenda setting by virtue of their bureaucratic rank, their technical expertise and their overall contribution to the national economy (SOES contribute around 25-30% of the country's industrial output).[638] Currently there are about 106 SOEs in China, out of which 47 firms ranked in the 2014 Fortune Global 500.[639] SOEs are therefore extremely powerful as they are clustered around highly strategic and competitive industries (such as electricity, defense, automobiles, shipping, and petroleum). SOEs are categorized into two administrative ranks. The 53 most lucrative and strategically important SOEs that the central government considers an "important backbone state-owned enterprises" (*zhongyao gugan guoyou qiye*) enjoy the vice-ministry rank (*fubuji*), which implies that the top executives of these SOEs have the rank as vice provincial party secretaries or governors.[640] The remaining 53 SOEs are a heterogeneous conglomeration of lesser-known firms, which receive the administrative rank of department-level (*zhengtingji*). These administrative ranks provide SOEs with substantial leverage and privileges in terms of advocating for benefits to their companies, obtaining licenses, vetoing against policy drafts and processes, communicating and participating in meetings with officials of a certain rank, and participating in study groups and further training at the CPC's Central Party School.[641]

China's power sector was delegated to five state-owned power-generating companies (known as *the Big Five*), namely China Huaneng Group, China Datang Group, China Huadian, Guodian Power and China Power Investment Corporation). These five SOEs collectively own about 47% of China's power generating assets, the remaining of which is owned by independent power producers (IPPs) in partnership with privately-listed arms of the state-owned companies. The state has no direct control over these SOEs (for instance personnel assignments) but remains their legal owner through the State-owned Assets Supervision and Administration Commission (SASAC, *Zichan Jiandu Guanli Weiyuanhui*).[642] As the majority shareholder, SASAC oversees all of China's SOEs, including the state grid companies and the *Big Five* power generation companies. On behalf of the state, SASAC does not interfere in production and operation activities of SOEs, but controls major political decisions (such as making personnel decision of managers, deciding on major investments, strategically aligning and reforming the economic structure and layout of

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[637] Li, C. (2011). China's Midterm Jockeying: Gearing Up for 2012. *China Leadership Monitor*, 34. Retrieved on 3 March 2015, from http://www.hoover.org/publications/china- leadership-monitor/article/68001.

[638] Lardy, N. R. (2014). *Markets Over Mao: The Rise of Private Business in China*. Washington D.C, USA: Peterson Institute for International Economics.

[639] Chinese State-owned Assets Supervision and Administration Commission (SASAC) (2014). Central State-Owned Enterprises Enter Fortune Global 500. *State-owned Assets Supervision and Administration Commission*. Retrieved on 01 September 2014, from http://www.sasac.gov.cn/n1180/n1226/n2410/n314259/n315134/15951889.html.

[640] A small number of executives come to their companies with a higher administrative rank by virtue of their previous positions. For example, Wang Yupu, appointed as party secretary and board chairman of Sinopec in April 2015, gained full ministerial rank (zhengbuji) by serving previously as the vice party secretary of the Chinese Academy of Engineering starting in 2013.

[641] Leutert, W. (2016). Challenges Ahead in China's Reform of State-Owned Enterprises. *Asia Policy*, 21(1), 83-99.

[642] Lawrence, S., & Martin, M. F. (2012). *Understanding China's political system. CRS Report for Congress*. Congressional Research Service.

SOEs with the official party line). Moreover, SASAC may also authorize directors to take independent decisions on "important matters of the company".[643]

Aside from SOEs, there are also non-state stakeholders from the business and industry sectors, who have become increasingly diversified in recent years. Although their influence and impact are nowhere near that of the SOEs, they can influence policymakers to some extent by providing personal feedback, writing letters and using national media to voice their views and concerns. Some representatives of this group include "famous" retired party officials; political veterans or renowned scientific experts may also have some informal saying in suggesting new policy issues to be set on the national agenda. Industry associations are also highly influential given they often serve as temporary or retirement posts for related government officials[644]. Other representatives of this group are

NGOs and Civil Society

Domestic and foreign civil organizations have also become a somewhat influential part in policymaking as they are able to raise awareness of environmental issues and bring issues to the attention of national decisionmakers.[645] Despite certain obstacles (such as dependence on state departments to function as an official 'sponsor'), a number of grassroots NGOs have been successful in raising public awareness especially in the environmental sector.[646] This success and their influence has been mostly attributed to changes in the media landscape in recent years and the explosive popularization of Twitter-like services known as *Weibo* (literally micro-blogs), which have empowered citizens to share news and views directly with each other, and thus put pressure on the traditional media and authorities to address issues that they might otherwise have ignored. Some micro-bloggers have millions of followers and the power to change the terms of public debate with a single post. As of January 2013, 42.1% of Chinese were online, with the total number of Internet users reaching 564 million. Nearly 75% of Chinese users accessed the Internet on mobile devices, and 309 million Chinese were Weibo users.[647] The diversification of China's media landscape has therefore significantly contributed to the influence of such non-government actors since it has changed how civil society actors are able to form alliances, re-frame existing issues and mobilize a broad audience and social sympathy.[648]

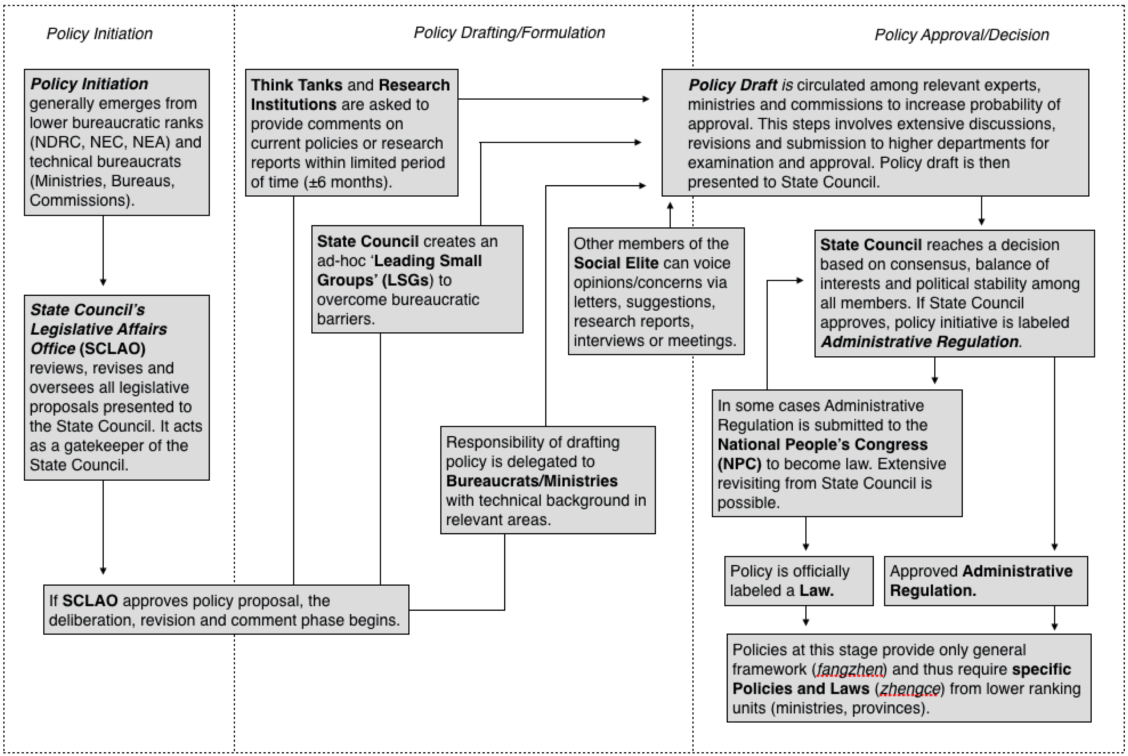
4.3.4.3 Energy Policymaking Processes

The processes and individual steps that are associated with policymaking in China are generally opaque and complex, given the existence of formal-institutional and informal-social layers of policymaking (see *Chapter 3.3.5 China's Two-Tier Policy Arena*). The opaqueness is amplified through the extensive amounts of bargaining and actors involved. More importantly, the

[643] Leutert, W. (2016). Challenges Ahead in China's Reform of State-Owned Enterprises. *Asia Policy*, 21(1), 83-99.
[644] Ahrens, N. (2013). China's Industrial Policymaking Process. *Center for Strategic and International Studies (CSIS)*, 1–40.
[645] Chan, G. (2004). China's compliance in global environmental affairs. *Asia Pacific Viewpoint*, *45*(1); Yang, G. (2005). Environmental NGOs and institutional dynamics in China. *The China Quarterly*, 181, 46–66.
[646] Lawrence, S., & Martin, M. F. (2012). *Understanding China's political system. CRS Report for Congress*. Congressional Research Service.
[647] Ibid.
[648] Mertha, A. (2009). "Fragmented Authoritarianism 2.0": Political Pluralization in the Chinese Policy Process. *The China Quarterly*, *200*, 995–1012. http://doi.org/10.1017/S0305741009990592.

individual composition, length and success of policy processes depend also on the degree of importance that the CPC attaches to the policy issue (under special circumstances policies are developed within only a few months and are able to circumvent individual steps of policymaking process).[649] Moreover, the policy arena in China is notably short of formal definitions of the powers and scope of authority of the component institutions, of clear statements of practice and procedure, and of explicit guidelines for inter-institutional relationships".[650] That being said, it is a challenging task to discern a typical policymaking process. Generally, policy processes encompass three phases, involving (i) policy initiation, (ii) policy drafting and formulation and (iii) policy approval and decision-making, as shown in Figure 20.

Figure 20 Tentative Diagram of Policymaking Process in China's Energy Sector[651]



Source: Author based on Chen, L. (2008). Bureaucratic System and Negotiation Network: A Theoretical Framework for China's Industrial Policy. In OECD Reviews of Innovation Policy: China (pp. 597-612). Paris, France: Organization for Economic Co-operation and Development (OECD).

Policy Initiation. Ideas and pressure for new policies often originate from lower levels of the power hierarchy, at the level of departments, bureaus, ministries and commissions. Higher-level authorities that are officially designated to deal with strategic energy planning, such as the NEC,

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649 In a study on innovation policy, Chen compares two policies, one of which was pushed through the policymaking within a few months, whereas the other policy was heavily protracted and eventually dropped from the national agenda. See Chen (2008). *Bureaucratic System and Negotiation Network: A Theoretical Framework for China's Industrial Policy* and Ahrens (2013). China's industrial policymaking process.

650 Andrews-Speed, P. (2010). The Institutions of Energy Governance in China. Paris, France: Institut français des relations internationales (Ifri).

651 Author's interviews. See also Chen, L. (2008). Bureaucratic System and Negotiation Network: A Theoretical Framework for China's Industrial Policy. In *OECD Reviews of Innovation Policy: China* (pp. 597-612). Paris, France: Organization for Economic Co-operation and Development (OECD).

NDRC and NEA can also instigate new policy initiatives. Once sufficient consensus is achieved on the importance and priorities of the new policy initiative, a policy proposal is drafted and then forwarded to the State Council. Here the State Council Legislative Affairs Office (*Fazhi Bangongshi*, SCLAO) assumes an important role as it reviews, revises and oversees all legislative proposals that are presented to the State Council from other government bodies. Since all legislative proposals must first receive approval form the SCLAO, the SCLAO serves as a gatekeeper of the State Council. Once policy initiatives receive the approval by the SCLAO, the *revision, deliberation and comment* phases begin.

Policy drafting and formulation. Once the SCLAO approves policy proposals, the phase *deliberation, revision and comment* begins. Once the decision has been reached and initial policies have been drafted, policy innovations will be conveyed to the public through formal speeches of the state leaders (General Secretary and other high-ranking officials of the Politburo Standing Committee). This verbal inclusion of new policy issues signals to subordinate bureaucracies that further action and consideration is required (through second-level policies), that provincial governments are encouraged to experiment on this new issues and that comments and feedback from stakeholders is appreciated.[652] During this stage prior to the actual drafting of legislation, policy issues circulate through the bureaucracies for a considerable amount of time until they gain sufficient momentum and leverage to be included into the national government agenda.[653] During this stage the drafts are then exposed to public comment and feedback (by setting up government websites for example). This has become a popular method in recent past and has safeguarded the government from making decisions that are likely to arouse public anger. That said, it must also be noted that the decisions about when to open a draft to commentary, to whom, and the method of exchange are all at the discretion of the drafting authority.[654]

These ministries can alter policy decisions at the drafting stage due to the consensus-building nature of decision-making[655]. Policy initiatives are circulated amongst the different stakeholders for approval, allowing them to amend the drafts according to their interests[656]. This procedure means that approval times are often lengthy and that the final policy proposal is a watered down version of the initial drafts. Furthermore, ministries intervene at the implementation stage and have the power to stall or promote projects according to their interests.

In some cases, the State Council will create an ad-hoc and temporary ‘Leading Small Groups’ (LSGs) (*zhongyang lingdao xiaozu*). LSGs are designed to deal with sensitive, high-priority and

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[653] See for instance Lieberthal, K., & Oksenberg, M. (1988). *Policy Making in China: Leaders, Structures, and Processes*. Princeton, USA: Princeton University Press; Lieberthal, K., & Lampton, D. M. (1992). *Bureaucracy, politics, and decision making in post-Mao China*. Berkeley, USA: University of California Press.

[654] Ahrens, N. (2013). China’s Industrial Policymaking Process. *Center for Strategic and International Studies (CSIS)*, 1–40.

[655] Meidan, M., Andrews-Speed, P., & Xin, M. (2009). Shaping China’s Energy Policy: actors and processes. *Journal of Contemporary China*, *18*(61), 591–616. http://doi.org/10.1080/106705609030338857.

[656] For a more detailed account of ‘documentary politics’ under Deng Xiaoping, see Wu, G. (1995). Documentary politics: hypotheses, process, and case studies. In C. L. Hamrin and S. Zhao (Eds.), *Decision-making in Deng’s China (*pp. 24–39). London, UK: M.E. Sharpe. For the most detailed account of the formal decision-making process, see Lieberthal, K., & Oksenberg, M. (1988). *Policy Making in China: Leaders, Structures, and Processes*. Princeton, USA: Princeton University Press; Lieberthal, K., & Lampton, D. M. (1992). *Bureaucracy, politics, and decision making in post-Mao China*. Berkeley, USA: University of California Press. While decision-making has evolved since Deng’s times, policy documents still go through an approval process marked by internal bargaining (Author’s interviews, Beijing, September 2006).

cross-ministerial policy issues and serve as informal, consensus-building, supra-ministerial consulting bodies to the state. LSGs provide policy drafts sufficient clout to overcome administrative and bureaucratic barriers and coordinate collaboration among the functions units. They are composed of personnel selected from the relevant ministries and committees and are comparatively flexible. Generally, the rank of the LSG depends on the most senior member of the LSG.[657] LSGs are oftentimes secretive bodies as the composition of LSGs is usually not publicized but generally consists of members from the State Council, senior CPC officials, and ministers. If policy evaluations entail specific business or technology expertise, the LSG will resort to private consultations with a panel of experts comprising of eminent scholars or heads from the industry and business. This period of deliberation, revision, and incorporating feedback through an LSG can take up to several years.[658] During the period of consultation, an LSG may issue studies and white papers. LSG do not formulate concrete policies (*zhengce*) but issue instead guiding principles (*fangzhen*) that provide the overall direction in which bureaucratic activity should move. They advise the leaders in on how they should proceed on any given issue of interest. The most important LSGs are attached to the Central Committee or State Council, and through that, report to the PSC. Once the LSG has finalized the draft law, it is submitted to the State Council for approval.
Non-governmental or semi-governmental actors are able to influence this stage of the policymaking process by voicing their concerns and opinions through letters, suggestions, research reports and interviews or meetings to influence the policy-making process. Foreign groups often influence decision-making though non-governmental channels, such as non-governmental visits, research seminars and letters to central leaders. Once sufficient consensus is mobilized and sufficient support mobilized, the final draft is then presented to the decision-making layer, usually entitled "Policy" (Preliminary Draft).

Policy Approval and Decision-making. In terms of *policy approval*, there are different governing bodies that can enact legislation. The highest legislative body is de jure the NPC (and de facto the NPC Standing Committee which functions as a surrogate parliament), followed by the State Council. Before bills are presented to the NPC for a yes-no vote, they are usually revised either by the NDRC or the NPC Standing Committee. The NPC usually accepts proposal with near unanimity. One reason for this is that most bargaining and disagreement already takes place during the pre-approval stage, so that by the time policy drafts reach the NPC they have already been watered down.[659] Once a bill is enacted by the NPC, it is considered legally binding. Laws themselves are mostly vague and provide rather the legislative framework, which is then filled by specific regulations (so-called opinions (*yijian*) and decisions (*jueding*)) from the State Council and relevant ministries. Laws at the national level are also important in creating some leeway for provincial and local governments to test and experiment with supportive laws, trial schemes and pilot projects. If provincial experimentation proves successful, the State Council will occasionally

[657] Chen, L. (2008). Bureaucratic System and Negotiation Network: A Theoretical Framework for China's Industrial Policy. In *OECD Reviews of Innovation Policy: China* (pp. 597-612). Paris, France: Organization for Economic Co-operation and Development (OECD).
[658] See Liu, L. (2009). Research Priorities and Priority-setting in China. *VINNOVA Analysis VA*, 1–52.
[659] Meidan, M., Andrews-Speed, P., & Xin, M. (2009). Shaping China's Energy Policy: actors and processes. *Journal of Contemporary China*, *18*(61), 591–616. http://doi.org/10.1080/10670560903033885.

consider integrating provincial policy practices into national legislation.[660] Therefore national policies can also sometimes result from successful experimentation at local level.[661]
The State Council and National People's Congress are usually in charge of the examination and approval of most policy issues (especially for those that exceed a certain investment budget). For less important policy issues the ministries are authorized to approve policies within their jurisdiction. The final decision is often reached by a small group consisting of the State Council, the Vice Premier, representatives from related ministries and commissions, and generally about five to ten other people.[662] According to the relevant regulations, although there are Vice Premiers in the State Council, they only support the work of the Premier, they do threshold or for policy adjustments across departments decisions are taken by the State Council not lead the State Council collectively. The State Council takes decisions through various conferences, such as the Standing Conference of the State Council, the Assembly Conference of the State Council, and the Premier Working Conference. However, these conferences, unlike the committees, do not work on the basis of a majority vote, in which the minority accepts the view of the majority. This small group of high-level policymakers reaches a decision based on consensus. In this informal decision-making circle, the opinion of every member has a decisive influence. Any member has the power to veto a potential decision.[663] The two main considerations during the decision-making process in the decision-making layer are a balance of interests and political stability. Policy drafts that require approval form the NPC must go through an additional round of revision by the NPC's Standing Committee and is then presented to the NPC for a vote.

Policy Implementation. The *policy implementation* is plagued by the same structures and processes as policy formulation. Finally, policies encounter the objective and institutional constraints of the system during the *implementation process*, hindering the translation of the initiative into reality.[664] Bargaining continues throughout implementation and the lower levels of government have great scope for distortion or non-implementation of policies[665]. Divisions amongst the top leaders, a lack of clarity in the policy documents, or the appearance that the policy initiative is not a high priority can each contribute to a failure to implement even if a 'consensus' had been reached in the first place[666]. The corollary of relying on consensus combined with the progressive delegation of power to the regions is that any radical initiative imposed by the Center without due process is liable to encounter substantial obstruction and non-compliance. As a result the challenges facing China's central government when implementing economic policy are just as great if not more daunting than those involved in the formulation of policy.

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660 Ahrens, N. (2013). China's Industrial Policymaking Process. *Center for Strategic and International Studies (CSIS)*, 1–40.
661 For more information on local experimentation, see Heilmann, S. (2011). Experience First, Laws Later. *China Analysis, 88*.
662 Chen, L. (2008). Bureaucratic System and Negotiation Network: A Theoretical Framework for China's Industrial Policy. In *OECD Reviews of Innovation Policy: China* (pp. 597-612). Paris, France: Organization for Economic Co-operation and Development (OECD).
663 Ibid.
664 Meidan, M., Andrews-Speed, P., & Xin, M. (2009). Shaping China's Energy Policy: actors and processes. *Journal of Contemporary China*, *18*(61), 591–616. http://doi.org/10.1080/10670560903033885.
665 Lampton, D.M. (1992). A Plum for a Peach: Bargaining, Interest, and Bureaucratic Politics in China. In K.G. Lieberthal & D.M. Lampton (Eds.), *Bureaucracy, Politics, and Decision Making in Post-Mao China (*pp. 35-58). Berkeley, USA: University of California Press.
666 Lieberthal, K. (1995). *Governing China. From Revolution through Reform*. New York, USA: W.W. Norton.

If consensus has been reached at lower levels of government and provided that the new policy ideas and propositions align with the principles of *Consultative Leninism,* the leadership will most likely approve the new ideas. All significant changes in direction of strategic policy, or of the rules governing policy creation, are to be officially endorsed by the Central Committee. But it only meets once a year. So matters are more likely to be discussed in the PSC (or Politburo), who are presumed to meet roughly weekly and fortnightly, respectively[667]. Decision-making remains secretive in China, especially at the pinnacle of power; for example, the meeting dates and the agendas of the PSC are very rarely made public. A regular occasion that provide the platform where such policy issues can be regularly discussed and agreed upon are the regular study sessions but the Politburo, which serve as a platform for the leadership to promote new policies or directions. These study sessions of the Politburo are meticulously orchestrated and then the topic is publicized widely[668]. In the worst case, however, lower levels of government are unable to reach a consensus, in which case the elite has either the choice to arbitrate between competing proposals, choose to drive the policy-making process themselves, or postpone the decision[669]. Given the number of unresolved issues, which rise to the highest levels of government, the last of these courses of action, the non-decision, is probably the most prevalent[670]. The Consequently, the prevailing political processes for policymaking is sometimes accompanied by a high degree of *unpredictability*[671].

4.3.4.4 Priorities and Determinants of Energy Choices

Energy policy choices in China depend on a range of *priorities* that are weighed differently and need to align to China's overall agenda. In general, the priorities in China's energy sector encompass (i) energy supply reliability to meet the growing energy demand; (ii) energy price stability; (iii) economic growth under consideration of environmental pollution; (iii) well-being of the country's environmental state and resources; (iv) efficient use of resources and low energy intensity per GDP and (v) social and equitable allocation of resources to all social groups.[672] The factors that influence energy choices can be generally divided into domestic and external factors. *Domestic factors* include those circumstances and conditions that are bound to China's territory, such as (i) institutions and actors and the interaction among them; (ii) energy resource endowment; (iii) the conditions of energy production, transportation between production bases and consumption areas and the infrastructure required for effective distribution of energy sources; (iv) information and human resources and (v) specific policies. Energy choices are also determined and shaped by *international determinants* such as (i) international actors, energy interactions with foreign countries and governments; (ii) international markets and foreign demand; (iii) international norms and treaties that China abides to and (iv) regional and international security.[673]

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[667] Cabestan, J. P. (2009). China's Foreign- and Security-policy Decision-making Processes under Hu Jintao. *Journal of Current Chinese Affairs*, *38*(3), 63–97.
[668] Meidan, M., Andrews-Speed, P., & Xin, M. (2009). Shaping China's Energy Policy: actors and processes. *Journal of Contemporary China*, *18*(61), 591–616. http://doi.org/10.1080/10670560903033885.
[669] Andrews-Speed, P. (2010). The Institutions of Energy Governance in China. Paris, France: Institut français des relations internationales (Ifri).
[670] Ibid.
[671] Ibid.
[672] Andrews-Speed, C. P. (2004). *Energy Policy and Regulation in the People's Republic of China*. The Hague, London, New York: Kluwer Law International.
[673] Meidan, M., Andrews-Speed, P., & Xin, M. (2009). Shaping China's Energy Policy: actors and processes. *Journal of Contemporary China*, *18*(61), 591–616. http://doi.org/10.1080/10670560903033885.

4.4 Support Mechanisms and Instruments for Solar Energy

There are several reasons that justify government intervention in the energy sector by means of policies. Owing to their significant economies of scale, scope and density, energy sectors tend to be natural monopolies that are dominated by large and power full actors who disadvantage small and medium renewable energy producers. Therefore, government intervention and support is needed to create the necessary protective spaces that innovative technologies require to mature until they are able to compete with conventional and established energy fuels. There is also an ethical obligation for governments to intervene in the energy sector. Energy production and consumption are often associated with significant, environmental externalities to the society as a whole. Therefore governments have a clear responsibility to penalize and sanction such externalities either through subsidies to cleaner energy sources or by means of internalizing the externalities.[674] This is often done through the control of energy prices. Given the monopolistic and oftentimes centralized structures, governments should therefore create a *level playing field*, so that innovative renewable energy technologies scan enter the market. Effective support mechanisms should ensure the following criteria: (i) a *clear and guaranteed pricing system* to lower investment risks and minimize costs; (ii) a clear planning and administration procedures with long-term contracts to create confidence among RE user and investors; (ii) firm and plausible targets; (iii) priority access to the grid, guaranteed purchase and clear identification of grid connection responsibilities, and (iv) public acceptance.[675]

There are different ways by which the government can stimulate a greater deployment of solar energies, such as by (i) regulatory policies and government mandates; (ii) economic incentives involving tax relieves or subsidies; (iii) R&D support; or via (iv) market-based mechanisms. The following section provides a brief overview of common support schemes, as shown in Table

Table 20 Overview of Selected Solar Energy Support Mechanisms

Instrument	Description	Success factors
Price driven		
Feed-in tariffs/laws (FIT)	FITs specify the remuneration to renewable energy producers for energy fed to the grid. Renewable energy producers receive a guaranteed price for renewable power generation (per kWh) for a specific period of time (FITs are often digressive over time). This remuneration price is determined administratively by public authorities.	(i) Long-term contracts (15-20 years); (ii) guaranteed buyers (must-take or default contract terms); (iii) reasonable rates of return for energy producer; (iv) applicability for a variety of renewable resource generation types; (v) low administrative costs; (vi) flexibility to capture market and cost efficiencies and (vii) integration into long-term planning to create a stable environment for a renewable industry to thrive

[674] Andrews-Speed, C. P. (2004). *Energy Policy and Regulation in the People's Republic of China*. The Hague, London, New York: Kluwer Law International.

[675] EPIA, & Greenpeace International. (2011). *Solar generation 6: Solar photovoltaic electricity empowering the world*. Brussels, Belgium and Amsterdam, Netherlands.

Quantity driven		
Renewable Portfolio Standards (RPS)/Quota obligation	*Mandatory Purchases with Set Percentages*. Government-mandated policy aimed to create a market for renewable energy by setting a target quantity of renewable energy to be included in the electricity mix by a specific date. An RPS also specifies who is responsible for obtaining that renewable energy and specifies penalties for non-compliance.	(i) Appropriate target levels (that are long-term and incremental with time); (ii) strong and effective enforcement with consequential penalty system; (iii) output-based generation targets; (iv) credit-worthy buyers in place to allow long- term contracts and renewable energy financing; (v) existence of a certificate-based trading platform t facilitate compliance targets.
Tendering Policies	Tender mechanisms use an auction to determine the required remuneration levels. Tendering policies guarantee to purchase the output of a qualifying renewable energy facility at a specified price for a specified period of time.	(1) Existence of a healthy renewable energy industry, usually made up of multiple independent power producers and not one large monopoly who can outbid other producers; (ii) Strong support for a resource planning and portfolio management process
Net Metering	Special tariffs. Net Metering provides credit offsets which the renewable energy producer can use during other times of the day or year when there is no renewable electricity output, thereby reducing the amount of electricity that a customer purchases from a utility.	(i) Electricity tariffs that are not too heavily subsidized to allow for quick cost recovery; (ii) grid reliability
Economic Incentives	Tax credits or reductions on individual and corporate income taxes, price discounts and rebates and low interest loans and loan guarantees, grants, guarantees (Risk-sharing mechanism, loans, public procurement (preferentially purchase of RE services through public entities)	Success factors include (i) binding long-term target (with clear indication of time frame and certainty, (ii) well-functioning market for trading certificates, (iii) technology neutral, (iv) low transaction costs and (v) promotion of innovation.
Tradable Green Certificates (TGC)	Under a TGC system, the government sets a specific and gradually increasing quantity – or minimum limit – for the amount of renewable electricity in the supply portfolio. An obligation is placed on either the electricity suppliers or end users of electricity. The generators (producers), wholesalers, retailers or consumers are obligated to supply or consume a certain percentage of electricity from renewable energy sources. At the settlement date, they have	Success factors include (i) binding long-term target (with clear indication of time frame and certainty, (ii) well-functioning market for trading certificates, (iii) technology neutral, (iv) low transaction costs and (v) promotion of innovation.

	to submit the required number of certificates to demonstrate compliance

Feed-in laws. Mandatory Purchases with Set Prices. In this system it is guaranteed that renewable energy developers can sell their power at a specified sales price (the feed-in tariff or avoided cost), combined with a purchase obligation by electric utilities. Standardized interconnection requirements for renewable generators are also important of these types of purchases. The price level should be high enough and the duration of the sales contract long enough to ensure a market for renewable electricity. Feed0in laws have been applied in Germany, Spain and Denmark. A feed-in law is a price-based policy that specifies the price to be paid for renewable energy. The amount of renewable energy actually obtained depends upon the types of renewable energy resources available in a particular region and their cost relative to the feed-in price. Feed-in laws offer renewable energy developers a guaranteed power sales price (the feed-in tariff), coupled with a purchase obligation (a guaranteed market) by electric utilities. Standardized interconnection requirements for renewable generators are also a common and important component of feed-in laws.

Renewable Portfolio Standards. This policy instrument is designed according to the principle *Mandatory Purchases with Set Percentages.* Government-mandated policies designed to create a market for renewable energy. However, unlike the feed-in law, the RPS is a quantity-based policy that establishes a target quantity of renewable energy to be included in the electricity mix by a specific date. An RPS also specifies who is responsible for obtaining that renewable energy and specifies penalties for non-compliance. As currently implemented, RPS policies tend to be silent on price and leave that to be determined by the market. Under an RPS, a country or state requires all utilities or retail suppliers to purchase a certain amount of renewable energy.

Tendering System. Tendering systems function similarly to feed-in laws and renewable portfolio standards, the only difference being the competitive bidding process through which a guaranteed price and the eligible project are determined. During the competitive bidding process, renewable energy facility developers are invited to submit proposals with specific price offers for new renewable energy generation facilities. Usually the power generator with the lowest price will win the power purchase agreement and will be guaranteed the purchase of output through the grid operator at the specified price for a specified period of time. Similarly to feed-in tariffs, the tendering system lowers financial risks by offering secure, long-term financing and a guaranteed purchase of electricity. Factors of success of the tendering systems are (i) Strong support for a resource planning and portfolio management process; (ii) incorporated flexible legislation to ensure that goals are achieved; (iii) the existence of a healthy renewable energy industry, usually made up of multiple independent power producers and not one large monopoly who can outbid other producers; (ii) Strong support for a resource planning and portfolio management process.

Cap and Trade system (Tradable Green Certificate Systems) describes a market-based, cost-efficient instruments, where a central authority sells or distributes a limited quantity of polluting certificates. The demand for these certificates is induced by a “cap” (for instance through the existence of a national target for RE). Polluters must possess and if necessary purchase certificates in the amount equal to their emissions. Financial derivatives of permits can also be traded on secondary markets. Polluters will be required to prove that they consume at least the specified amount of RE. Proof of compliance is carried out when consumers hand over certificates to the authorities at a given time. Sanctions are imposed if the target is not met.

Net Metering Policies. Net metering describes a system where homeowners with renewable energy systems receive kilowatt credits for their electrical output that they can use at a later point to offset their electricity consumption from the grid (depending on the type of contract credits can be transferred to the next month or over the entire year). It provides credit offsets that can be used for the purchase of grid electricity at other times of the day or year when there is no renewable electricity output, thereby reducing the amount of electricity that a customer purchases from a utility.

Economic Incentives. The most common financing incentives include tax credits or reductions on individual and corporate income taxes, reductions or exemption from certain energy taxes, price discounts and rebates and low interest loans and loan guarantees. Economic incentives can be easily tailored to specific needs, for example, investment tax credits can attract more investment capital, and production tax credits based on the energy output of a project can result in improvements in generating plant efficiency.

4.5 Summary

This chapter discussed the rationale behind and the challenges concerning the development of photovoltaic energy in China by examining technical, economic and industrial circumstances in China. In China's context, photovoltaics have reached the point where they can be considered a viable and cost-competitive alternative to fossil fuels with merits especially in the field of resource availability, technology, geography, environment and market potentials.

Solar Resource Availability and Accessibility: China is endowed with exceptionally high theoretical potential of solar resources, of which only a fraction of China's is used to date in the form of utility PV and distributed PV. Considering the certainty of fossil fuel depletion on the one hand, and the below average per-capita fossil fuel resources and impaired accessibility of remaining coal reserves in China on the other hand, criterions such as resource availability and accessibility of solar systems will gain even more importance in near future. The probability of "peak coal" in 2013 and closing window of opportunity for high-carbon sources provide additional arguments for solar energy. Additional merits of solar resources and availability pertain to its geopolitical implications on global supply chains, logistic challenges, externalities, and energy diplomacy.

Technological Potentials of Solar Energy: The variability and intermittency of solar power plants pose significant technical challenges to grid operators. Grid connection is particularly important in China with 98,9% of solar plants connected to the grid and average solar curtailment rates of 9%. Curtailment reflect technical factors such as insufficient transmission and distribution capacities, but are also rooted in entrenched structural and institutional challenges such as preferential treatment of coal power plants, limited coordination between project developers and grid companies, incomplete energy sector deregulation, and fragmented transmission authorities.

Geographic Potentials of Solar Energy: Energy demand and supply in China struggles with the geographic discrepancy between energy supply and demand, which has created long and costly supply chains. Especially distributed solar PV offers solutions to bridge the geographic mismatch and to preempt the need for additional power transmission and dispatch infrastructure. Also, distributed solar PV can distinct geographic benefits in regard to poverty alleviation and electrification of the 4 Million rural inhabitants that do not have access to the grid.

Environmental Potential: The *closed cycle* and *inherent safety* of solar power plants reveal unique environmental advantages that are of particular relevance for China, where coal-based electricity has led to massive greenhouse gas emissions, airborne diseases and water scarcity. Yet the burgeoning of new polysilicon producers in combination with ineffective regulatory enforcement or comparably low environmental standards in China has led to serious environmental concerns and highlights the need for a more careful disposal of toxic by-products of solar manufacturing especially *Silicon Tetrachloride* ($SiCl4$). Solar electricity can contribute significantly to a lowering of GHGs, since solar utility PV and rooftop PV emit only 5,8% and 5% respectively, of the GHG emissions of coals power plants. The fact that solar power plants require no additional water resources are compelling arguments in China, where coal power plants have contributed to a decade long drought and desertification in northern regions.

Economic Potential of Solar Power Plants: The auspicious outlook for solar energy also reflects impressive cost and technology gains, especially on China's solar manufacturing front. Through successful research and development work, the solar-specific costs have already been substantially improved and will continue to be improved. LCOEs for solar electricity in China are exceptionally high compared with heavily subsidized coal electricity. If, however, external costs would be internalized then costs considerations would include the full costs of environmental penalties and damages to the environment would typically double the price for electricity delivered by fossil fuel power plants. The cost competitive of solar power plants is anticipated to further decrease in future through advancements in (i) higher conversion efficiencies, (ii) use of innovative and less cost intensive materials (such as organic materials); (iii) learning curve effects and accumulation of experience (*Swanson's law*); and (vi) future economies of scale for non-crystalline solar technologies that have not reached market maturity yet (CSP). LCOEs for distributed solar PV are exceptionally high in China, due to additional administrative, logistical and remuneration risks.

Market Potential of Solar Power Plants: China also features favorable market opportunities and supply chains for solar deployment, as China's solar manufacturing industry has achieved economies of scale throughout the entire solar PV value chain, from polysilicon production to solar cell and solar panel manufacturing. China's remarkable solar industry development owes itself to the unique ability of Chinese manufacturers to develop across the entire spectrum of the solar value chain, from polysilicon production to wafers, cells and modules. Yet the intensity and rate of growth and the massive support from provincial governments has also led to massive overcapacities and overinvestment, which have been spurred by dwindling foreign markets and anti-dumping penalties from the EU and US. This untapped market potential makes Chinese consumers an attractive target group for Chinese solar manufacturers.
Solar PV technologies, which were once perceived as a primary export commodity for foreign markets, are hence increasingly recognized as viable solutions to tackle some of China's most urgent issues such as deteriorating air quality, chronic water shortages in northern China, restoration of land, an overinflated solar manufacturing industry and the risk of social tensions, the faltering of the overall economic growth. A solar-intensive energy future would introduce China new choices and competition in energy markets and would diversify the *mix* of power suppliers and products traded, increase competition among power producers, reduce the likelihood of rapid price fluctuations and supply disruptions, and lessen China's dependence on

foreign oil and gas monopolies. Given the adequate policy support, a transition towards solar photovoltaics could become an alternative that is both sustainable and beneficial on many fronts, both at national and international level. A central challenge to policymakers in China is to frame policies that simultaneously satisfy the country's developmental and environmental challenges. This chapter has demonstrated the enormous contribution and potential that solar energy can make in addressing these challenges. Solar energy usage in China has several fundamental facets that are particularly pertinent to the Chinese energy situation.

Nevertheless, the example of wind in China illustrates the perils that lie ahead when tapping the potential of solar resources in China. Unlocking the massive potential of solar power in China will require tremendous efforts in terms of (i) grid connection and infrastructure, (ii) the expansion of additional electricity storage, (iii) transmission and distribution capacities, (iv) technical solutions to cope with the variability of intermittent nature solar output; (v) tackling of administrative and remuneration barriers of distributed and building-integrated solar PV systems and (vi) reforming the energy sector towards a more market-driven approach. Solving these issues will entail carefully crafted policies and considerable policy efforts.

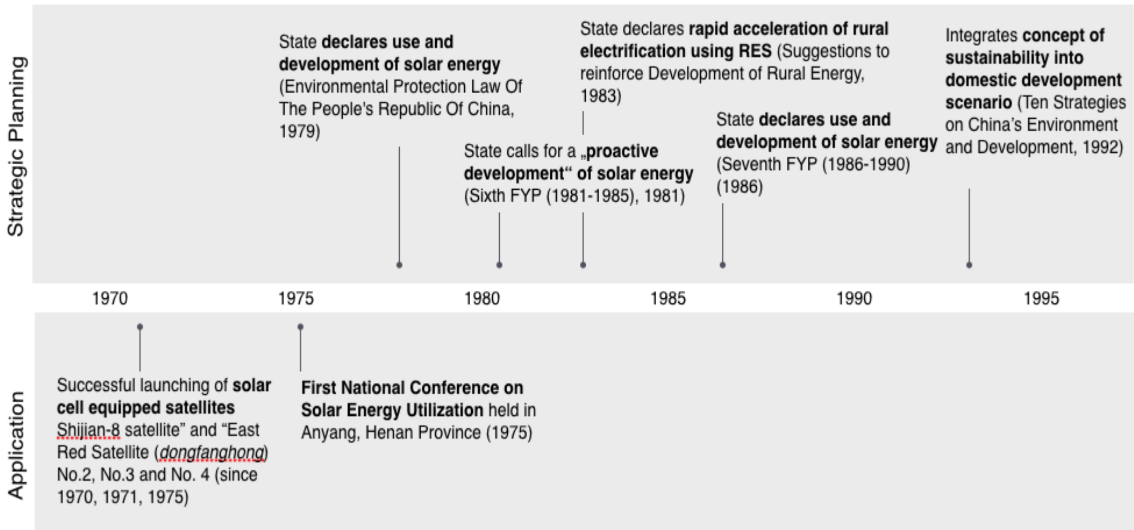
There are many indications that China is already in the midst of transition towards greater integration of solar photovoltaic energy. At the end of 2010, China had an installed solar power capacity of less than 1 GW, and within three years it became a leading nation in terms of solar PV installations per year. Today, China represents the fastest growing solar market globally. While, in 2014, a total 38.7 GW of new solar PV capacity was installed globally, China accounted for the largest share (roughly 27%) of this new capacity, adding some 10.6 GW. Therefore, PV systems are one of the *fastest growing renewable energy technologies* today and are projected to play a major role in global electricity production in the future. Given the right policy environment, the domestic solar PV market in China will trail the same impressive development path that the solar PV manufacturing industry had trailed years before.

PART 5 Tracing the Trajectory of Solar Policies in China

This chapter outlines the most important milestones of solar energy policies in China by focusing on selected solar policies that are considered milestones and conducive to understanding the general pattern of solar policy development. Emphasis is not placed on solar industrial policies as this would go beyond the scope of this study. In reviewing the key elements of the reforms of China's solar energy policy over the past decades, this chapter seeks to trace their evolution and to provide a general picture of status and installation of solar PV in China.

5.1 First Phase: Beginning of the Policy Cycle (1970-1990)

Figure 21 Timeline of Solar Policy Development (1970-1990)



Source: Author

Table 21 Overview of renewable energy promotion schemes in China (1970-1990)

Year	Issuing Authority and Policy	Category
1971	Solar cells are successfully applied to four satellites, namely "Shijian-8 satellite"; "East Red Satellite (*dongfanghong*) No.2"; "East Red Satellite (*dongfanghong*) No.3"; East Red Satellite (*dongfanghong*) No.4".	Application/ Piloting
1975	The "First National Solar Energy Utilization Working Exchanges Conference" is held in Anyang, Henan Province to exchange experience on energy research and deployment.	Strategic Planning
1979	The Standing Committee of NPC approves the Environmental Protection Law Of The People's Republic Of China (for trial implementation) which states "Develop and use on a large-scale […] solar energy" (Article 19)	Law

1981	State Planning Commission issues Sixth Five-Year Plan (1981-1985), which indirectly covers solar energy in its Renewable Energy Programs (as part of the National Science and Technology Development Program) and calls for "*proactive development of solar energy"*	Strategic Planning
1983	State Council's issues "Suggestions to reinforce development of rural energy with recommendations for promoting the development of rural energy" which leads to rapid electrification policies and programs	Strategic Planning
1986	State Planning Commission issues Seventh Five-Year Plan (1981-1985), which indirectly covers solar energy in its Renewable Energy Programs (as part of the National Science and Technology Development Program)	
1986	State Council issues "Provisional Regulations on The Control Of Energy Conservation" in which it states "[…] Areas with the necessary conditions will actively develop and make positive use of new energy sources such as methane, solar energy." (Article 33)	Provisional Regulations
1991	State Planning Commission issues Eighth Five-Year Plan (1991-1995), which indirectly covers solar energy in its Renewable Energy Programs (as part of the National Science and Technology Development Program)	Policy Support Strategic Planning
1992	China releases the "Ten Strategies", which calls for specific measures to improve the environment (such as implementation of sustainable development strategies; measures to prevent and control industrial pollution; measures ot combat the "four evils"; to improve energy efficiency, improve energy structure; promote ecological agriculture, and so forth)	

From 1958 to the 1980s, solar power technologies were still at an embryotic stage and mostly applied in innovative, niche sectors, such as space research. In 1971, for instance, China successfully launched its "Shijian-8 satellite" equipped with NP junction silicon solar cells and its three "East Red (*dongfanghong*)" Satellites with solar cells developed by the Tianjin Institute of Power Sources.[676] Solar cells were also the primary focus of several research institutes. In 1970s, for instance, the Institute of Semiconductors produced 5690 pieces of NP junction solar cells, among which 3350 pieces of NP junction silicon solar cells achieved the standards necessary for space application.[677]

Interest in solar PV technologies outside these niche sectors began to expand in the mid 1970s, when China encountered growing energy shortages in rural areas and China's policymakers recognized the potential of solar PV for rural electrification and poverty alleviation. At this stage, solar energy played only a minor role in the state's efforts to promote rural energy and energy

[676] Kong, R. (2015). Power and Energy: Proceedings of the International Conference on Power and Energy. Shanghai, China: CRC Press.
[677] Ibid.

conservation, reflected in slogans such as ‘‘suiting measures to local conditions, making different sources mutually complementary, utilizing in a comprehensive way and seeking for benefits’’ and ‘‘laying equal stress on exploitation and conservation, putting energy conservation first in the near future’’ (p.31).[678] At first step towards solar energy utilization was made in 1975, when China held its first "National Solar Energy Utilization Conference" held in Anyang, Henan Province to promote the development and knowledge exchange of solar energy in rural areas. Soon after in 1979, China launched its *Environmental Protection Law* approved by the NPC Standing Committee declaring the large-scale development of solar energy (Article 19). In 1981, the state went even further including solar energies into its Sixth Five-Year Plan (1981-1985), calling for a "proactive development of solar energy" (Section 'Renewable Energy Programs under National Science and Technology Development Program'). From this point on, solar energy utilization became a firm yet peripheral component in China's long-term planning, including the Seventh FYP (1986-1990) and Eighth FYP (1991-1995).

It was also at this stage, that the government launched a series of pilot projects for rural energy projects involving solar, such as the 'Integrated Rural Energy Development Program (IREDP)' or 'Hundred-County Program'. These pilot projects were heavily supported through extensive financial resources and technical expertise from foreign donors such as the World Bank and proved to be a pivotal driver of China's modernization drive. The World Bank for instance, listed the promotion of solar PV in rural areas as one of the 15 key strategies for environmental protection in China's energy sector.[679] Such financial support and technical expertise therefore enabled China to catch up on cutting edge technologies in the energy sector following years of isolation.[680] Meanwhile, significant progress was also achieved in the field of technology, research and application. In the mid 1980s, two single crystalline silicon solar cell production lines were launched, which later paved for the way for large-scale commercialization of solar cells. In parallel, state investments began to flow into the solar sector. In 1987, the State Council established special subsidized loans and subsidies for rural energies and renewable energy projects, such as PV cell production lines, at 50% of the commercial bank interest.[681] By the end of the 1980s, China had successfully exposed its already well-trained and disciplined manpower to the technology and knowledge available outside its borders and was ready to embark on a new era of solar energy innovation.[682]

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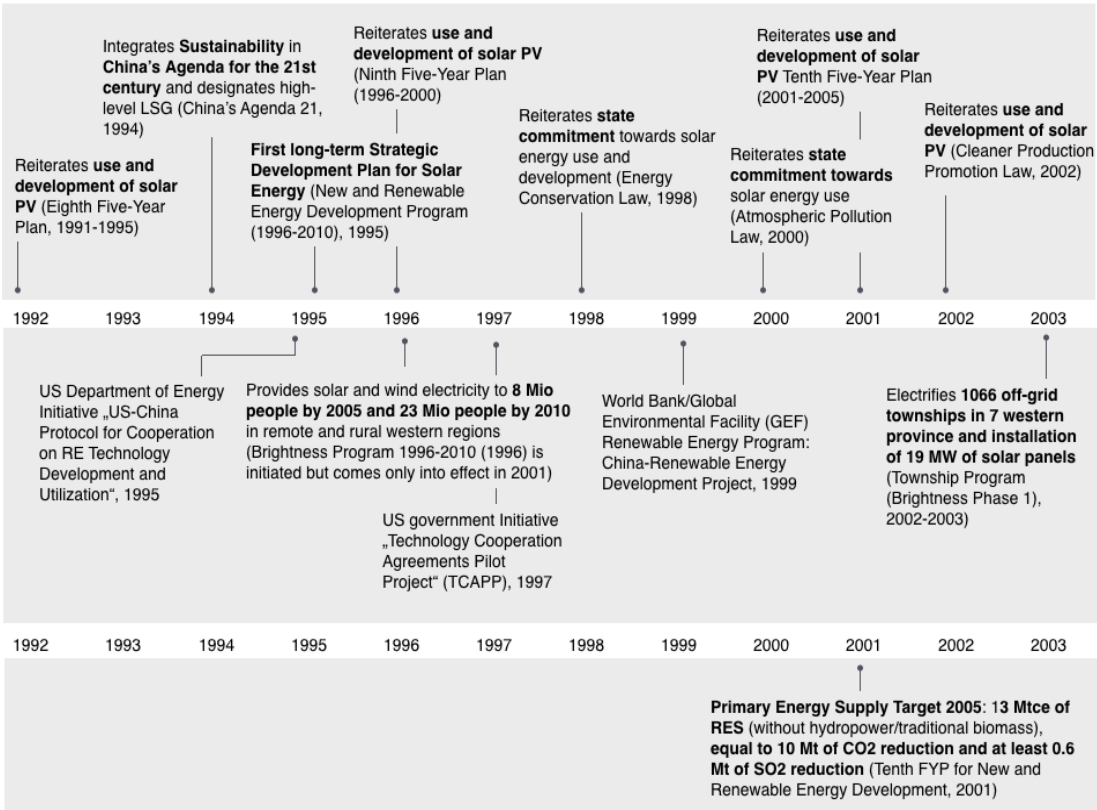
678 Keyun, D., Shuhua, G., & Wenqiang, L. (1996). Rural energy development in China. *Energy for Sustainable Development*, *3*(3), 31–36. http://doi.org/https://doi.org/10.1016/S0973-0826(08)60193-3.
679 Martinot, E. (2001). World bank energy projects in China: influences on environmental protection. *Energy Policy*, *29*(8), 581–594. http://doi.org/https://doi.org/10.1016/S0301-4215(00)00152-X.
680 Ibid.
681 Zhi, Q., Sun, H., Li, Y., Xu, Y., & Su, J. (2014). China's solar photovoltaic policy: An analysis based on policy instruments. *Applied Energy*, *129*, 308–319. http://doi.org/10.1016/J.APENERGY.2014.05.014.
682 Martinot, E. (2001). World bank energy projects in China: influences on environmental protection. *Energy Policy*, *29*(8), 581–594. http://doi.org/https://doi.org/10.1016/S0301-4215(00)00152-X.

5.2 Second Phase: Laying the Foundations for Solar Energy in China (1993 -2002)

Figure 22 Timeline of Solar Policy Development (1990-2002)



Source: Author

In the 1990s, solar policies accelerated and became an integral part of China's planning and development strategies, as shown in Table 21. During the period 1993 to 2002, solar energy policies were still at a nascent stage and revolved mainly around three major priorities: (i) integrating solar energies into China's mid- and long-term planning; (ii) piloting and experimenting with the deployment of solar energies through large-scale programs in rural areas (Brightness Program); and (iii) promoting and support the industrial basis for solar technology manufacturing and achieving significant cost reductions. The following sections briefly describe the key policies and their relevance to solar energy development.

Given that the solar market was still in its infancy, solar energy technologies were mainly considered a costly niche technology (for space research) or alternative for rural electrification and poverty alleviation. Although the China's government was slowly beginning to encourage the development and use of solar PV within in its medium and long-term strategies, China was still far from achieving a coherent policy support framework for solar energies. Government priorities for solar policies at this stage revolved around (i) maturing the technology and preparing it for commercialization; (ii) piloting solar projects to test feasibility and applicability (such as in the case of the Brightness Program and Township Electrification Program) and (iii) to drive down the high costs of solar PV by establishing economies of scale (in other words transitioning pilot projects into larger-scale applications to mass-production technologies). Given the absence of a coherent solar policy support framework, solar policy technologies at this time were far from being commercialized and mostly used for non-civil applications. The solar market at this time is strongly underdeveloped with only 3 MW of solar photovoltaic systems installed and in use, of which around one third was in dispersed household systems (the rest in communication systems). The main driving force for solar PV deployment were the government's Brightness and Township program which act as major driving force for solar PV market expansion in China in the late 1990s and early 2000s. From 1990 until 2004, rural electrification programs represented the main source of demand for solar PV systems in China. Aside from the government-sponsored projects, renewable energies are not competitive due to high initial costs, investment risks and low payback periods.[683]

5.2.1 Strategic Planning and Policy Support

1994 White Paper on China's Population, Environment and Development in the Twenty-First Century (China's Agenda 21)

In 1992 former Premier Li Peng (Jiang Zemin Administration 1993-2001) attended the United National Conference on Environmental and Development (UNCED, also known as 'Earth Summit') held in Rio de Janeiro, during which he -on behalf of China- pledged to actively implement the agreed UN resolutions. Immediately after the UNCED, the Chinese government issued the "*Ten Policies*" to promote environmental protection and development in China. In 1993, the State Council's Environmental Protection Committee established a LSG led by Deputy Ministers from the State Planning Commission (SPC) and the State Science and Technology Commission (SSTC) to organize, coordinate, formulate and implement China's Agenda 21. Parallel to the LSG, a working group was established with representatives from 52 ministries and committees and more than 300 experts. The concerted efforts led to the issuing of a 240-pages draft with the title "White Paper on China's Population, Environment, and Development in the 21st Century" or "China's Agenda 21". After several rounds of revisions through both national and international experts, the State Council finally approved the document in March 1994.

China's Agenda 21 comprises of 20 chapters, 200,000 words and 78 programs that highlight China's environmental strategy for sustainability for the 21-century in accordance to the Rio Declaration. The first eight chapters of the document deal with strategic concerns, legal and policy issues, economics and finance, education, population, social services and poverty. Each of the subsequent ten chapters is clustered around a particular theme: (i) sanitation and health, (ii) human settlement, agriculture and rural development, (iii) industry and transport, (iv) energy, (v) natural resources, (vi) biodiversity, (vii) desertification, (viii) disasters, (ix) atmospheric protection, and (x) solid waste. The final section deals with public participation in sustainable development. China's Agenda 21 marked the beginning of a new path, specifically emphasizing the need "to improve […] new renewable energy sources"[684] and "to hasten construction of rural energy and to improve the deterioration of the ecological environment caused by overconsumption of biological energy" (Objective 13.12). Although it did not mention any targets or specific actions for solar PV development, it served as an important blueprint for the subsequent mid- and long-term plans that followed.

Subsequently in 1994, the State Council instructed lower level government institutions at all levels, to consider China's Agenda 21 as an overarching strategic guideline for the formulation of

[683] Wang, Z., Ren, D., & Gao, Hu (2009). Zhongguo kezaisheng nengyuan chanye fazhan baogao 2008 (China Renewable Energy Industry Development Report 2008). Beijing, China: Gongye Chubanshe.

[684] United Nations Conference on Environment and Development (UNCED). (1992). *Agenda 21 (in Chinese)*. Retrieved on March 21, 2014, from http://www.un.org/chinese/events/wssd/agenda21.htm.

economic and social development plans, and particularly to integrate it into the Five Year Plan (1996-2000), plans for the year 2010, and into day-to-day management.[685] Government authorities under the State Council begun to engage in formulation of various sectoral Agenda 21s and plans of action, which were suited to their own area of specific requirement. For example, the Ministry of Forestry formulated the Forestry Action Plan for China's Agenda 21, the State Oceanic Administration drafted China's Ocean Agenda 21, China's National Environment Protection Agency formulated China's Agenda 21 for Environmental Protection, the Ministry of Water Resources drafted China's Agenda 21 on Water Resources, etc. Other government authorities formulated programs of action according to their specific conditions and in line with the country's Ninth Five -Year Plan.[686]

1995 New and Renewable Energy Program (1996-2010)

One of the early and most significant results of the Agenda 21 was the issuing of the *New and Renewable Energy Development Program* 1996-2010 (*Xinnengyuan Kezaisheng Nengyuan fazhan Gangyao*), developed by the country's three most important state planning commissions, namely the State planning Commission (SPC), State Economic and Trade Commission (SETC), State Science and Technology Commission (today Ministry of Science and Technology MOST). Similar to the *China's Agenda 21*, the program stressed the need to vigorously expand renewable energies including solar energy, especially in rural areas where solar energy could alleviate poverty and provide the means for social and economic development. The policy also proposed a specific timeframe for the future development of solar PV:

- 1996-2000: During this period, China intends to establish an industrial solar base with appropriate infrastructure to support and develop technologies that have not yet reached the stage of commercialization. Parallel to this, the government plans to launch pilot projects to test the feasibility and practicability of solar PV in the Chinese context.
- 2000-2010: during this period, the government plans to scale-up technologies to the national level and position China to the level of industrialized nations.

The general timeframe is complemented through the following individual objectives: (i) to improve the conversion efficiencies of renewable energy technologies; (ii) to lower the production costs associated with PV; (iii) to increase the renewable energy share in the overall power mix and integrate the development of renewable energy into the general plan of economic development and government budgets, (iv) to formulate government policies favorable to renewable energy's cost reduction particularly regarding (a) increased investment and financing for research and development; (b) expanded credit including long-term, low-interest loans and (c) exemption from taxes, provision of price subsidies and incentives; (v) to strengthen the industrial base for manufacturing and support services for renewable energy development to increase product quality and decrease production costs; and (vi) to facilitate an increased international cooperation, introducing advanced technologies and financing from abroad. The program also set forward a set of solar application activities such as the construction and completion of PV power stations for rural electrification in nine Tibetan counties by 2000 and the vigorous promotion of small-scale PV systems for rural electrification in 28 counties, 10,000 townships and 1,000 islands.

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[685] United Nations. (1997). Institutional Aspects of Sustainable Development in China. New York, USA: UN.
[686] Ibid.

Similarly, to previous policies, the New and Renewable Energy Program (1996-2010) severed only as a general guideline and blueprint for concrete policy drafting at lower bureaucracies. Key issues, such as financing and budget allocations to support the ambitious goals were still unclear.[687] Nevertheless it marked an important milestone in the development of solar policies, as it reflected concerted efforts by three of China's most important state authorities, namely SPC, SETC and MOST.

1995 The Electric Power Law

Shortly after the 1995 New and Renewable Energy Development Program, the Standing Committee of the NPC issued another landmark legislation titled "*The Electric Power Law of the People's Republic of China*", which was adopted at the 17th Meeting of the Standing Committee of the Eighth National People's Congress on December 28, 1995 but entering into force in 1996. The Electric Power Law was relevant for the development of solar PV for two reasons: First, it supported adopted preferential policies for rural electrification and offered special energy support to remote and poverty-stricken areas (Article 47) and secondly, it supported the use of renewable energy for rural electrification and power generation. The law declared "the state encourages and supports the use of renewable and clean energy resources for electricity generation. (Article 5)" and "the state encourages and supports the rural electric power source construction through the utilization of solar energy […] to increase the rural electricity supply" (Article 48).

1998 Energy Conservation Law (ECL)

The *Development of New and Renewable Energies* paved the way for many other policies and programs to follow, such as the 'Energy Conservation Law of the People's Republic of China' (*Jieyue nengyuanfa*, "*Energy Conservation Law"*), [688] which was approved by the NPC's Standing Committee in 1997 and became effective in 1998. The purpose of the ECL was to provide a sound legislative framework for government efforts on energy conservation, energy efficiency and higher energy productivity. Its relevance for solar PV energy was its declaration that "the state encourages the development and utilization of new and renewable energy" (Article 4) and that "various level governments shall arrange energy conservation funds […] to be used in support of rational utilization of energy and development of new energy resources and renewable energy resources" (Article 11). Moreover, it states that "investments on energy conservation and energy development will be judged against contribution to energy conservation" (Article 10) and that "governments shall […] strengthen energy construction in the rural areas, develop and exploit the new and renewable energy, including solar energy" (Article 38).

Therefore, the Energy Conservation Law mostly repeated what had been promulgated by previous solar policies, namely a continuous promotion, development and use of new and renewable energies. Similar to previous policies, the formulation of specific rules and methods was left to lower levels of the government bureaucracy. Under the implementation process for the Energy Conservation Law, the SETC issued a list of lower-level policies to regarding the reduction of

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[687] Martinot, E. (2001). World bank energy projects in China: influences on environmental protection. *Energy Policy*, *29*(8), 581–594. http://doi.org/https://doi.org/10.1016/S0301-4215(00)00152-X.

[688] National People's Congress. *Law of the People's Republic of China on Energy Conservation* (1977). Beijing, China: Standing Committee of the Eighth National People's Congress. Retrieved on 3 March 2015, from: http://www.npc.gov.cn/englishnpc/Law/2009-02/20/content_1471608.htm.

small fossil fuel fired power plants, obsolete transportation equipment, and vehicles in urban areas over 15 years old.[689]

2000 Law on the Prevention and Control of Atmospheric Pollution

Another legal document that refers to the promotion of renewable energy resources is the Law on the Prevention and Control of Atmospheric Pollution,[690] which was initially adopted by the NPC's Standing Committee in 1987, amended in 1995 and finally revised in 2000 (promulgated by Order No. 32 of the President of the People's Republic of China on April 29, 2000). Its relevance for solar power is that it "encourages and supports the development and utilization of clean energy like the solar energy, wind energy and water energy" (Article 9). Moreover, it states that "relevant departments under the State Council and the local people's governments at various levels shall adopt measures to improve the mix of urban energy and popularize the production and utilization of clean energy" and "the people's governments of key cities […] may, within the regions under their respective jurisdiction, delimit areas […] [*where they can*] stop using such seriously polluting fuels and shall instead use natural gas, liquefied petroleum gas, electricity or other clean energy" (Article 25).

2000 Renewable Energy White Paper

In 2000, the State Development Planning Commission (SDPC) issued 100-page Renewable Energy White Paper, which provided an outlook for new and renewable energy resources in China based on an extensive assessment of available energy resources. The Renewable Energy White Paper was relevant for solar policy development because it predicted a growing energy supply shortage by 2010. The SDPC concluded that even after taking full advantage of new technology and improved energy conservation practices, China's ability to supply energy from domestic sources would fall short of demand by about 8% in 2010 and 24% in 2040. The White Paper attributed this predicament mainly to several factors, such as (i) lack of a clear renewable energy strategy; (ii) lack of adequate incentives (such as favorable tax treatment and subsidies); (iii) inadequate investment in renewable energy; (iv) lack of rationalization in the industry and the need for consolidation and (v) generally poor management and quality control. The issuing of the Renewable Energy White Paper alarmed energy planners and led to an accelerated development of solar policies.

2001 Tenth Five-Year-Plans (2001-2005)

Five Year Plans since the 1980s have persistently promulgated a proactive developing of solar energy. The Tenth FYP (2001-2005) was no exception in this sense, as it announced that "emphasis should be placed on the development of all types of new energy"[691] through further improvement of energy efficiency, establishing a competitive energy sector and aligning energy with national economic and social development goals. Similar to previous FYPs, it re-iterates that more attention should be placed on developing renewable energies, especially in regard to cutting down production costs and increasing the share of renewables in the overall energy capacity. Moreover, it aims to leverage renewable energy technologies up to the most advanced level in the

[689] Ibid.
[690] Ibid.
[691] Zhu, R. (2001). *Report on the Outline of the Tenth Five-Year Plan for National Economic and Social Development*. Speech delivered at the Fourth Session of the Ninth National People's Congress on March 5, 2001. Beijing, China.

world and to promote industrialization and commercialization. Moreover it recommends some practical programs for renewable energy development, consisting of supplying power in rural areas without access to electricity, developing small decentralized hydro-electricity stations, advancing PV and wind power, and building electricity equipment. The same priorities were repeated during the subsequent years, for instance in the 'Tenth Five-Year Plan for Sustainable Development (2001-2005).

5.2.2 Application and Piloting Solar PV

A particular focus during this stage was also laid on piloting solar energy technologies, as shown in the figure below.

Table 22 Overview of renewable energy promotion schemes in China

Year	Program Name	Description
1995	U.S.-China Protocol for Cooperation in the Fields of EE and RE Technology Development and Utilization	This Protocol was signed February 1995 by the U.S. Department of Energy and the State Science and Technology Commission and renewed for five years in April 2000. One of its goals is 1) to help China diversify its energy resources and thereby reduce its future demand for oil and 2) to mitigate environmental damage associated with energy consumption through deployment of RE and EE efficiency. In terms of renewable energy, particular focus is placed on (i) rural energy, (ii) business development, (iii) and policy and planning.
1996	Brightness Program	
1997	Technology Cooperation Agreements Pilot Project (TCAPP)	CAPP is an initiative of the U.S. government aimed to assist developing countries in attracting clean energy investments that will meet their development needs and reduce GHG emissions. In 1997, TCAPP was initiated in China and launched in 1999 in collaboration with the State Development Planning Commission of China (SDPC) and the U.S. Environmental Protection Agency signed a Statement of Intent for a three-year effort (Clean Air and Clean Energy Technology Cooperation project). The National Renewable Energy Laboratory (NREL) leads the TCAPP implementation for the U.S. government and SDPC is the lead organization for this project in China. Teams have been formed to work on the following six fields: wind resource assessment; wind turbine testing for certification; wind business partnerships; motors training; motor testing, labeling, standards, and certification; and motor financing and business partnerships. (www.nrel.gov/china)
1999	World Bank/Global Environmental Facility (GEF)	This project aims to establish sustainable markets for wind and PV technologies so as to supply electricity in an cenvironmentally sustainable manner and to provide modern energy to remote rural populations. The World Bank and GEF

	Renewable Energy Progrvam: China-Renewable Energy Development Project	will provide $100 million and $35 million in funding, respectively. The project was approved in June 1999 and is now underway. (http://www.worldbank.org.cn/english/content/702q1225506.shtml)
1999	UNDP/GEF Capacity Building for the Rapid Commercialization of Renewable Energy Program	Launched in April 1999, this five-year program consists of capacity building, technical assistance, and technology transfer activities that address the challenges to the commercialization of renewable energy in China. It couples capacity building activities in the fields of resource assessment, standards development, and business and finance, with work in specific market sectors (bagasse, biogas, hybrid village systems, and large-scale wind). This project led to the establishment of the Chinese Renewable Energy Industries Association (CREIA). This project is jointly financed by the Chinese, Australian and Dutch governments and GEF and implemented by UNDP in partnership with the SETC and the Chinese State Environmental Protection Administration. (http://www.ccre.com.cn)
2005	World Bank China Renewable Energy Scale-Up Program (CRESP) (Phase I-III)	The objective of the CRESP program (three phases) is to enable commercial renewable electricity suppliers to provide energy to the electricity market efficiently, cost-effectively and on a large scale. - CRESP Phase I: aims to create a legal, regulatory, and institutional environment conducive to large-scale, renewable- based energy generation. - CRESP Phase II is to support the ambitious renewable energy scale-up program in China with a focus on efficiency improvement and reduction of incremental costs. - CRESP Phase III: The objective of the program is to enable commercial renewable electricity suppliers to provide energy to the electricity market efficiently, cost-effectively, and on a large scale
2002	Township Electrification Program	The aim is to electrify 1066 off-grid townships in 7 western provinces (Xinjiang, Qinghai, Gansu, Inner Mongolia, Shaanxi, Sichuan, Tibet); (ii) support the government's western development efforts and to establish a stable financing scheme, markets, industries, technical capacity, and training systems.

1996 The Brightness Program (1996-2010)

Pursuant to the strategic planning and drafting of solar policies at national level, China's policymakers began to launch solar pilot projects in rural regions in line with the strategic goals that were previously formulated in the 1994 Agenda 21 and the 1995 New and Renewable Energy

Development Program. In 1996, the SPC launched the *Brightness Program* (*Zhongguo guangming gongcheng*), which was heavily influenced by China's participation at the 1996 World Solar Peak Conference in Zimbabwe. Although the *Brightness Program* was first proposed under the leadership of former SDPC during 1996, it was not until late 2002 that the State Council authorized it. The *Brightness Program* was an umbrella program consisting of two separate Programs, namely the *Township Program* and the *Village Electrification Program* both of which were implemented in remote regions in the provinces Gansu, Qinghai, Inner Mongolia, Tibet, and Xinjiang. The *Brightness Program* was financed through the State Council (with approximately CNY 400 million, equivalent to EUR 53 million)[692] as well as through local governments and the governments of Germany and the Netherlands.[693]

The Brightness Program was relevant for the development of solar policies because it constituted the first nation-wide program to implement renewable electricity at large scale and aimed to provide solar and wind electricity to eight million people by 2005 and to 23 million people by 2010 (at that time around 30 million people in remote western regions had no access to electricity).[694] The Brightness Programs main objective was to cover the daily energy needs of rural households and villages, which was estimated at on average 100W per person. The Brightness Program eventually also served the purpose of providing an important learning opportunity for China's policymakers and an effective way to reduce solar costs.

2002 Township Electrification Program (Brightness Program 1st stage) (2002-2003)

In 2001, the Brightness Program launched its first phased titled Township Electrification Program (*Songdian daoxiang*), which was authorized by the State Council in 2002 and delegated to the NDRC. It received extensive funding from the government (EUR 200 Mio from the central government and EUR 470 Mio investments from Provinces).[695] It is considered the largest renewable energy-based rural electrification program in terms of investment volume ever carried out by a country. It is also considered the largest renewable energy-based rural electrification program in terms of scale of dissemination of renewable energy technologies for decentralized rural electrification ever implemented in China.[696]

The primary aims of the Program were to (i) electrify 1066 off-grid townships in 7 western provinces (Xinjiang, Qinghai, Gansu, Inner Mongolia, Shaanxi, Sichuan, Tibet); (ii) support the government's western development efforts and (iii) establish a stable financing scheme, markets, industries, technical capacity, and training systems.[697] The Township Electrification program was based on a competitive bidding process, where system providers competed for tenders to install off-grid systems in off-grid villages. The focus was on PV home systems (40W), village PV

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692 National Renewable Energy Laboratory (NREL) Statistics.

693 The Government of Netherlands supported the "Silk Road" Brightness Program in Xinjiang Province, whereas the German Government provided technical and financial support for the Brightness Program in Yunnan, Qinghai, Inner Mongolia Province. See World Bank. (1999). Renewable Energy Development Project: Project Appraisal Document. Washington, DC: World Bank.

694 National Renewable Energy Laboratory (NREL) (2004). Township Electrification Program. *NREL*. Retrieved on 1 September 2013, from http://www.nrel.gov/docs/fy04osti/35788.pdf.

695 Haugwitz, F. (2005). China's Brightness Program: Off-Grid Power Supply PV for Rural Electrification. In *Intersolar Freibung*. Freiburg, Germany.

696 Chinese Academy of Sciences (2007). *Study and Proposal for Quality Control Chain of Renewables Energy Off-grid Program*. Beijing, China: Institute of Electrical Engineering Chinese Academy of Sciences, Beijing.

697 Haugwitz, F. (2005). China's Brightness Program: Off-Grid Power Supply PV for Rural Electrification. In *Intersolar Freibung*. Freiburg, Germany.

systems (5-6 kW) and a small number of hybrid PV-wind systems.[698] By 2004, the program covered 1013 non-electrified townships in eleven western provinces, providing electricity to 1.3 million people (300,000 households) and constructing 670 solar PV power stations and 51 solar PV/wind hybrid power stations.[699] Altogether, the Township Program led to the installation of 19 MW of solar PV panels, providing relatively strong stimulation to the utilization of solar PV and to solar cell manufacturing in China.

The Township Program provided China's policymakers with invaluable lessons for its plans on commercializing solar energy. The challenges of the programs were mostly (i) an extremely rapid execution focused primarily on hardware and testing various mechanisms such as bidding, contracting and system installation; (ii) the focus on only minimum standards and energy needs; (iii) challenges of ownership and tariff structures; and (iv) insufficient training for system operators.[700] Nevertheless, the Township Electrification Program was an innovation in the sense that it marked a shift from piloting and experimenting with solar energy at small scale to actually implementing solar energies at a large scale in varying settings and provinces.[701] At that time, it was by far the largest solar implementation endeavor that the Chinese government had ever ventured.

[698] National Renewable Energy Laboratory (NREL). (2004). *Township Electrification Program* (Renewable Energy in China). Golden, USA.

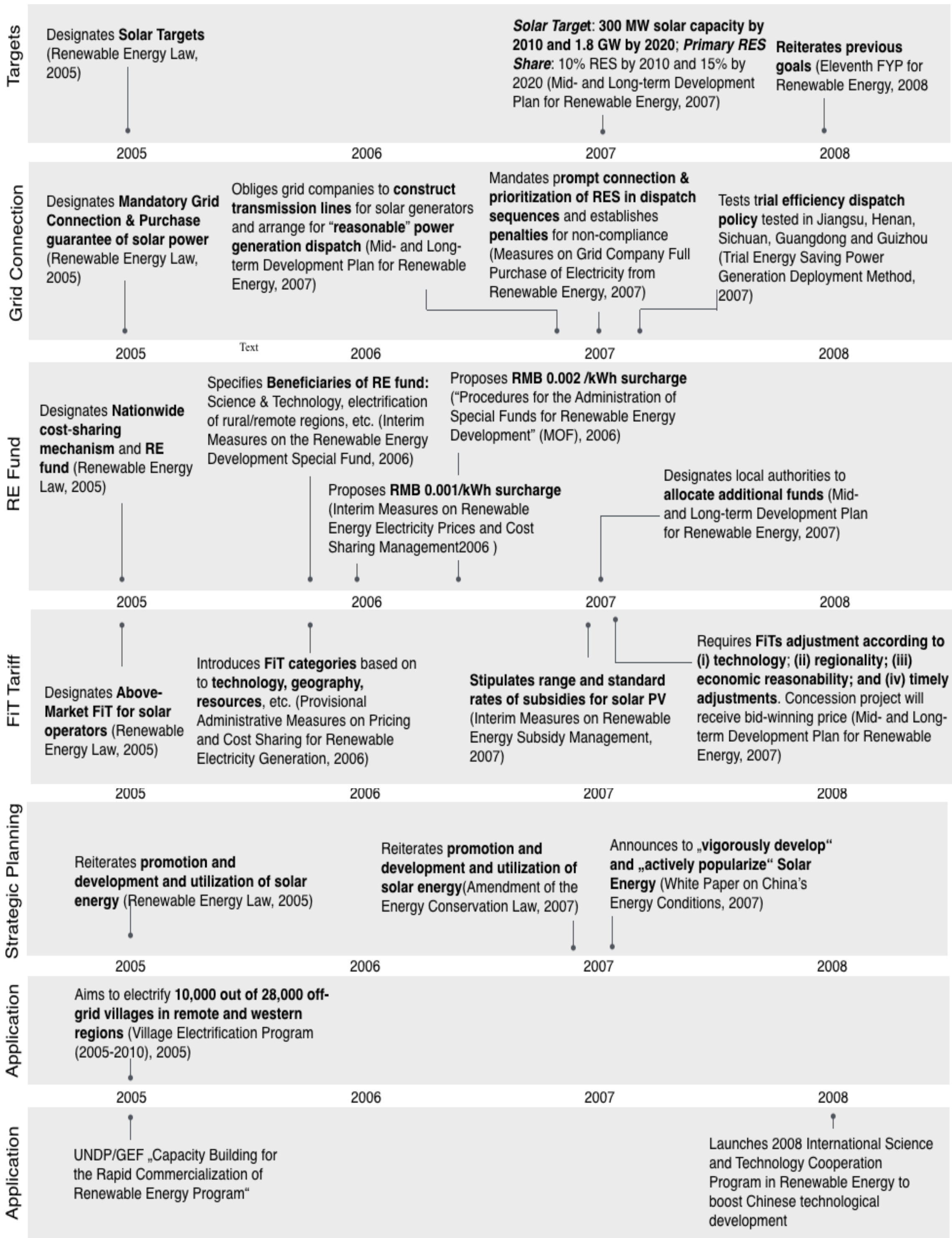
[699] Chinese Academy of Sciences (2007). *Study and Proposal for Quality Control Chain of Renewables Energy Off-grid Program*. Beijing, China: Institute of Electrical Engineering Chinese Academy of Sciences, Beijing.

[700] Haugwitz, F. (2005). China's Brightness Program: Off-Grid Power Supply PV for Rural Electrification. In *Intersolar Freibung*. Freiburg, Germany.

[701] Yu, J. (2007). Woguo Taiyangneng Fadian Xianzhuang Fazhan Zhang`Ai Ji Cujin Cuoshi. *Huatong Jishu*, *3*.

5.3 Third Phase: Establishing a Legislative Framework for Solar Energy (2003-2008)

Figure 23 Timeline of Solar Policy Development (2003-2008)



Source: Author

In the second phase of solar policy development saw an increased diversification of solar energy policies, as shown in Figure 25. Solar policies no longer revolved only around issues such as policy support, strategic planning and piloting or application, but also included an array of support mechanisms to scale up solar energies to national level. While solar policies prior to 2003 revolved mostly around enshrining solar policies into high-level policies and declaring solar energies part of the national agenda, the second stage of solar policy development (2003-2008) revolved much around establishing a favorable legislative framework and adjusting individual support mechanisms for solar energy to address the key challenges and barriers of solar energy, such as (i) the lack of specific, clear long-term development objectives (ii) lack of incentives and financial remuneration; (iii) inadequate funding for research and development; (iv) insufficient market regulation and the lack of industry standards; (v) high risks and costs associated with solar PV and (vi) scattered projects and the absence of economies of scales. Solar policies of the second phase can therefore be clustered around six main themes, namely (i) establishment of solar targets; (ii) solar grid-connection; (iii) establishment of a renewable energy fund; (iv) initiation of a feed-in tariffs and remuneration regulations; (v) strategic planning to reiterate the importance of solar PV and (vi) piloting and scaling up solar PV applications at national level (see Figure 25).

5.3.1 Solar Energy Targets

Solar energy targets are an important element of solar energy policy as it can create market demand and lower investment risks for solar energy technologies. Solar Energy targets were first mentioned in 2001 and slowly developed since then. In 2007 government indicated for the first time concrete targets and goals for solar energy installations and capacity. The following section briefly highlights the landmark policies that have specified solar targets for the period 2003-2008.

Table 23 Overview of Solar Energy Targets (2003-2008)

Year	Policy	Description
2001	Tenth FYP for New and Renewable Energy Development (2001-2005)	*Renewable Energy Target:* Renewable energy target (without hydropower and traditional biomass) of 13 metric tons of coal equivalent (Mtce) by 2005, equaling 10 metric tons (Mt) of CO_2 reduction and at least 0.6 Mt of SO_2 reduction
2005	Renewable Energy Law (REL)	The law obliges the State Council's energy department (the energy body under the NDRC) to specify mid- and long-term national targets for renewable energy production (Article 7) and a national renewable energy development and utilization plan (Article 8).
2007	Mid- and Long-term Development Plan for Renewable Energy	- Solar Energy Capacity Target: 300 MW by 2010 and 1.8 GW by 2020 - Primary RES Share: 10% by 2010 and15% by 2020
2007	White Paper on China's Energy Conditions	Reiterates increase of renewable energy consumption to 10% of the total energy consumption by 2010 and 15 % by 2020.
2008	Eleventh FYP for Renewable Energy	Reiterates target of reaching 10% of energy consumption from RES by 2010

2001 Tenth FYP for New and Renewable Energy Development (2001-2005)

Although the Chinese government had firmly integrated solar energy development into its long-term goals and strategies solar PV deployment was still lacking a firm legal basis and a stable policy framework. Most importantly, the Chinese government had announced in several legal documents and plans its support for the use and development of solar energies, but had not indicated yet to which extent solar energies would contribute to the overall energy supply. In 2001, the government issued its *Tenth FYP for New and Renewable Energy Development (2001-2005),* in which the government for the first time indicated the future quantity of the renewable energy output. It declared that by 2005, renewable energy would supply 13 metric tons of coal equivalent (Mtce) by 2005, equivalent to 10 metric tons (Mt) of CO2 reduction and at least 0.6 Mt of SO2 reductions. Although this was the first time that the Chinese government indicated specific target goals, there were still no specifications and no obligation by the central government to indicate the future share of solar energy.

2006 Renewable Energy Law

In 2005, the Chinese government issued a landmark legislation titled *Renewable Energy Law (*REL, *Zhongguo renmin gonghe guo nengyuan falu)*[702] of the People's Republic of China. The law was a result of a three-year legislative process that began in 2003, when the Tenth Session of the Standing Committee of the NPC included it into its legislative term for 2003. After nearly two years of collaborative efforts between the NPC's Environmental and Resources Protection Bureau, the State Council, research institutes and societal task forces, the REL was finally approved by the NPC's Standing Committee in February 2005 and went into effect on January 1, 2006.[703]
Similar to previous policies, the REL reiterates the importance of "promoting the development and utilization of renewable energy". Moreover, it emphasizes the importance of solar energies, reiterating that "the state shall give priority to the development and utilization of renewable energy in energy development and promote the establishment and development of the renewable energy market". Yet the REL was novel in the sense that it established for the first time a comprehensive legislative framework for renewable energies and addresses many of the shortcomings that are necessary for successful energy policies (see Chapter 4.4.5 Energy Policy Instruments). More specifically it mandated (i) national renewable energy targets (*Zongliang mubiao zhidu,* Article 4); (ii) mandatory connection and purchase policies (*Qiangzhi shangwang jizhi*, Article 14); (iii) feed-in tariffs and cost sharing mechanisms (*Feiyong fentan zhidu*, Article 19 and 20) and (iv) establishment of a renewable energy development fund (*Zhuanxiang zijin zhidu*, Article 24), a shown in Table 22. Although the REL was the first step towards building a comprehensive legislative framework and support mechanisms for solar energies, the law itself remained rather vague and served more as an umbrella legislation and guidance (*fangzhen*) for supplementary ministerial regulations and measures (*zhengce*) at lower levels to flesh out the specific RE targets, the level of feed-in tariff, and price sharing mechanisms still need to be worked out in detail.

[702] Chinese Ministry of Commerce, http://english.mofcom.gov.cn.
[703] NDRC (2006). *The Renewable Energy Power Administration Regulation*. Beijing, China: The National Development and Reform Committee.

Table 24 General Provisions of the Renewable Energy Law

Measure	Description
RE targets	The law obliges the State Council's energy department (the energy body under the NDRC) to specify mid- and long-term national targets for renewable energy production (Article 7) and a national renewable energy development and utilization plan (Article 8).
Mandatory Grid Connection and Purchase	Requires grid companies to both connect and purchase all of the renewable power generated within their coverage area
RE Development Fund	Establishes a "Renewable Energy Development Special Fund"
Solar feed-in tariff	The law states that the pricing administration under the NDRC is obliged to set feed-in tariffs for different types of renewable energy generation. The feed-in tariffs guarantee an above-market rate that the grid company will pay to the renewable generator. Whereas the mandatory connection and purchase policy guarantees that the renewable power generated will be purchased, the feed-in tariff guarantees the price at which this power will be purchased. The additional cost of the feed-in tariff over and above the cost of conventional power is paid by a national surcharge on end-users of electricity and is discussed in more detail in the following sub-section. (Articles 19 and 20)

2007 Mid- and Long-term Development Plan for Renewable Energy

On 2007 the State Council issues the landmark policy titled *Medium and Long-term Plan for Renewable Energy Development (Kezaisheng nengyuan zhongchangqi fazhan guihua),* which announced that the share of renewable energy in primary energy supply would reach 10% and 15% respectively.[704] Moreover, the plan specified that solar energy installed capacity would achieve 300 MW by 2010 and 1,8 MW by 2020. Particularly rural areas would see an increase in solar energy, as the accumulated capacity for solar PV in remote and rural areas would increase to 150MW by 2010 and 300 MW by 2020, as shown in the following table. The 2007 Medium and Long-term Development Plan for Renewable Energy also elaborates on a series of measures that were previously addressed in the REL and which will be discussed in the following sections. Similar to the REL, the Mid- and Long-term Development Plan for Renewable Energy constituted a milestone in the development of solar energies as it specified and elaborated on all of the support mechanisms that were established in the REL, declaring that it would create a sustainable and stable market demand for renewable energy by stimulating "favorable price policies, mandated market share (MMS) policies, government investment, government concession programs, and other measures. These measures will be adopted under the principles of integrated government

[704] For an abbreviated version see http://www.martinot.info/China_RE_Plan_to_2020_Sep-2007.pdf (in English) and http://www.china.com.cn/policy/txt/2007-09/04/content_8800358.htm (in Chinese)

guidance, policy support, and market stimulation." Last but not least, the Mid- and Long-term Development Plan for New and Renewable Energies also introduces a Mandated Market Share:

> "The MMS policies will be adopted for non-hydro renewable power generation according to the following targets: In areas covered by large scale power grids, non-hydro renewable power generation's share of total power generation will reach 1% by 2010 and over 3% by 2020. Power generators with self-owned installed capacity of over 5 GW will be required to have a non-hydro renewable energy installed power capacity self-owned that accounts for 3% of their total self-owned capacity by 2010 and for over 8%of their total self-owned capacity by 2020."

Table 25 China's first solar energy targets specified in the Medium and Long-term Development Plan for Renewable Energy

Year	2005	2010	2020
Shares of RES in primary energy consumption	n/a	10%	15%
Solar Energy Target	70 MW	300 MW	1,8 GW
Accumulated capacity of solar PV in remote, rural areas	19 MW	150 MW	300 MW
Grid-connected BIPV capacity economically developed large and mid-sized cities	n/a	50 MW	1 GW
Large-scale, grid connected solar power plants	n/a	20 MW	200 MW
Solar thermal power station capacity	n/a	50 MW	200 MW
Solar PV application in communications, meteorology, long distance pipelines, railways, highways, etc.	n/a	30 MW	100 MW

2008 Eleventh FYP for Renewable Energy Development

NDRC enacted the Eleventh Five-Year *Plan for Renewable Energy Development* in March 2008 and reiterates the previous target from the Mid-and Long0term Plan for Renewable Energy Development (300 MWp of solar power capacity by 2010). Moreover, it proposes to establish 100MWp of solar home (PV) systems and small-scale PV power plants in off-grid regions in Tibet, Qinghai, Inner Mongolia, Xinjiang. For urban areas, it plans to install 50 MWp by 2010 on roofs of new high-grade villas and the municipal landmark building in large and medium-sized cities with favorable solar resource conditions.

5.3.2 Grid Connection and Guaranteed Purchase

Grid connection and guaranteed purchase are of major importance to reduce the investment risks associated with solar energy technologies (see Chapter 4.4 *Support Mechanisms and Instruments for Solar Energy*). Grid connection mechanisms were first mentioned in the 2005 REL and then specified through a series of subsequent policies, as shown in Table

Table 26 Overview of Solar Policies on Grid Connection (2003-2008)

Year	Policy	Description
2005	Technical Codes For Grid Connection	Standardization Administration released three technical codes applicable to geothermal, photovoltaic and wind power, which are either recommended or applied as guidelines, but not considered compulsory national standards under Standardization Law. Since these technical codes were released simultaneously with the REL, without sufficient time for detailed analysis, many of the terms are set with reference to foreign technical rules, and too ambiguous and outdated to currently be useful.
2005	Renewable Energy Law	Grid companies must connect and purchase all RE power generated within their jurisdiction (Mandatory connection + purchase policy guarantee)
2007	Mid- and Long-term Development Plan for Renewable Energy (NDRC)	Power grid companies must construct transmission lines for RE power stations and arrange for "reasonable" power generation dispatch. The State Council will formulate regulations for grid connection operation and management of renewable power generation. "Power grid companies […] have the responsibility of purchasing, respectively, renewable power […]. The energy administrative authorities under the State Council are responsible for formulating all kinds of regulations for grid connection operation and management of renewable power generation. Power grid companies are responsible for construction of transmission lines for renewable power stations. The organizations responsible for power dispatch must, according to the trends of renewable power generation, reasonably arrange for power generation and dispatch, so that renewable energy resources are utilized as much as possible.
2007	Measures on Grid Company Full Purchase of Electricity from Renewable Energy (SERC)	Grid companies must: promptly provide connection to solar energies (Article 7); enable "priority dispatch" system, in which renewable generators are given priority in the electricity dispatching sequence (Article 8); In case of grid instability, dispatcher is allowed to manage the renewable power generator (e.g., curtail transmission from a generator) and must promptly notify the renewable generator in writing with an explanation and include an estimation of the non-purchased volume

2007	Trial Energy Saving Power Generation Deployment Method (NDRC, SERC, Energy Office)	Loading order of power- generating units was set based on the level of pollution emitted from the generating unit, with zero-emissions units being dispatched first, and the highest emission units being dispatched last. The trial efficiency dispatch policy started with five provincial pilot projects in Jiangsu, Henan, Sichuan, Guangdong, and Guizhou. These pilot projects were relatively successful and provided provincial and central government officials with priority dispatch experience, paving the way for its inclusion in the amendments to the REL

2005 Technical Codes for Grid Connection

The REL was not the government's only attempt to oblige grid companies to connect solar power producers. There had been previous efforts to develop technical standardization under the 2005 *Technical Codes for Grid Connection,* introducing three technical codes for grid connection applicable to geothermal power, photovoltaic power, and wind power.[705] These technical codes were never put into practice, however, and were eventually superseded by the 2005 REL.[706]

2005 Renewable Energy Law

REL was the first policy to compel grid companies to connect and purchase all renewable power generated within their specific coverage area. It states:

> "Power grid enterprises shall conclude grid connection agreements with enterprises which generate electricity by using renewable energy resources and which have gone through the administrative licensing or archive-filing formalities according to the plan for the development and utilization of renewable energy resources, purchasing in full amount the on-grid electricity of the grid-connected power generation projects which meet the grid connection technical standards in the coverage area of their power grids. Electricity generating enterprises are obliged to cooperate with power grid enterprises in protecting grid security […]. Power grid enterprises shall strengthen the power grid construction, expand the scope of areas where electricity generated by using renewable energy resources is provided, develop and apply intelligent power grid and energy storage technologies, improve the operation and management of power grids, improve the ability for absorbing electricity generated by using renewable energy resources, and provide services for bringing electricity generated by using renewable energy resources on grid." (Article 14, *Renewable Energy Law*)

[705] The standards include grid connection standards for wind (GB/Z 19963-2005), solar photovoltaic (B/Z 19964-2005) and geothermal (GB/T 19962-2005). See China Standardization Administration (SAC). Announcement of Newly Approved National Standards of the People's Republic of China (2005). SAC.
[706] Schuman, S. (2010). Improving China's Existing Renewable Energy Legal Framework: Lessons from the International and Domestic Experience. In *Natural Resources Defense Council White Paper*. NRDC. Retrieved on 1 March 2015, from http://www.nrdc.cn/phpcms/userfiles/download/201106/24/130895524612.pdf.

2007 Mid- and Long-term Development Plan for Renewable Energy

Pursuant to Article 14 of the REL, the NDRC issued the *Mid and Long-term Development Plan for Renewable Energy* in 2007. The policy specifically obliges grid companies to construct transmission lines for RE power stations and arrange for "reasonable" power generation dispatch. Moreover, it states that the State Council is responsible for formulating regulations for grid connection operation and management of renewable power generation:

> "Power grid companies […] have the responsibility of purchasing, respectively, renewable power […]. The energy administrative authorities under the State Council are responsible for formulating all kinds of regulations for grid connection operation and management of renewable power generation. Power grid companies are responsible for construction of transmission lines for renewable power stations. The organizations responsible for power dispatch must, according to the trends of renewable power generation, reasonably arrange for power generation and dispatch, so that renewable energy resources are utilized as much as possible. (*Mid- and Long-term Development Plan for Renewable Energy,* 2007)

2007 Measures on Grid Company Full Purchase of Electricity from Renewable Energy

In 2007, the State Electricity Regulatory Commission (SERC) issued the *Measures on Grid Company Full Purchase of Electricity from Renewable Energy* (Full Purchase Measure). This regulation specified certain requirements for connection and purchase of renewable power and calls for a "prompt" provision of connection services to renewable generator by the grid companies (Article 7). Moreover it emphasized the need for a "priority dispatch" system, in which renewable generators are given priority in the electricity dispatching sequence to guarantee the requirements of the mandatory connection and purchase policy (Article 8). It also addresses the possibility of grid instability that could result from the intermittency of renewable energy sources and states:

> "in cases where grid stability is threatened […] the grid company must promptly notify the renewable generator in writing with an explanation and include an estimation of the non-purchased volume. The grid operator must also report the incident including the reasons for taking action and the corrective measures taken to SERC, which will supervise these measures (Article 10, *Measures on Grid Company Full Purchase of Electricity from Renewable Energy*).

The *Full Purchase Measures* also holds grid companies liable for non-compliance and establishes penalties for grid companies if they fail to abide to the regulations (Article 20). The penalty provision applies if the grid company (i) fails to construct, or delays a prompt construction of transmission lines to RE power producers; (ii) refuses to execute or hinders the power purchase agreement or a grid connection and dispatch agreement; (iii) fails to provide or delays grid connection services; (iv) fails to provide renewable generators priority in the dispatch sequence or (v) fails to purchase the full amount of renewable power that is connected to the grid.

Despite these ambitious aims regarding penalties and liability, the implementation of this particular policy proved unfeasible in practice as non-compliance by grid-companies persists to this day and there have not been any known cases of compensation for renewable power generators by grid companies (see Chapter 4.2.2.2 on grid curtailment of solar power generators).[707]

2007 Trial Energy Saving Power Generation Deployment Method (trial)

In August 2, 2007 and pursuant to the Energy Conservation Law, the NDRC, State Environmental Protection Administration, SERC and Energy Office launched the *Trial Energy Saving Power Generation Deployment Method*[708]. The aim of this policy was to test the integration of renewable energy and dispatch sequence in favor of renewables while maintaining grid stability. Power sources with lowest GHG emissions were prioritized first during dispatch. This trial dispatch policy marked a departure from the general practice in China, as traditionally the dispatch order is arranged in accordance to lowest average cost (including capital costs as well as operation and maintenance costs). The trial efficiency dispatch policy was carried out in five provincial pilot projects in Jiangsu, Henan, Sichuan, Guangdong, and Guizhou. The success and lessons from these pilot projects were later integrated into the REL amendments in 2009.

5.3.3 Feed-in Tariffs and Remuneration

Table 27 Overview of relevant policies (2005-2008)

Year	Policy	Description
2005	Renewable Energy Law	Pricing administration under the NDRC should set feed-in tariffs (FiT) for different types of renewable energies. The FiTs should (i) guarantee an above-market rate that the grid company pays to the renewable generator. The additional cost of the feed-in tariff over and above the cost of conventional power is paid by a national surcharge on end-users of electricity (Articles 19 and 20)
2006	Provisional Administrative Measures on Pricing and Cost Sharing for Renewable Electricity Generation (NDRC Price Bureau)	Categorized feed-in tariffs according to technical performances of different renewable energy technologies, geographic locations, and availability of renewable energy resources. Prices will be determined and regulated by the Bureau of Commodity Prices of the NDRC. Establishes the principle of "actual cost plus reasonable profit".
2007	Interim Measures on Revenue Allocation from Renewable Surcharges (NDRC/SERC)	established an interprovincial equalization program, under which provincial grid companies are required to exchange their shortfall or surplus of surcharges with grid companies from other regions. Ultimately each grid company receives the amount to which it is entitled, on the basis of the renewable power generated in its coverage area

[707] Author (2013). Interview with Bloomberg China New Energy Finance. Beijing, China.
[708] China State Council (2007). Jieneng fadian diaodu banfa (shixing) (Measures on Energy Saving Electricity Dispatch (Trial) Beijing, China: China State Council.

2007	Interim Measures on Renewable Energy Subsidy Management (NDRC)	It stipulated that the range and standard rates of subsidy to solar PV shall be approved and announced by the Bureau of Commodity Prices of the NDRC. PV subsidies should cover: (1) price differences between RE electricity and that of local desulfurized coal-fired units; (2) price differences of operation and maintenance costs of off-grid solar PV power systems by public investment over the local grid average sale price; and (3) the grid connections costs of the solar power projects. Equalization of surcharges and payments of subsidies to renewable generators were required to occur monthly (Art. 16 and 11).
2007	2007 Mid- and Long-term Development Plan for Renewable Energy	Solar energy tariffs should be (i) based on the different technical and regional characteristics of various RE technologies; (ii) economically reasonable; (iii) adjusted in timely manner according to the situation of development of renewable energy technologies; (iv) for concession projects determined by tender, the bid-winning price will be the renewable energy power price and can be subsequently adjusted according to the market situation. All expenses of solar borne by grid companies in their purchase of renewable power will be passed to all of society by a surcharge to the retail price of power.

Under Articles 19 and 20 of the Renewable Energy Law, the pricing administration under the NDRC is directed to set feed-in tariffs for different types of renewable energy generation. The feed-in tariffs guarantee an above-market rate that the grid company will pay to the renewable generator. Whereas the mandatory connection and purchase policy guarantees that the renewable power generated will be purchased, the feed-in tariff guarantees the price at which this power will be purchased. The additional cost of the feed-in tariff over and above the cost of conventional power is paid by a national surcharge on end-users of electricity and is discussed in more detail in the following sub-section.

Since the Renewable Energy Law was enacted, China has instituted several feed-in tariff programs, a process China has generally approached by first establishing national concession programs that set a feed-in tariff on a project-by-project basis through competitive bidding. National concession programs provide the central government with valuable experience in setting an appropriate national feed-in tariff that is neither too high and thus an inefficient use of public funds. Setting appropriate grid tariffs is particularly difficult, because the government wants to stimulate the industry while not encourage over-capacity.

2005 Renewable Energy Law

The REL mandates government authorities below the NDRC and responsible for pricing administration (e.g. NDRC Price Bureau) to establish feed-in tariffs (FITs) for different types of renewable energy generation. The FITs should guarantee renewable power generators an above-market rate that the grid company will pay to the renewable generator. Therefore the feed-in tariff warrants that grid operators will purchase solar power form RE operators at a reasonable price (FITs should therefore be higher than the benchmark on-grid price for coal-fired power plants).

The REL also stipulates that the additional cost from such a FIT will be financed through a national surcharge, which will be distributed to electricity end-users via a surcharge on electricity (Articles 19 and 20).

2006 Provisional Administrative Measures on Pricing and Cost Sharing for Renewable Electricity Generation

Pursuant to the Article 19 and 20 of the REL, the NDRC Price Bureau issued the "*Provisional Administrative Measures on Pricing and Cost Sharing for Renewable Electricity Generation*" in 2006. The Policy calls for differentiated feed-in tariffs according to technical performance, geographic location and availability of renewable energy resources. It stipulates that these prices will be determined and regulated by the Bureau of Commodity Prices of the NDRC. This policy therefore establishes the remuneration principle of "actual cost plus reasonable profit".

2007 Interim Measures on Revenue Allocation from Renewable Surcharges

In 2007, the NDRC and SERC issued the "*Interim Measures on Revenue Allocation from Renewable Surcharges"*. This policy established an interprovincial equalization program, under which provincial grid companies are required to exchange their shortfall or surplus of surcharges with grid companies from other regions. Ultimately each grid company receives the amount to which it is entitled, on the basis of the renewable power generated in its coverage area. Given the vast differences in the abundance of renewable resources across China, electricity generated from renewable sources is often consumed in a different region from which it is generated. This policy therefore obliges provincial grid companies to exchange their shortfall or surplus of surcharges with grid companies from other regions. Each grid company receives the amount to which it is entitled, on the basis of the renewable power generated in its coverage area.

2007 Interim Measures on Renewable Energy Subsidy Management

In 2007, the NDRC also released the *"Interim Measures on Renewable Energy Subsidy Management"* which stipulates that the range and standard rates of subsidy to solar PV shall be approved and announced by the Bureau of Commodity Prices of the NDRC. Moreover, PV subsidies should cover (i) price differences between RE electricity and that of local desulfurized coal-fired units; (ii) price differences of operation and maintenance costs of off-grid solar PV power systems by public investment over the local grid average sale price and (iii) the grid connections costs of the solar power projects.

2007 Mid and Long-term Development Plan for New and Renewable Energy

Pursuant to Article 19 and 20 of the REL, the Mid and Long-term Development Plan for New and Renewable Energy announces that FITs will become more differentiated, reflecting several factors:

> "Administrative authorities under the State Council […] will set and improve the renewable energy price policy system […] based on the different technical and regional characteristics of various renewable energy technologies. They will also do so based on the principles of benefiting renewable energy development and being economically reasonable. Further, they will adjust the prices at appropriate times according to the situation of development of renewable energy technologies. For concession power projects determined by tender, the bid-winning price shall be

adopted as the renewable energy power price and may be subsequently adjusted according to the market situation. All of the excess expense of renewable power over conventional power borne by the grid companies in their purchase of renewable power will be passed to all of society by a surcharge to the retail price of power." (Article 3, Mid and Long-term Development Plan for New and Renewable Energy)

5.3.4 Renewable Energy Development Fund

Table 28 Overview of relevant policies related to the Renewable Energy Development Fund

Year	Policy	Description
2005	Renewable Energy Law	The law mandates that the costs associated with feed-in tariffs (Article 20) and the reasonable costs associated with connecting renewable generators to the grid (Article 21) are to be shared nationwide through a surcharge on end-users of electricity.
2006	Interim Measures on Renewable Energy Electricity Prices and Cost Sharing Management (NDRC)	Set a nationwide renewable surcharge levied on electricity users at a uniform rate based on the users' consumption of electricity. In 2006, the surcharge was set at CNY 0.001/kWh
2006	Interim Measures on the Renewable Energy Development Special Fund (MOF)	Specified beneficiaries of the RE fund: (i) Research in the science and technologies; (ii) basic rural energy needs; (iii) stand-alone electricity projects in remote areas and islands; (iv) exploration of renewable energy resources, evaluation, and relevant information system; and (v) Encouraging the localization of production for equipment used in the deployment renewable energy. Projects seeking funding for research and development are required to apply through the national "863" and "973" High-Technology Development Research programs under the Ministry of Science and Technology.
2006	Procedures for the Administration of Special Funds for Renewable Energy Development (MOF)	Proposes to streamline the revenues generated from selling electricity to end-consumers into a special fund designated for renewable energy projects. The surcharge placed on the end-consumer electricity price was 0.002 CNY per kWh in 2006,
2007	Mid- and Long-term Development Plan for Renewable Energy	Provisions: (i) the amount of the fund will depend on the development need of energy technology; (ii) local authorities should allocate additional funds; (iii) government should support RES through preferential tax policies; R&D for renewable energy technologies and equipment manufacturing t

2005 Renewable Energy Law

The REL in 2005 established a cost sharing mechanism and announced the creation of a renewable energy fund to promote and accelerate the use of solar energy. The REL itself remained relatively vague on the fund, but specified that the costs for the fund should be shared nationwide through a surcharge on end-users of electricity.

2006 Interim Measures on Renewable Energy Electricity Prices and Cost Sharing Management

In 2006, the NDRC released the "*Interim Measures on Renewable Energy Electricity Prices and Cost Sharing Management*", which designates the NDRC's pricing department to take responsibility for setting a nationwide renewable surcharge levied on all electricity end-users. It also establishes a RE surcharge of CNY 0.001/kWh, which is levied directly from the end-users' electricity bill by the grid company.

2006 Interim Measures on the Renewable Energy Development Special Fund

In 2006, the Ministry of Finance released the "*Interim Measures on the Renewable Energy Development Special Fund,*[709] which specifies the beneficiaries of the fund. According to the policy, the fund will be channeled (i) for research in the science and technologies associated with developing and deploying renewable energy; (ii) to establish standard and demonstration projects; (iii) to use renewable energy program for basic rural energy needs; (iv) to establish stand-alone electricity projects in remote areas and islands; (v) to explore renewable energy resources, evaluation, and relevant information system; and (vi) to encourage the localization of production for equipment used in the deployment renewable energy.

The special fund is therefore similar to the renewable subsidy programs "Golden Sun", which was launched in July 2009 and provides on-grid solar PV projects in remote areas 50% of total investment cost and off-grid solar PV projects in remote areas 70% of total investment cost.[710]

In 2004, the tendering program of the renewable energy fund ("863 Program") received massive criticism from Chinese scientists abroad, who accused the allocation system of cronyism, plagiarism, falsified data, pet projects and unworthy labs (a popular Chinese proverb among scientists during this time was "Pavilions near the water receive the most moonlight").[711] A few years later, the Chinese government overhauled the tendering system and announced tenders online to increase transparency and avoid conflict of interests.

2007 Interim Measures on Renewable Energy Subsidy Management

Pursuant to the Article 20, 21 and 22 of the Renewable Energy Law, the NDRC issued the "*Interim Measures on Renewable Energy Subsidy Management*" (kezaisheng nengyuan dianjia fujia shouru tiaopei zanxing banfa) in 2007. It is stipulated that the range and standard rates of subsidy to solar PV shall be approved and announced by the Bureau of Commodity Prices of the NDRC[712]. The subsidies for solar PV power generation projects should cover: (i) the price

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[709] China Ministry of Finance. Interim Measures on the Renewable Energy Development Special Fund (2006). Beijing, China: Finance and Construction Department, Ministry of Finance.

[710] China Ministry of Finance. (2009). Interim Measures on Golden Sun Demonstration Project Financial Subsidies Fund. Beijing, China: Ministry of Finance, Finance and Construction Bureau.

[711] Osnos, E. (2009, December 21). Green Giant: Beijing's crash program for clean energy. *New Yorker*.

[712] National Development and Reform Committee (NDRC). (2007) The Interim Measures on Renewable Energy Subsidy Management. Beijing, China: NDRC.

differences between RE power and the standard on-grid price for local desulfurized coal-fired units; (ii) the price difference between operation and maintenance costs of the independent solar PV power systems by public investment over the local grid average sale price and (iii) the grid connections costs of the solar power projects.
According to the Surcharge Allocation Measures, the equalization of surcharges and payments of subsidies to renewable generators were required to occur monthly (Art. 16 and 11). In practice, however, the equalization has occurred every six to nine months. This delay is the result of the complicated, bureaucratic process of determining how much each province is entitled to and from which other provinces the funds should be collected. This delay was also the result of tensions among provinces and grids. Such conflicts led to considerable delays in the remuneration of RE power producers and led to considerable stagnation and bottlenecks in cash flow.

2007 Mid- and Long-term Development Plan for Renewable Energy

The 2007 Mid and Long-term Development Plan for Renewable Energy also encourages the idea of a renewable energy fund, which is "determined according to the requirements for developing renewable energy and the financial strength of the nation". Moreover, it calls for the possibility to introduce *preferential tax policies* to support the development and deployment of renewable energy.

5.3.5 Strategic Planning and Policy Support

Parallel to establishing the support mechanisms for solar energy promotion, the government also continued to express and reiterate the importance of solar energy use and development in several policies.

2007 Amendment of the Energy Conservation Law

The Amendment of the Energy Conservation Law in 2007 states that China encourages and supports the development and use of new energy, renewable energy and the biomass in rural areas, and China will widely promote the biomass, solar and wind and other renewable energy technologies. Moreover, it explicitly states that priority should be given to renewable energies. This concept later paved the way for the quota system, which was established in the Renewable Energy Law Amendments in 2009.

2007 White Paper on China's Energy Conditions

In 2007, the Chinese government released its White Paper on China's Energy Conditions, which led to shift in government paradigm. Although the policy stresses that China's energy resources are abundant, it acknowledges that the per-capita average of energy resources is "very low" and that priority should be given to domestic energy resources. Consequently, it announces to "actively popularize technologies utilizing wind, biomass and solar energy for power generation" and to "actively implement policies supporting renewable energy development, foster a renewable energy market featuring sustained and stable development, and gradually establish and improve an industrial system and a market and service system of renewable energy."

5.3.6 Application and Piloting Solar PV

2005 Village Electrification Program (2005-2010)

In 2005, China launched the Village Electrification Programm, the second Phase of the Brightness Program (1996). The program aimed to electrify 10,000 out of 28,000 un-electrified villages in China's off-grid western region during the period of the Eleventh Five-Year Plan (2005-2010).[713] Unlike Phase 1 of the Brightness Program (Township Program, 2003-2005), the Village Electrification Program paid particular focus on capacity building, certification, and training of national and local engineers and technicians.

2007 Mid and Long-term Plan for New and Renewable Energy

China's Mid- and Long-term Plan for New and Renewable Energy also emphasized the application of solar energy particularly in areas where there are no small hydropower resources. According the policy, another 1 million households will receive access to electricity by means of small-scale, off-grid solar PV power stations and wind-PV hybrid power stations, small household wind turbines and solar (PV) home systems.
The Policy also emphasizes a increased use of solar energy in urban areas. It designates "the administrative authorities under the State Council to be responsible for the construction industry and the Standardization Administration of China will take responsibility for developing national standards for solar systems in buildings, and update the relevant construction standards, engineering specifications, and management regulations of urban construction to create good conditions for the development of solar systems in buildings. In the towns with rich solar resources, through the use of necessary policy measures, the market share of solar thermal technologies will be driven up."

2008 Eleventh FYP for Renewable Energy Development

Pursuant to the requirements of the "Renewable Energy Mid and Long-term Plan" and the New Renewable Energy Development Plan, the NDRC released the Eleventh Five-Year Plan for Renewable Energy Development. This plan proposed to establish national standards for public lighting in urban areas using PV, and technical standards to support PV construction, including the addition of building on-grid PV, large-scale on-grid PV and other technical standards.[714] It identifies the construction of the rooftop PV generating system in city housing and large-scale on-grid PV power plant as key projects for solar energy utilization and development. The plan also outlined a development plan and technological categories for solar power in different regions. Aside from explicitly encouraging the production and consumption of renewable energy and the increase of its share in total primary energy consumption, the Eleventh FYP for Reneawble Energy establishes the following targets:

- 10% of energy consumption from RES by 2010; and
- Reduction of energy intensity by 20% per Unit of GDP.

[713] National Renewable Energy Laboratory (NREL). (2004). *Township Electrification Program* (Renewable Energy in China). Golden, USA.
[714] The National Development and Reform Committee (NDRC). *Renewable energy development eleventh five-year plan*. (2008). Beijing, China: NDRC.

5.3.7 Industrial Development

Table 29 Overview of relevant policies (2007-2008)

Year	Policy	Description
2007	Mid- and Long-term Development Plan for New and Renewable Energy	Declares that by 2010 a basic system of RE technologies and industry will be established. By 2020, a relatively complete renewable energy technology and industry system will have been established, so that a domestic manufacturing capability based mainly on China 's own IPRs will have been established, satisfying the needs for deploying renewable energy on a large scale in China"
2008	International Science and Technology Cooperation Program (NDRC/MOST)	Aims: (i) to boost Chinese technological development; (ii) introduce cutting-edge technologies in the national market, (iii) attract overseas scientists and (iv) develop exchange programs with international research centers.

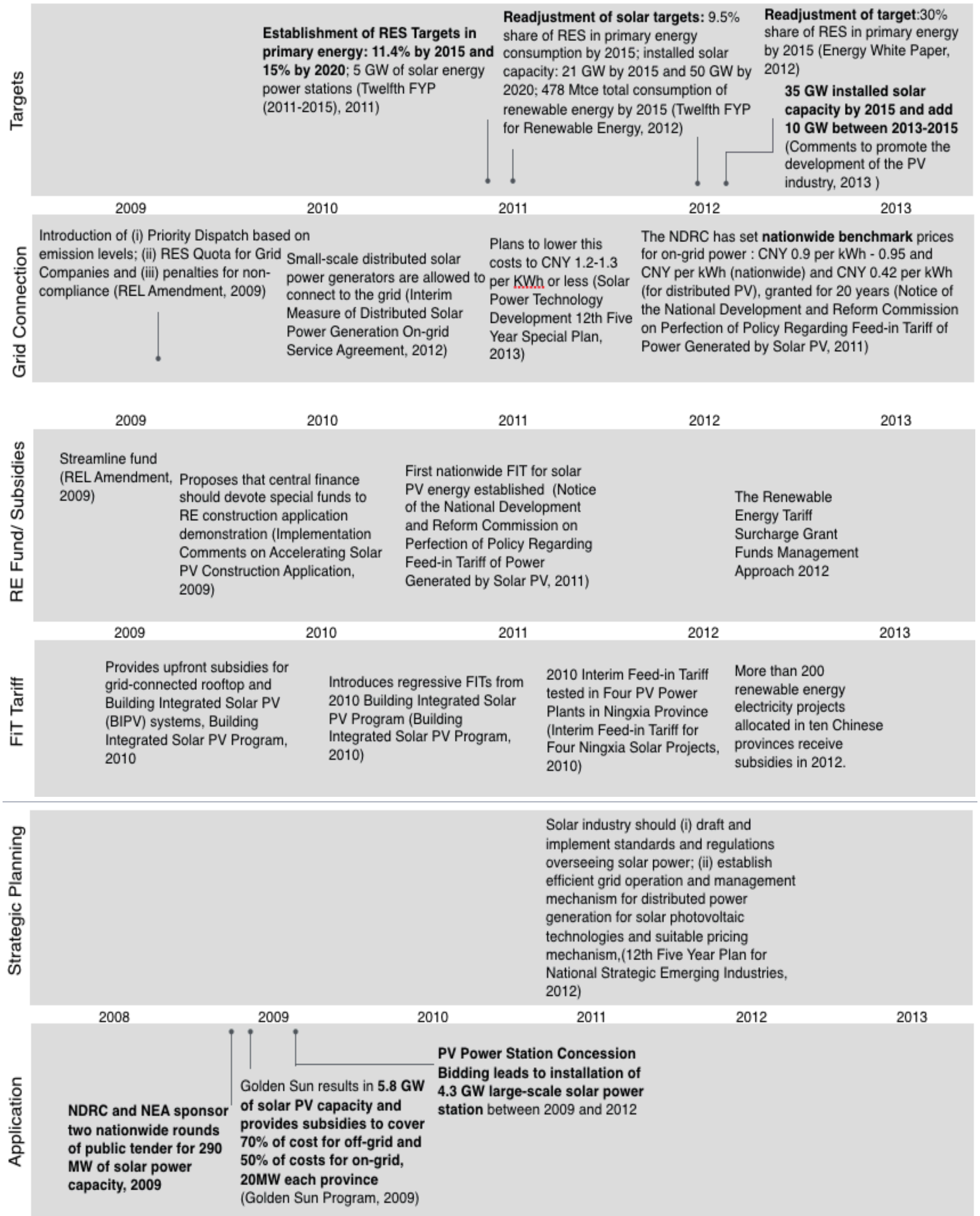
In 2007, the "*Mid- and Long-term Development Plan for New and Renewable Energy"* announces that China would increase technical innovation capabilities and service levels and put scientific research related to renewable energy, technology development, and industrialization into all kinds of national scientific and technological development plans. More specifically it sets two targets for the country's industrial development:

- By 2010: a basic system of renewable energy technologies and industry is established so that equipment capabilities based mainly on domestic manufacturing are in place.
- By 2020: a relatively complete renewable energy technology and industry system is established, so that a domestic manufacturing capability is able to satisfy the needs for deploying renewable energy on a large scale in China.

Pursuant to this policy, the NDRC and the Ministry of Science and Technology (MOST) launched an "*International Science and Technology Cooperation Program in Renewable Energy"* in 2008 with the aim (i) to boost Chinese technological development; (ii) introduce cutting-edge technologies in the national market, (iii) attract overseas scientists and (iv) develop exchange programs with international research centers. In 2010, slightly more than 103 agreements on technology sharing, transfer and trading had been concluded with 97 countries.

5.4 Fourth Phase: Adjusting the Legislative Framework for Solar Energy (2009-2013)

Figure 24 Evolution of the Legislative Framework for Solar Energy in China



Source: Author

5.4.1 Solar Energy Targets

Table 30 Overview of Solar Energy Targets

Year	Policy	Description
2011	Twelfth FYP (NPC/ NDRC)	China's government introduces for the first time binding energy targets. •Target for share of non-fossil fuels in primary energy supply: 11.4% by 2015 and 15% by 2020; • Target for energy intensity will decreases 16% by unit of GDP decreasing; • Target for CO2 emissions reducction: 17% decrease per unit of GDP by 2015; •Target for installed solar energy capacity: 5 GW of solar energy power stations, mainly in Tibet, Inner Mongolia, Gansu, Ningxia, Qinghai, Xinjiang and Yunnan by 2015 .
2012	Twelfth FYP for Renewable Energy	Total consumption of renewable energy will reach 478 Mtce by the end of 2015, what accounts for 9.5% of the total energy consumption. Installed solar power capacity by 2015: 21 GW
2012	China Energy White Paper 2012 (State Council)	Target for share of non-fossil fuels in primary energy supply: 11.4 % and increase that of installed generating capacity from non-fossil fuels to 30% by the end of 2015. By 2015, the nation aims to establish a total of 200 green-energy counties and 1,000 villages using solar energy as demonstrations.
2012	Interim Measure of Distributed Solar Power Generation On-grid Service Agreement (SGCC)	China plans to increase installed generation capacity for solar power to over 21GW by 2015.
2013	The state council's Comments to promote the development of the PV industry (State Council)	In order to deal with the current problems the PV industry is facing, and further regulate and promote the healthy and sustainable development of the solar industry, a target that an average annual increase of approximately 10 GW in PV power installed capacity during 2013-2015 with a total PV power installed capacity being more than 35 GW by 2015. Opinions on how to regulate industrial development order, to improve the management and service of grid connection, to strengthen organizational leadership, etc are specified.

2011 Twelfth FYP (2011-2015)

In 2011, the National People's Congress and NDRC released the country's Twelfth FYP. The Twelfth FYP devotes considerable attention to energy and climate change and establishes for the first-time *binding energy targets*. It establishes the following *legally binding targets* by the end of 2015:

- Target for share of non-fossil fuels in primary energy supply: 11.4% by 2015 and 15% by 2020;
- Target for energy intensity: 16% decrease per unit of GDP by 2015 (The 12th FYP builds directly on the 11th FYP energy intensity target and its associated programs, setting a new target to reduce energy intensity by an additional 16 percent by 2015
- Target for CO2 emissions: 17% decrease per unit of GDP by 2015;
- Target for installed solar energy capacity: 5 GW of solar energy power stations, mainly in Tibet, Inner Mongolia, Gansu, Ningxia, Qinghai, Xinjiang and Yunnan by 2015

Above that the plan also aims to support the development of new energy industries, such as new assemblies of efficient solar power generation and heat utilization.

2012 Twelfth FYP for Renewable Energy

In 2012, the NEA released its Twelfth FYP for Renewable Energy in which it readjusted the solar energy targets:

- 478 Mtce total consumption of renewable energy by 2015;
- 9.5% share of RES in primary energy consumption by 2015; and
- 21 GW of installed solar power capacity by 2015 and 50 GW by 2020

According to the Twelfth FYP for Renewable Energy, China will promote diverse patterns of solar-power development by integrating intensive exploitation with distributed utilization. It will construct large on-grid photovoltaic power stations and solar power generation projects in Qinghai and Gansu provinces, and the Xinjiang Uygur and Inner Mongolia autonomous regions, which boast abundant solar energy and scattered plots of unutilized land, for the purpose of increasing local supplies of electricity. Meanwhile, it will encourage the central and eastern regions to construct distributed photovoltaic power generation systems linked to local buildings. The *plan* specifies that by the end of 2015, the installed capacity of distributed power generation and large power station should both reach 10 GW. This implies that distributed solar PV power generation should be regarded as an important part of China's future solar PV market application. And the government does not encourage the development of solar PV projects that require long distance electricity transmission in the near future,

2012 Energy White Paper

In 2012, the State Council released a strategy document titled Energy White Paper, which identified the problems in Chinese energy sector provided a plan to further “vigorously develop” its energy supply system in order to meet ever growing energy demand. The Energy White Paper updates the previous targets that had been outlined in its FYP and extends these targets considerably:2)

- Installed generating capacity from non-fossil fuels to 30% by the end of 2015.
- Establishment of 200 green-energy counties and 1,000 villages using solar energy as demonstrations by 2015

2013 State Council's Comments to Promote the Development of the PV industry

In 2013, the State Council readjusted the solar target in its “Comments to Promote the Development of the PV industry“. In this document, the State council addresses the “current problems the PV industry” and discussed the needs to promote a “healthy and sustainable development of the solar industry". It readjusts the previous solar targets to 35 GW by 2015, equivalent to roughly 10GW of additional solar installed capacity for the period 2013-2015.

5.4.2 Grid Connection and Guaranteed Purchase

Table 31 Overview of relevant policies (2009-2013)

Year	Policy	Description
2009	Amendment of Renewable Energy Law	Penalties & Quotas: It imposed that grid companies should fulfill certain quotas of renewable energy in their total power purchase (Article 14, paragraph 1). If grid companies do not fulfill their quota, they will face penalties (Article 29). Dispatch Priority**:** NEA, SERC, and MOF responsible for establishing priority dispatch regulations that prioritizes RE generators in the electricity dispatch sequence; grid companies should prioritize low-emission power generators first (according to their level of emissions); Grid Connection Requirements: RE power producers had to confine to certain technical standards in order to benefit form the mandatory connection and purchase policy (alleviates pressure on grid companies)
2011	Technical Rules for Solar PV System Connected to Power Grid (SGCC)	Provide requirements for the quality of electric power and basic safety for small solar PV stations. There are no requirements for grid planning, safe operation and reliability, inspection standards and management system for grid-connected solar PV systems, among others
2012	Interim Measure of Distributed Solar Power Generation On-grid Service Agreement (SGCC)	State Grid Cooperation for China (SGCC) announced a plan to allow small-scale distributed solar power generators to connect to its power lines and allow solar power generators with less than 6 MW of installed capacity and lower than 10,000 kV to be connected to the grid. SGCC will also provide technological assistance and waive charges associated with connecting to the grid. Distributed solar power generation will allow the industry to develop, as long as the grid-connection problems can be solved was established on Oct 2012 by State Grid.

2009 Amendment of Renewable Energy Law

In December 2009, the Standing Committee of the NPC approved an amendment to the REL. The revised Law states that a "protective full-amount acquisition system" will be launched to oblige grid companies to buy the total amount of power produced by renewable energy power producers. The Amendment introduced a series of new concepts, which are briefly describes below:

RES Quota for Grid Companies. The REL Amendments established a quota system (Article 14), which obliges grid companies to fulfill certain quotas of renewable energy in their total power purchase (Article 14). If grid companies are unable to fulfill their quotas they will face penalties (Article 29). This was a novel approach in renewable energy policy because it created an enforceable, legal obligation for the grid companies to purchase a set percentage of renewable power. The Amendments, however, did not specify the quota percentage of renewable energies but instead designated responsibility to the NEA, SERC and MOF to jointly set the quota amounts and instructed the NEA and SERC to enforce them annually.

Priority Dispatch based on emission level. Based on the lessons learned from the "*Trial Efficiency Dispatch"*, the REL Amendments require grid companies to assign priority to power generators based on the criteria of emissions and not production costs. Therefore zero-emission power producers should be given priority in dispatch over high-emission units such as coal-fried power plants.[715]

Technical requirements for grid connection. The REL Amendment also alleviated some pressure on the grid operators, by introducing technical standard that power producers should fulfill before being considered eligible for the mandatory connection and purchase policy (alleviates pressure on grid companies). Prior to the REL Amendment, grid companies had to purchase all electricity from power producers, regardless of whether these met certain technical standards. Therefore the REL Amendments alleviated the pressures of the grid companies and extended responsibility also to renewable power generators who were obliged to meet certain technical requirements for grid connection (Article 14). Therefore the *ReLaw Amendments* lessened the responsibilities of the grid companies and stated that generators and grid companies were now mutually responsible for ensuring grid stability.

Increasing the Central Government oversight. The *ReLaw Amendment* also strengthened central government oversight over provincial-level planning for development of renewable energy within the province, municipality, or autonomous region. Previously, the original ReLaw simply delegated the energy department at the relevant level the discretion to formulate the planning for its own jurisdiction without any direction or oversight at the national level. This lack of unified planning to massive coordination regional imbalances, competition among provinces and to grid-connection difficulties. With the *ReLaw Amendments*, provincial-level governments must now file their renewable energy development plans with NDRC and SERC before they may be implemented. Moreover, provincial-level renewable energy development plans must be formulated on the basis of the National Plan for Renewable Energy Development and Deployment. Previously provincial governments were only obliged to incorporate the mid- and long-term renewable energy targets. The filing system created by the amendments will presumably enable the central government to access and oversee the details of provincial-level planning. The official explanation provided in conjunction with an earlier draft of the amendment states:[716]

> "Although the renewable energy industry in our country has developed quickly in recent years, a number of issues have gradually been revealed, such as.... national and local-level planning have lacked coordination. The result has been that the development plan for renewable power generation has fallen out of step with the development plan for the electrical grid, and this lack of coordination is impacting

[715] Schuman, S. (2010). Improving China's Existing Renewable Energy Legal Framework: Lessons from the International and Domestic Experience (NRDC White Paper). New York, USA.
[716] The draft amendments were released in August 2009 and included an explanation for the proposed draft amendments. The final amendments passed in December 2009, however, do not include an official explanation. The draft version and final amendments differ in a number of respects, but the draft Art. 8 related to provincial planning is exactly the same as the final version.

the targets of the plan more and more every day...Therefore, we need to increase overall coordination of [renewable energy] planning through law and regulations...and make clear that local governments must determine their implementing plans in accordance with the national plan."

The amendments demonstrate that China intends to underpin central government oversight over local government planning and implementation of renewable energy policy. It is also a sign that provincial renewable energy planning will become more unified across the country.

2012 Interim Measure of Distributed Solar Power Generation On-grid Service Agreement

In 2012, the State Grid Cooperation for China (SGCC) announced a plan to allow small-scale distributed solar power generators to connect to its power lines and allow solar power generators with less than 6 MW of installed capacity and lower than 10,000 kV to be connected to the grid. SGCC therefore declares to provide free connection services for distributed solar PV electricity producers that are located close to customers and with installed capacities of less than 6 MW each. The services cover technological assistance including equipment testing, integration plan development, among others.

5.4.3 Feed in Tariffs

Table 32 Overview of relevant policies (2008-2013)

Year	Policy	Description
2010	Building Integrated Solar PV Program	Provides upfront subsidies for grid-connected rooftop and Building Integrated Solar PV (BIPV) systems. Systems of a minimum peak capacity of 50kW benefit from a capital premium determined annually by the government. The level of subsidies for the years 2009 to 2012 decline as follows: 2009: CNY 15/W 2010: 13/W, USD 1.95/W equivalent, for grid-connected rooftop systems and to CNY 17/W, USD 2.55/W equivalent, for building-integrated PV systems (BIPV) 2011: CNY 9/W 2012: CNY 7/W
2010-2013	Interim Feed-in Tariff for Four Ningxia Solar Projects (NDRC)	The National Development and Reform Commission (NDRC) set up a special feed-in tariff of CNY 1.15/kWh, equivalent to USD 0.17, for four PV power plants in the Ningxia province. This decision stands as a first step in the process of implementing a national feed- in tariff for solar PV generated electricity. The projects, of a total capacity of 40 MW, are being developed by the China Energy Conservation Investment Corporation (CECICI), the Huadian Group Corporation and Ningxia Electric Power.
2011	Solar PV feed-in tariff	As of July 2011, non-tendered solar PV projects set up in China will be able to apply for a benchmark feed-in tariff. In Notice 1594 of July 2011, the National Development and Reform Commissions (NDRC) guarantees solar PV projects approved before July 1st, 2011 and put in operation by

		December 31st of the same year, with a 1.15 CNY/kWh tariff (18 USD cent equivalent). This tariff also applies to solar PV projects situated in Tibet and approved on July 1st or afterwards and approved before July 1st but not in operation by December 31st 2011. For solar PV projects in other regions, a CNY 1/kWh (USD cent equivalent) tariff will apply. For solar PV projects approved through concessionary bidding, the applying bidding price can not be higher than the above mentioned benchmark feed-in tariff for solar PV. All tariffs will be adjusted periodically by the NDRC in accordance with future investment, cost changes and technological advancement.
2012	12th Five Year Plan for National Strategic Emerging Industries (State Council)	Solar industry should (i) draft and implement standards and regulations overseeing solar power and solar heat utilization; (ii) establish efficient grid operation and management mechanism for distributed power generation for solar photovoltaic technologies and suitable pricing mechanism.
2012	2012 Renewable Energy Electricity feed-in tariff (MOF, NDRC, NEA)	It lists over 200 renewable energy electricty projects allocated in ten chineese provinces receive subsidies in 2012.
2012	The Renewable Energy Tariff Surcharge Grant Funds Management Approach (MOF/NDRC/NEA)	To promote renewable energy development and utilization of the specification renewable energy tariff surcharge fund management, improve capital efficiency. Investment or subsidies for the construction of public renewable energy independent power systems, perform the same geographical segment sales price, its reasonable operating and management costs beyond the part of the sales price by renewable energy power Price additional to provide appropriate subsidies, subsidy standards is tentatively set at CNY 4,000 CNY/kW per year.
2013	Solar Power Technology Development 12th Five Year Special Plan	A cost of electricity generation from grid-connected PV systems is CNY 1.2-1.3 per KWh. It is planned to lower this costs to CNY 1.2-1.3 per KWh or less
2013	Notice on Improving the Development of Solar PV Industry by Utilizing the Price Leverage Effect	The NDRC has set the benchmark on-grid power tariff at CNY 0.9 per kWh and 0.95 and CNY per kwh according to the solar power resources and construction costs in different resources zones nationwide. Distributed PV power generation projects will be given a standard subsidy of CNY 0.42 per kWh. The feed-in tariff support is granted for period of 20 years and will decline over time.

2010 Building Integrated Solar PV Program

In the third phase of solar policies (2009-2013), China's government released a number of policies to adjust a solar FIT that would create the necessary incentives to scale up solar energies to the national level. In 2010, the government released the "*Building Integrated Solar PV Program"* in which it proposes upfront subsidies for grid-connected rooftop and Building Integrated Solar PV (BIPV) systems. Moreover, it specifies that PV systems of at least 50kW peak capacity would benefit from a capital premium determined by the government on an annual basis. The policy also establishes a regressive FIT depending on the type of application (grid connected rooftop or building integrated) which decreases from CNY 0.17/W in 2009 to CNY 0.7/W in 2012 respectively.

2010 Interim Feed-in Tariff in Four PV Power Plants in Ningxia Province

In 2010, the NDRC set up a special feed-in tariff for solar PV application, which establishes a FIT of CNY 1.15/kWh (USD 0.17) for four PV power plants in the Ningxia province. These pilot projects were conducted for a total capacity of 40 MW and in collaboration with the China Energy Conservation Investment Corporation (CECICI), the Huadian Group Corporation and Ningxia Electric Power. The experience and lessons drawn from these pilot projects later paved the way for the national FIT for solar power systems.

2011 Solar PV feed-in tariff

In July 2011, the NDRC announced the first nationwide FIT scheme for solar PV energy, with its release of the Notice of the National Development and Reform Commission on Perfection of Policy Regarding Feed-in Tariff of Power Generated by Solar PV. The new policy categorizes all non-bidding solar projects into two price segments:

- Projects approved prior to July 1, 2011 and which have achieved commercial operation prior to December 31, 2011 are entitled to a tariff of 1.15 CNY per kWh.
- Projects approved after July 1, 2011 (or approved prior to that date but have not begun commercial operation by December 31,2011) are entitled to a tariff of 1 CNY per kWh.
- Exceptions include solar projects located in Tibet, which, under certain circumstances can still receive a FIT of CNY 1.15.

The NDRC made clear that the government has the right to make adjustments to the tariff, based on factors such as investment cost changes and technology development. The new FIT policy also provides that solar power projects won via the concession process shall not enjoy a price higher than the FIT. FITs that were established during previous subsidy programs, such as the Solar Roofs Program or the Golden Sun Demonstration Program are not eligible to apply for the new tariff scheme.

2013 Notice on Improving the Development of Solar PV Industry by Utilizing the Price Leverage Effect

Due to growing criticism that the solar tariffs do not reflect the geographic differences among provinces and regions, the NDRC releases a new category of FITs in the *"Notice of the National Development and Reform Commission on Improving the Development of Solar PV Industry by Utilizing the Price Leverage Effect"* in 2013. The new FIT scheme divides China into three categories based on regional different in solar availability, and offers the following remuneration:

- 0.9 CNY/kWh or Type-I areas, including Ningxia; Haixi of Qinghai Province; Jiayuguan,Wuwei, Zhangye, Jiuquan, Dunhuang, Jinchang of Gansu Province; Hami, Tacheng, Aertai, Kelamayi of Xinjiang Province; Inner Mongolia (other than Chifeng, Tongliao, Xinganmeng, Hulunbeier);
- 0.95 CNY/kWh for Type II Areas, including Beijing; Tianjin; Heilongjiang; Jilin; Liaoning; Sichuan; Yunnan; Chifeng, Tongliao, Xinganmeng, Hulunbeier in Inner Mongolia; Chengde, Zhangjiakou, Tangshan, Qinhuangdao of Hebei Province; Datong, Suzhou, Yizhou of Shanxi Province; Yulin, Yanan of Shannxi Province; places other than the Type-I areas in Qinghai, Gansu and Xinjiang
- 1 CNY/kWh per kWh for Type-III for areas other than the above

The FIT is granted for period of 20 years and aims to ensure an internal rate of return of more than 8% across all four regions. This FIT scheme however only applies to utility-scale solar projects. Under the current electricity rate dynamic, distributed solar generation can only enjoy the local rate of desulphurization coal-fired plants, which differentiates by regions, and the rate is usually between 0.4 to 0.5 CNY/kWh along coastal provinces.

5.4.4 Renewable Energy Fund

Table 33 Overview of Amendments to the Renewable Energy Fund

Year	Policy	Description
2009	Amendment to REL	Proposes to streamline RE Fund.
2009	Implementation Comments on Accelerating Solar PV Construction Application (MOF, MOHURD)	Proposes that central finance should devote special funds to renewable energy sources to support PV construction application demonstration
2011	Solar PV feed-in tariff	RE Fund surcharge is raised again to CNY 0.008/kWh
2012	Interim Measures on Renewable energy development fund Imposition and Management (MOF/NDRC/NEA)	Policy outlines funding measures, management, supervision and inspection mechanism of Renewable Energy Development Fund. Scheme will continue to support scientific and technological research. Additionally, it will also finance a pilot project for exploiting renewable energy, construction of renewable energy projects for domestic use in rural areas as well as independent power systems in remote areas and islands, localized equipment production and exploiting renewable energy, among other projects, says the draft amendment.
2013	NDRC	From 25 September 2013, the surcharge for the renewable electricity generation is increased from CNY 0.008/kWh to CNY 0.015/ kWh. Upgraded subside for coal-fired plants with technology to lower emissions of nitrogen oxide from CNY 0.008/kWh to CNY 0.01/ kWh.

2009 REL Amendment

In 2009, the REL Amendments established a new mechanism for collecting and distributing the Renewable Energy Fund from electricity end-consumers and renewable energy power generators. According to the original REL from 2005, grid companies had to withhold the surcharge from end-users's regular electricity bill. The REL Amendment, however, instructs these surcharges from electricity end consumer to be streamlined first and channeled to the national Renewable Energy Development Fund, from which each grid company can then apply for compensation for the additional cost of purchasing the renewable power and the reasonable costs associated with grid connection. Such a nationwide single fund has several advantages, such as (i) effective oversight and management of considerable amount of surcharges; (ii) a quick re-allocation of surcharges collected in China's wealthier eastern provinces to China's less developed western provinces; (iv) tax benefits and the prevention of income and value added taxes (VAT), which inevitable leads to percentage of surcharges available for the promotion and deployment of renewable energy.

Renewable Electricity Surcharge: In order to keep paste with the dramatic increase in electricity generation from renewable sources, the surcharge imposed on electricity prices first mentioned in the *Cost-Sharing Mechnism* of *ReLaw* was raised from CNY 0.001/kWh in 2006 (approximately USD 0.00015) to CNY 0.004/kWh in 2009. In 2011 it was raised again to CNY 0.008/kWh (equivalent of USD 0.0012).[717]

5.4.5 Distributed solar PV

Table 34 Overview of Amendments to Distributed Energy Policy

Year	Policy	Description
2012	The Notice on the Establishment of Demonstration Areas for Large-Scale distributed solar PV Power Generation (NEA)	Net Metering: The Notice implements standards for subsidy creation for self-generation systems and for net metering mechanism.
2013	Comments on support of PV power financial services (NEA)	"In order to maximize leverage to effectively stimulate distributed photovoltaic investments". the state provides support to various "self-use priority surplus grid national grid control" method for construction and operations of distributed PV power project, established and place cooperation of voted financing institutions, special for distributed PV power project provides financial service; the state provides access to financing platform provides award letter, financing platform to commissioned loan, effective of funds operation way, to meet conditions of object provides financing support; country opened behaviour distributed PV power project to provides medium-and long-term loan

[717] International Energy Agency (IEA) Statistics, http://www.iea.org

		mainly, and Short term loans and working capital loan, supplemented by a wide range of credit products, loan term of up to 15 years for key clients to invest in the project and the national planning and construction of the demonstration project may apply differential pricing.
2013	Interim procedures of the management of distributed power generation (NDRC)	“Method" exempted distributed power generation projects electricity generation business license, encourage enterprises, professional Energy Service Companies and including individuals, all kinds of electric power customer investment in building and operating distributed generation projects. For distributed power generation, power grid enterprises should be based on the access mode, power range, provide grid services and efficiency. "Approach" that, given the construction funds subsidies or subsidies for distributed power generation unit generating capacity to meet the conditions, construction funds subsidies are limited to the scope of the power universal service.
2013	Notice on the related issues of the application of subsidies based on electric quantity of distributed PV power grid	MOF develops mechanism to enable a greater use of distributed photovoltaic power generation
2013	Notice on the policy of PV electricity VAT	In order to encourage the use of solar power, and promote the healthy development of related industries, MOF develop photovoltaic power generation value-added tax policy. From October 1, 2013 to December 31, 2015, 50% VAT will be refunded to the user of self-used solar power.
2013	Distributed photovoltaic power generation service guide of China Southern Power Grid Company Limited (Interim)	In order to strengthen services for distributed solar power projects and promote orderly development of photovoltaic industry coordinating, enactment of this service guide. Guide distributed in photovoltaic grid-connected applications, Program formulation and review, engineering design and construction of access systems and network elements such as settlement and subsidies to pay details.

In the second phase of solar policy development, particular attention was paid to distributed solar power generation. To this end, the NEA released the “*The Notice on the Establishment of Demonstration Areas for Large-Scale distributed solar PV Power Generation (NEA)”,* which specifies standards for subsidy creation for self-consumption of electricity and for net metering. In 2013, MOF developed a photovoltaic power generation value-added tax scheme, in which 50% of the Value Added Tax (VAT) will be refunded to the user of self-used solar power.

5.4.6 Application and Piloting Solar PV

Table 35 Overview of pilot projects for solar PV

Year	Policy	Description
2009	Golden Sun Program (NDRC)	The 2009 Golden Sun Program provides subsidies to grid connected and off-grid solar PV power generation projects and calls for 500 MW of installed PV capacity by 2012 China-wide. Subsidy schemes have been designed both at the national and provincial levels and apply to 2011. At the national level, developers of off-grid PV systems are eligible for a subsidy covering 70% of the installation cost. Grid-connected projects of a 300 kW minimum peak capacity are eligible for a subsidy covering 50% of the cost of installation, transmission and distribution of generated electricity. The subsidy is applicable to a maximum installed capacity of 20MW in each given Province. Developers must make sure that the solar plant components -panels, batteries, invertors- are certified by authorized institutions and that the whole PV system meets the requirements issued by the National Grid Company to benefit from such financial support. At the provincial level, the Program expects each Province to set up preferential tariffs for PV generated electricity individually. To date, Zheijiang and Jiangsu are the only two provinces doted with a tariff policy. Moreover, the Golden Sun project reforms the solar electricity market structure. Access to state-owned concessions is now submitted to a competitive bidding process in which the best offer determines the approved price levels.
2011	Amendments Golden Sun Program (MOF)	MOF adjusted the solar PV subsidy framework under the Golden Sun Program. Instead of subsidizing 50% of the cost of installation, transmission and distribution of generated electricity in grid-connected PV projects, the new rule includes a fixed tariff. Polysilicon-based modules will receive a subsidy of CNY 9/W (USD 1.40) and thin-film modules of CNY 8/W (USD 1.24).
2012	The Notice on the Establishment of Demonstration Areas for Large-Scale distributed solar PV Power Generation (NEA)	Mandates provinces to establish demonstration areas for large-scale distributed solar photovoltaic installations in order to further upscale solar generation and utilization in China. Provinces are obliged to select urban area and create large-scale deployment of solar technologies Program for their territory. The generation capacity of solar installation should fully meet power demand of the selected area. Smart-grid technologies should be encouraged. The Notice implements standards for subsidy creation for self-generation systems and for net metering mechanism. Grid companies will be responsible for metering calculation and subsidiary payments. Each province can establish maximum of three demonstration areas within its territory. Installed generation capacity per province can not exceed more than 500MW of

		generation capacity from demonstration all demonstration areas combined over a period of next five years (2012 - 2017).
2013	The Interim Measures for the management of photovoltaic power plant project (NEA)	Regarding plan guidance and scale management, State Council authorities in charge of energy determine the scale and layout of photovoltaic power plant construction on the national level, and annual development scales on the province (autonomous region and municipality) level with reference to national energy development plans, renewable energy development plans, and argumentation of solar power resources in regions, economics of the photovoltaic power plant technology, electricity demand, and grid conditions, etc. Regarding project record management, works e.g. location planning, resource evaluation, construction condition argumentation, and market demand analysis, are required before the building of new PV power plants.
2013	The Notice of further improvement of New Energy Demonstration implementation	NEA also divided 100 demonstration cities quota into each province. NEA also encouraged the qualified city or interested city to apply for new energy demonstration zone.

2009 Concession Programs (2009-2010)

In 2009, the Ministry of Finance, Ministry of Science and Technology, National Energy Administration and other departments initiated "*Large-scale PV Power Station Concession Bidding*", which led to the installation of approximately 4.3 GW large-scale solar power station between 2009 and 2012, mainly in northwestern China. It supported over 700 different PV power generation projects focused on a user-side distributed PV system and independent PV system for regions without a power supply.

Given the positive experience of tendering in the wind sector, the NDRC and NEA sponsored two rounds of public tender for solar power projects in 2009. The solar projects included a 10 MW project in Dunhuang city (Gansu Province), during which a on-grid price of CNY 1.09/kWh was achieved. In June 2010, the NEA initiated a second round of public tender for an aggregate capacity of 280 MW, consisting of a 60 MW solar power plant in Inner Mongolia, a 60 MW solar power plant in Xinjiang, a 60 MW solar power plant in Gansu, a 50 MW solar power plant in Qinghai, a 30 MW solar power plant in Ningxia and a 20 MW solar power plant in Shanxi. The successful bidders were required to complete the construction in 24 months and received the exclusive right to operate the plant for 25 years with an on-grid price. The on-grid prices that were achieved through bidding ranged from CNY 0.9907/KWh to CNY 0.7288/KWh. This bid price, however, proved to be much lower than expected as the FIT allowed solar investors to barely break even, let alone get a decent investment return. Therefore it discouraged energy power companies and private solar equipment suppliers from investing in China's solar market.

2009 The Golden Sun Program

In 2009, the NDRC released the "Golden Sun Program, which aimed specifically at promoting large utility-scale PV projects. Its overall aim was to install more than 500 MW of solar power by 2012. The Program was financed through the renewable energy fund and subsidies were capped to 20MW of new solar power capacity for each Province.[718] The subsidy scheme offered two types of subsidies for solar energy producers:

1. Off-grid systems, which are eligible to apply for a subsidy to cover 70 % of the cost for installation and transmission; and
2. On-grid systems, which are eligible to apply for a subsidy to cover 50 % of the cost for installation, transmission and distribution.

The Program explicitly encouraged the use of off-grid solar systems to lessen the pressure on the national grid systems, while any excess electricity could be sold to the utility at the local tariff of desulfurized coal generation.[719] For solar power producers to be eligible for the subsidy, they must fulfill the following criteria: (i) a minimum peak capacity of 300 kW and (ii) compliance with the certification and minimum standards of the grid companies (regarding certification of panels batteries and invertors). At the provincial level, Provinces can individually set their preferential tariffs for PV generated electricity and add additional funds if desired. The Golden Sun's led to an installed capacity of over 5.8 GW and is considered to have played a decisive role in scaling up solar PV in China.

2009 Building Integrated Solar PV Program (BIPV)

Pursuant to the Golden Sun Program, MOF and MOHURD issued a second stimulus plan called the "Application Guideline for Solar PV Building Demonstration Project" in March 2009. The stimulus plan is applicable only to grid-connected rooftop systems and building-integrated solar PV systems with a generating capacity of at least 50 kW. The scheme offers the following subsidies:

- CNY 20/Watt for the BIPV projects; and
- CNY 15/watt for rooftop- and wall-based projects.

The height of this subsidy equals roughly the production costs associated to grid-connected rooftop systems, so that power producers only have to pay for the installation costs.[720]
Projects are required to have at least 300 kW minimum peak capacity and finish construction within one year while operations will have to last for at least 20 years. Applicants were required to make sure that the solar plant components -panels, batteries, invertors- are certified by authorized institutions and that the whole PV system meets the requirements issued by the National Grid Company to benefit from such financial support. At the provincial level, the program expects each province to set up preferential tariffs for PV generated electricity individually.

5.4.7 Industrial Development

Year	Policy	Description
2012	Solar Industry 12th Five Year Development Planning (MIIT)	According to the industry plan announced by the ministry, the country will reduce the cost of solar power to CNY 0.8 per KWh by 2015 and CNY 0.6 per KWh by 2020 and increase production of solar panels.

[718] Ibid.
[719] The Ministry of Finance (MoF), & the Ministry of Housing and Urban-Rural Development (MOHURD). *Application Guideline for Solar PV Building Demonstration Project*. (2009). Beijing, China: MoF/ MOHURD.
[720] Author (2013). Interview with Private Sector Consultants. Beijing, China.

		The plan requires China's leading polysilicon manufacturers to reach annual production capacity of 50,000 tons by 2015. Solar panel makers will have to reach 5GW annual production capacity by the same year. China will put more effort into the production technology for BIPV in the coming years. According to the plan, China aims to increase the conversion efficiency of monocrystalline silicon solar cells to 21%, polysilicon cells to 19%and amorphous silicon cells to 12% by 2015 Above was established in Feb 2012 and announced by Ministry of industry and Information Technology.
2012	The Renewable Energy Tariff Surcharge Grant Funds Management Approach (MOF/NDRC/NEA)	The goal is to increase energy efficiency of: crystalline silicon cells by 20% silicon thin-film cell efficiency above 10%, and cadmium telluride, copper indium gallium selenide thin-film batteries to the level of commercial application; Reduction of production costs: polysilicon materials by 30%, supporting materials by 50%
2013	Interim procedures of management of the code of practice of PV manufacturing (MIIT)	For the manufacturing industry to strengthen the management of PV, guide the photovoltaic industry to speed up the transformation and upgrading, the enactment of this approach. On the photovoltaic manufacturing industry application and auditing and supervision and management in detail.

5.5 Summary

China solar energy framework has developed through four specific phases.

First Phase of Solar Energy Development. Prior to the 1990, solar energies were mainly part of the rural electrification narrative along with other renewable energies, mostly hydropower and wind. During this stage solar energies began to slowly emerge in national policies, albeit only marginally and mainly as a part of policy support and strategic planning. However, policies that mention solar energy at this time are chronically disordered, incoherent and fragmented (e.g. Environmental Protection Law 1979). Moreover, policies appear inconsistent and seemingly sporadic mentioning solar energy issues in various legislations. The first step towards an order was the inclusion of solar issue into China's mid- and long term planning documents, namely the Sixth FYP. Solar energy policy also began to emerge on the piloting/application stage, yet with only a few scattered niche sectors able to afford solar energy technologies. Similarly, at this stage the PV industry was still in its infancy with a manufacturing capacity of merely 5 MW in 1994 (although actual production was 1.4 MW) and with products that were far from international standards.[721] The most important barriers of solar energy technology at this time were (i) the

[721] World Bank (1996). *China - Renewable energy for electric power (English)*. World Development Sources (WDS). Washington D.C., USA: World Bank. Retrieved on 3 March, 2015, from http://documents.worldbank.org/curated/en/785531468748774945/China-Renewable-energy-for-electric-power

absence of a general legislative framework for energy issues and the existence of a legal vacuum (note that China's first Electric Power Law was not developed until 1995 and there was no separate judicial system but instead several administrative officials at various levels), (ii) high costs of solar technology rendering it only feasible in certain niche sectors (China's PV industry lagged behind international standards of processing mainly in terms of product purity and energy consumption per unit of output. There were only few exceptions of companies that were able to master the core technologies), and (iii) a general lack of awareness about solar energy technologies among decisionmakers. China at this time appears to lack a single authoritative document, which lays down the country's solar energy policy. Instead this void is filled by several strategies and policies, which however exhibit a high degree of consistency with regard to policy objectives and specific policy goals. There is no explicit statement of the order of priority and the inter-relationship of the goals and objects seems to exist.[722] Unless the objectives of the national energy policy are ordered and prioritized no coherent plan for implementation can be developed.[723] Even through these strategies for solar energy development remained vague, fragmented and repetitive, they were an important step into paving a way for future solar energy policies in China's policymaking bureaucracy.

Second phase of solar energy development (1993-2002). The second phase of solar policy development saw a shift both in quantity, quality and focus of solar policies. Two important policies emerged during this time that paved the way for a heightened attention towards solar energy issues: China's Agenda 21 with a vision for the 21st century and the subsequent New and Renewable Development Plan for 1996-2010, which laid out a framework and overall strategy for the solar sector development until 2010. In terms of *quantity*, the period 1990s-2000 is marked by a noticeable increase in national policies that make references to solar energy, mostly at the level of strategic planning and policy support. In regard to *quality*, high-level policies specifically on solar energy were released (i.e. New and Renewable Energy Development plan). *For the first time,* China issue high-level and long-term planning documents particularly dedicated to solar energy (e.g. 1995 New and Renewable Energy Development Program) In particular the New and Renewable Energy Development Program (1006-2010) which laid a development strategy for the coming decade was a remarkable achievement. The policies that followed were mostly repeating what had been announced in the Agenda 21 and the New and Renewable Energy Development Plans. The subsequent policies are nevertheless important documents insofar that they reaffirm and repeat the government's intentions and efforts, thereby indicating the priorities, policy concerns and directions towards which the government is heading to. Therefore, solar policies at this time revolved around two main themes: (i) policy support and strategic planning which includes the repetitive expression of support for solar energy use and development use by different actors and institutions and (ii) the application and piloting of solar energies (which received required substantial support from foreign donors (such as the US government) and multilateral development banks (World Bank, GEF). At the application stage, several ambitious programs are launched, such as the initiation of the Brightness Programm to provide electricity access to 8 Mio. people by 2005 and 23 Mio people by 2010. A striking feature however remains, and that is the absence of documentation on the instruments acquired to achieve the expressed goals and objectives. Most documents are declarations of intent (that is the vigorous support of solar utilization and development), but without specific measures on how to translate these goals into specific measures. Yet the gradual integration of solar policies into national plans and strategies

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[722] Andrews-Speed, C. P. (2004). *Energy Policy and Regulation in the People's Republic of China*. The Hague, London, New York: Kluwer Law International.
[723] Ibid.

at this stage was a subtle but nevertheless decisive step in nurturing a cycle of decision-making that would take another several years before coming to fruition. Last but not least, the issuing authorities are mostly high-level authorities (NPC and State Council) which issue solar policies, therefore most solar policies at this stage are primary policies.

Third phase of solar energy development (2003-2008). The third phase of solar policy development revolved much around translating the goals into specific support mechanisms. The most important policy in this respect was the Renewable Energy Law, which was the first policy to pave the way for a coherent legislative framework on solar energies. The legislative framework established four new aspects of solar policies, around which subsequent solar policy activities then clustered, namely (i) defining solar targets, (ii) mandatory grid connection and purchase agreements; (iii) a renewable energy fund to finance renewable energy projects; (iv) a remuneration and feed-in schemes for solar power producers. Aside from these priorities, the government continued to reiterate the importance of solar energy through various policies (strategic planning and deploy solar energy technologies. Therefore, in terms of content there is a discernible shift towards more concrete measures and the diversification of priorities (no longer focused just on strategic planning and application. The REL has also led to a burgeoning of solar policies, there the amount of solar policies has increased substantially. During this stage, we also see new actors entering the stage (such as MOF, NDRC) and drafting secondary policies.

Fourth Phase solar energy development (2009-present).
The fourth phase of solar policy development revolved much around elaborating and specifying the measures that had been put forward in the 2006 REL. The most significant changes in solar policy is the (i) introduction of binding targets to grid operators and (ii) the frequent adjustments of solar targets (first 5 GW of installed power capacity by 2015 in the 12th FYP; then changed to 21 GW of installed solar power capacity by 2015 by FYP for Renewable Energy Sources; and finally adjusted to 35 GW of installed solar power capacity by 2015).

PART 6 Explaining China's Solar Policy Trajectory from the Punctuated Equilibrium Theory and Fragmented Authoritarianism Perspective

6.1 The Emergence of Solar Issues on China's National Agenda

The recent burgeoning of solar energy policies leads to the question why and when solar energy issues and societal concerns succeeded in becoming part of the national agenda. Jones et al. (2007) assert that a pre-condition for policy change and major policy punctuations is the access to the national agenda.[724] Agenda can be understood as "the focus of collective organizational attention" (p.40),[725] that is when all organizations shift from parallel processing to serial, with its severe attention limits. Birkland (2006)[726] interprets agenda as "a series of *beliefs* about the existence and magnitude of problems and *how* they should be addressed by government" (p.63).[727] *Agenda setting* is therefore the process by which sufficient urgency and importance is attached to a specific issue attached to so that these are brought to the attention of China's highest decisionmakers.[728] According to Birkland (2006),[729] the agenda sphere can be distinguished into four distinct levels:

- the *agenda universe* (issues that have the potential to become important);
- the *systemic agenda* (issues that merit attention by the public and government);
- the *institutional agenda* (issues that are explicitly up for active and serious consideration by the government); and
- the *decision agenda* (issues that are about to be acted upon by the government).

Applied to the Chinese context, solar energy issues seem to have been part of China's national agenda since the 1970s, as shown in Figure 28. The following sections briefly describe when and why solar energy issues were able to attract the collective attention of China's policymakers and how these fit into the overall agenda and mid-term planning at that time.

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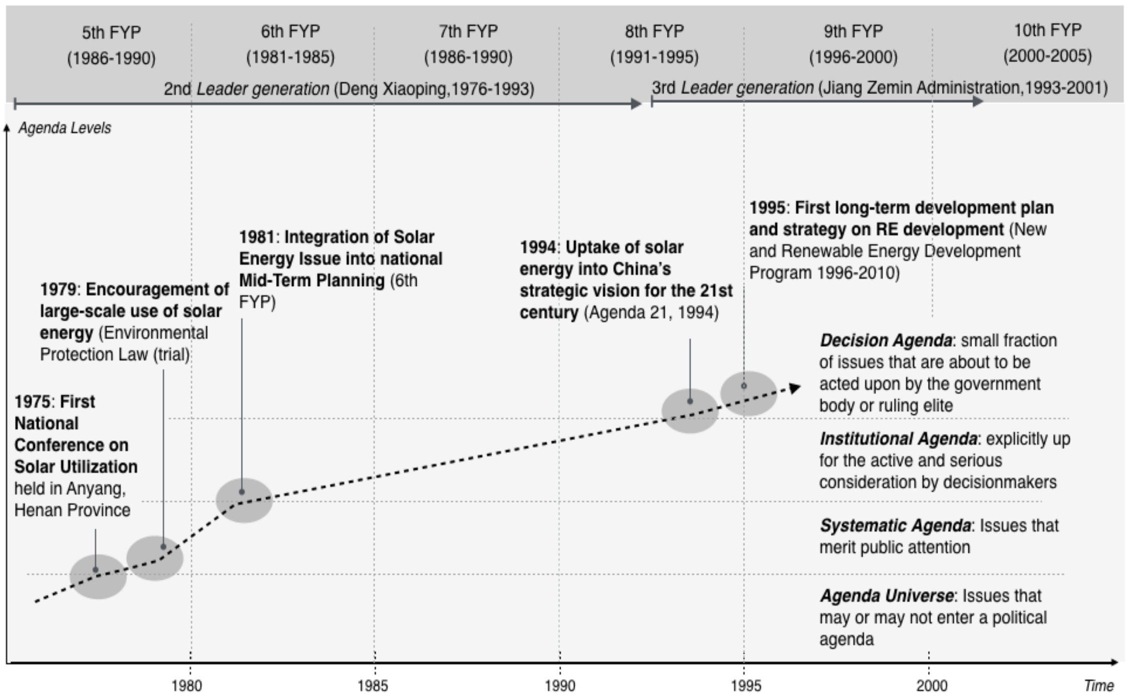
724 True, J. L., Jones, B. D., & Baumgartner, F. R. (2007). Punctuated equilibrium theory: Explaining stability and change in American policymaking. In P. A. Sabatier (Ed.), *Theories of the Policy Process* (2nd ed.). Boulder, USA: Westview Press.
725 Jones, B. D., & Baumgartner, F. R. (2012). From There to Here: Punctuated Equilibrium to the General Punctuation Thesis to a Theory of Government Information Processing. *Policy Studies Journal*, *40*, 1–20. http://doi.org/10.1111/j.1541-0072.2011.00431.x.
726 Birkland, T. A. (2006). Agenda setting in public policy. In F. Fischer & J. M. Gerald (Eds.), *Handbook of Public Policy Analysis* (pp. 89–104). London, UK: Routledge.
727 Ibid.
728 Hilgartner, S., & Bosk, C. L. (1988). The rise and fall of social problems: A public arenas model. *American Journal of Sociology*, *94*(1), 53-78,
729 Birkland, T. A. (2006). Agenda Setting in Public Policy. In F. Fischer, G. J. Miller, M. S. Sidney (Eds.). *Handbook of public policy analysis: Theory, Politics and Methods* (pp. 63-78). Boca Raton, USA: Chemical Rubber Company Press (CRC).

Figure 25 The Emergence of Solar Energy Issues on China's Agenda



Source: Author

6.1.1 Solar Energies enter the Systematic Agenda Level (1975)

The year 1975 marks the point where solar energy issues transitioned from the *agenda universe* to the *systematic agenda*. This was the year that the government held the first national conference on solar energy utilization held in Anyang, Henan Province to exchange information and experience among government authorities, scientists and practitioners. Several years later in 1979s, the use of solar energy was also mentioned, albeit only peripherally, in the 1979 *Environmental Protection Law*. Prior to that there are no indications that the government paid particular attention to the issue of solar energy. Through its enforcement in national law (*falu*) and its explicit consideration and approval of state's most post powerful decision-making authorities (Standing Committee of the NPC), solar energy issues were no longer considered an issue that may or may not be enacted upon (*agenda universe*), but were suddenly perceived as an issue that merited public attention and promulgated by the political decisionmakers (*systematic agenda*).[730]

Solar energy technologies at this stage did not attract much attention from government officials for several reasons: (i) high associated costs with solar PV; (ii) nascent technological progress and the absence of a solar industry; (iii) the lack of practical experience and piloting and (iii) the preoccupation of decisionmakers with more urgent macro-economic issues. Solar PV technologies at this time were extremely costly and only feasible in certain niche areas (such as space research). Aside from that, the year 1975 also marked the beginning of a transitioning period, as a new leadership generation revolving around Deng Xiaoping came to power (referred to as *second-generation leadership* (1976-1993), see *Annex IV China's Leadership Generation*). Leaders of the second generation stood out in terms of their political priorities and way of thinking (most of them having studied abroad). Instead of proclaiming *mass movements* or *class struggles*

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[730] Cobb, R. W., & Elder, C. D. (1983). *Participation in American Politics: The Dynamics of Agenda-Building (2nd ed.)*. Baltimore, USA: Johns Hopkins University Press.

as had been done by the previous leadership generation, the second generation focused more on economic restructuring, reforms and the recouping of economic losses suffered during the previous years of political turmoil that had resulted from the Cultural Revolution and the Great Leap Forward. Therefore, the overall agenda during this time revolved much around a series of major political and economic reforms that strived towards re-establishing China at the vanguard of global political, economic and industrial developments, a period that is known as China's opening-up reform (*Gaige kaifang*, 1977-1992). Despite these more urgent, macro-economic issues, policymakers at this time were nevertheless very much aware of the solar energy potential and the socio-economic benefits it could provide, particularly in context of greater energy efficiency and rural electrification.

6.1.2 Solar Energies enter the Institutional Agenda Level (1981)

In 1981 the issue of solar energies started to surface on the *institutional agenda*, that is they were "explicitly up for the active and serious consideration of authoritative decisionmakers" (definition of the institutional agenda).[731] During this time, solar energies were for the first time included into China's Sixth Five-Year Plan (FYP) and since then repeatedly emphasized in the Sixth FYP (1981-1985), Seventh FYP (1986-1990) and Eight FYP (1991-1995). Although the Sixth FYP (1981-1985) only reiterated what previous policies had stated ("proactive development of solar energy"), it was not so much its content, but more importantly the fact itself that solar energies were included to China's long-term plan that constituted this transition. As discussed in *Chapter 3.3.6 Policy Categories and Legal Framework*, long-term planning documents such as FYP are an extraordinarily crucial element of Chinese policymaking, as they determine and communicate the central governments' overall priorities, goals and vision. More importantly they serve as a guiding document for territorial and functional governments to follow (which then draft their own FYP in accordance to the national FYP). Although FYPs are not followed to the letter, they have a powerful role in guiding official policy and paving the way for specific and concrete policy measures taken by lower level ministries, governments and commissions. Given the fragmented nature of China's political system, FYP therefore serve as general guidelines (*fangzhen*) along which all further policy activities are then drafted. The uptake of solar energies into China's medium-term planning therefore marked the point at which the central government clearly communicated to lower, level governments, ministries and commission that these should take solar energy into consideration when drafting their own concrete policies (*zhengce*).

Solar energy issues at this time fitted well into the government's overall agenda. During this time, the second-generation leadership had just launched its Sixth Five-Year-Plan (1981-1985), which aimed to achieve a *comparatively well-off level off society* (*xiaokang shuiping shehui*) (p.575).[732] Above that, *decentralization* played a major role, especially in the energy sector with provincial governments gaining increasing control over power generation assets and provincial grids. A corollary was the proliferation of non-agricultural enterprises in rural areas, such as township and village enterprises, which led to an empowerment of provincial, county and local levels of administration. The sudden proliferation of rural entrepreneurs and economic activities in remote and rural regions also sparked concerns of energy supply, which in turn increased the government's interest in alternative energy sources especially for off-grid regions in remote and

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[731] Ibid.

[732] This was announced in 1982 during the Twelfth Congress of the Chinese Communist Party (CCP) which set the goal of quadrupling the gross industrial and agricultural output and raising the living standard of the country by 2000. See Steiger, B., Friedrich, S., Schütte, H. W., & Emmerich, R. (Eds.). *Das große China-Lexikon-Geschichte, Geographie, Gesellschaft, Politik, Wirtschaft, Bildung, Wissenschaft, Kultur*. Darmstadt, Germany: Wissenschaftliche Buchgesellschaft.

rural areas. There are many pertinent examples that illustrate the government's intention to use solar energy predominantly for rural electrification, such as the "*Suggestions to reinforce development of rural energy with recommendations for promoting the development of rural energy*" released by the State Council in 1983.

6.1.3 Solar Energies enter the Decision Agenda Level (1994)

The release of China's Agenda 21 ("*White Paper on China's Population, Environment and Development in the Twenty-First Century*") in 1994 marked the point when solar energy issues were finally taken up for immediate government action and hence began to surface on the *decision agenda*. In China's Agenda 21, the government explicitly calls for an improvement and acceleration of new renewable energy sources, particularly in rural regions (Objective 13.12). Similar to the Sixth Five Year Plan, it was not so much the content that caused the transition from the institutional to the decision agenda, but more importantly the circumstances and government actions surrounding this policy document, that reflected a heightened level of government attention towards solar energy. Shortly after Agenda 21, the State Council, one of China's most powerful decision-making authorities in China, instructed lower level governments, commissions and ministries to consider China's Agenda 21 as an overarching strategy and guideline along which economic and social development plans and day-to-day management should be formulated.[733] This announcement immediately propelled solar energy issues not only on the agenda of the central government, but also on those of numerous agendas of provincial, country, township and village governments throughout the entire country, obliging them to pay serious attention to solar energy issues (see for instance Annex 1 Diagram of Political and Administrative Structure of the Country). The government at this time had indeed good reasons to consider solar energies an issue of national importance during its Seventh Plan period (Seventh FYP, 1986-1990). After more than a decade of open-door policy and economic transitioning, China's economy had skyrocketed: between 1978 and 1993, China's economy had grown on average 11% per year, expected to further grow by 8-9.5% each year until 2020 (p.2).[734] This explosive economic growth had shifted China's economy from a mostly agrarian, developing state to almost a "lower-middle-economy".[735]

Despite the bright and promising outlook, policymakers and planners saw themselves increasingly confronted with severe repercussions and challenges of this massive economic growth, namely the adverse environmental degradations and the growing social inequalities between west and coastal regions. These severe interregional tensions and social conflicts were the result of an uneven distributed growth. In the 1980s, Deng Xiaoping had announced his grand vision and strategy of first developing coastal regions and then moving towards the interior and western provinces and allowing them to catch up. Throughout the 1980s, the Chinese government was therefore spending considerable efforts on developing and investing in coastal regions, providing them with access to state investments, foreign markets, and foreign direct investment (FDI). By the time the Agenda 21 was issued, central and western regions lagged behind their eastern counterparts economically, socially and structurally. The central government had not yet

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733 United Nations (UN) (1997). Institutional Aspects of Sustainable Development in China. New York, USA: UN.

734 World Bank (1996). China`s Renewable Energy Sector for Electric Power. New York, USA: World Bank.

735 The World Bank defines "lower-middle income economies" as those with lower middle-income economies are those with a GNI per capita between $1,026 and $4,035. In 1998 China's GNI per capital amounted to $750.

kept Deng Xiaoping's promise to eventually shift economic prosperity to the western provinces and to correct the regional inequality, causing enormous interregional tensions and social conflicts within the country. In March 1994 and March 1995 during the sessions the National People's Congress (NPC), Premier Zhu Rongji finally declared a coordinated regional economic development to gradually reduce the gap in development between regions.[736] Shortly thereafter, former General Secretary Jiang Zemin declared the government's intention to end rural poverty by 2000. Therefore, the heightened attention towards solar energy technologies and its inclusion to the decision agenda took place against the backdrop of government efforts to socially and economically develop long neglected western and central provinces. One priority in this aspect was to provide basic energy services by means of renewable energies, which were considered more feasible in remote and rural areas without grid-connection. Therefore, solar energies fitted very well into the overall agenda as it was seen as a viable and long-term solution to overcome the growing economic and social discrepancies within the country.
In summary, solar energies have been on the national agenda since the 1970s. The issues of solar energy were successful in entering the national agenda and attracting government attention because they were mainly seen as a vehicle or means to tackle some of China's more pressing issues at that time, namely (i) rural poverty, (ii) lack of basic energy services in remote and rural off-grid regions and (iii) a growing social and economic divide among western and coastal provinces.

6.2 Policy Dynamics: Punctuations and Triggers from the PET Perspective

PE theory describes policy processes as extended and long periods of stability and incrementalism that are occasionally disrupted by significant shifts in policymaking that represent larges-departures from the status quo. These shifts are induced by so-called *punctuations*, which can vary in their scope and degree of innovation. Hall[737] asserts that there are three types of policy change:

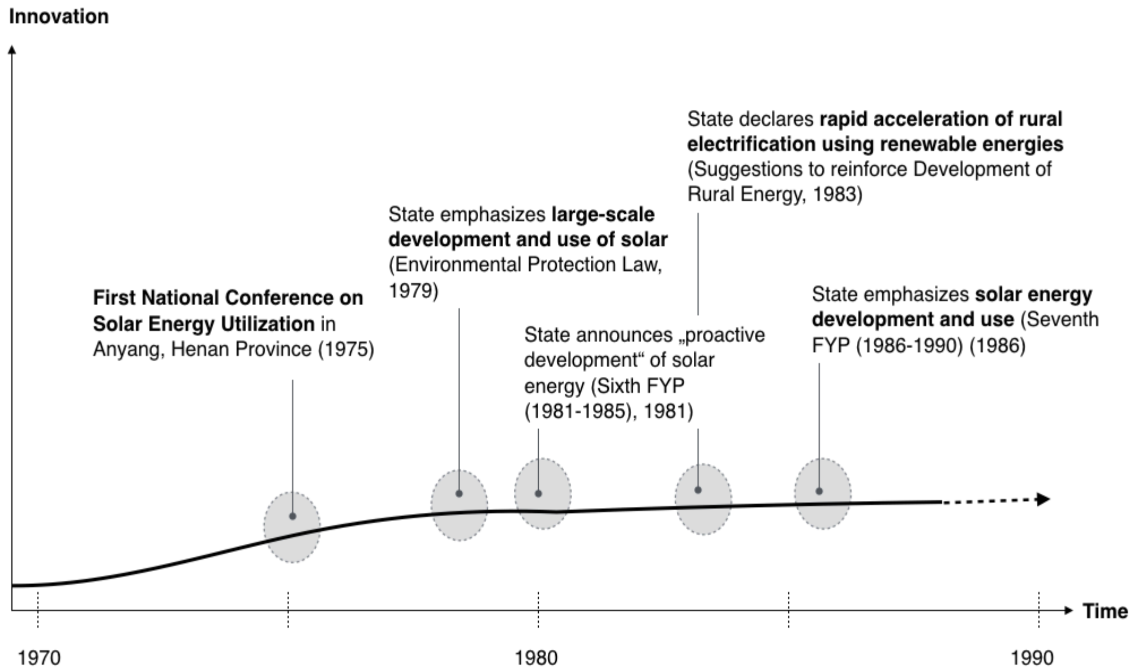
- *First Order Changes*, are those routine adjustments of known policy instruments that result form experience, social learning and new knowledge, while the overall goals and instruments of policy remain the same;
- *Second order changes* are those that lead to changes or introduction of new instrument themselves resulting from social learning mainly within the state itself (*second order policy changes);* and
- *Third order changes* are those that lead to entirely new sets of goals and systems (paradigms) and engender radical departures from the existing orthodoxy and status quo.

Punctuations therefore represent a disjuncture between the previous policy discourse and an entirely new paradigm and set of priorities. *Incrementalism* on the other hand, preserve the broad continuities and maintain the general direction (such as overall aims and agendas) and therefore represent the type of routinized decision-making that is normally associated with policy processes. The following section applies the criteria of *first, second* and *third order changes* to the solar policies in China, in order to identify and distinguish the periods of incremental and punctuated policy change and to distinguish those policies that constituted paradigm shifts in policymaking and those that were merely part of the incremental policy process.

[736] Lai, H. H. (2002). China's Western Development Program: Its Rationale, Implementation, and Prospects. *Modern China*, *28*(4), 432–466.
[737] Hall, P. A. (1993). Policy paradigms, social learning and the state. *Comparative Politics*, *25*(3), 275–296.

6.2.1 Policy Punctuations during the First Phase (prior to 1990s)

Figure 26 Policy Change and Policy Punctuations for the Period (1970-1990)

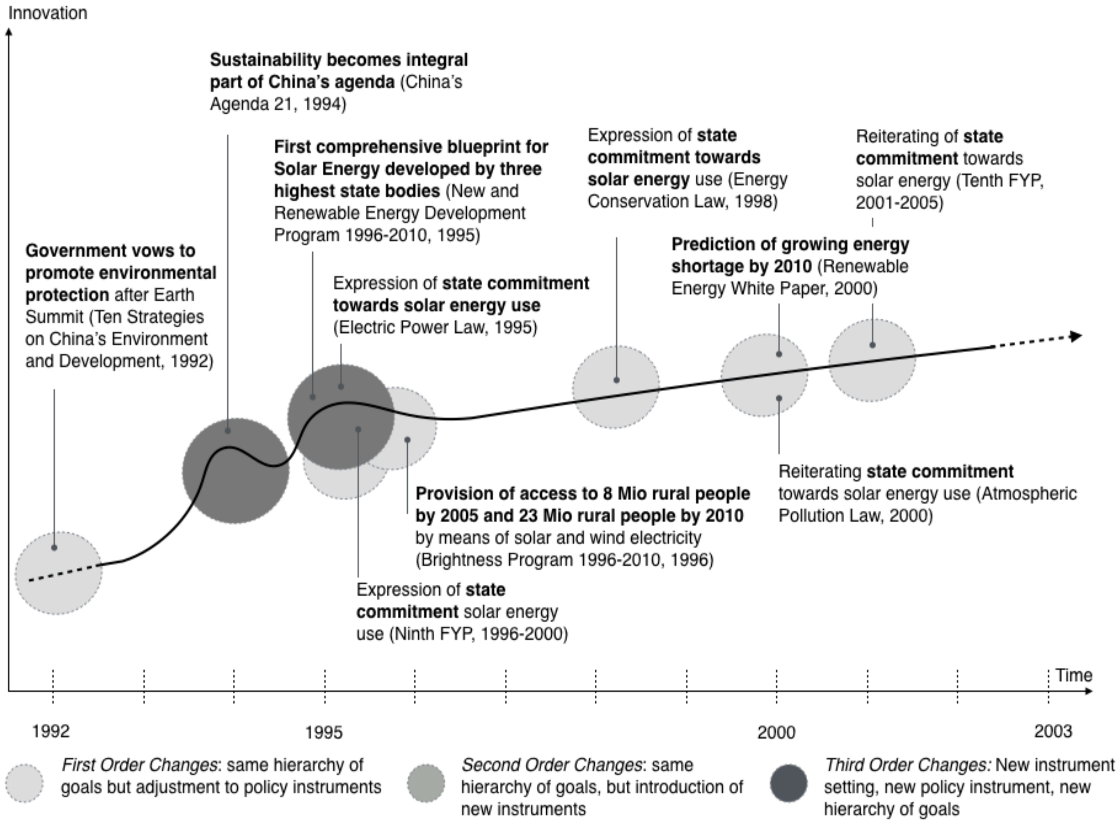


Source: Author

Prior to the 1990s, solar policies in China developed rather sparsely and slowly, as shown in Figure 27. Policy change towards solar energy can be considered at most *incremental*, given that there was no coherent regulatory framework, law or even policy specifically dedicated to solar energies. Policies of this stage included merely the repetitively call and encouragement of a greater use of solar energy (examples hereof are the *1979 Environmental Protection Law, the Sixth FYP (1981-1985)* and *Seventh FYP (1986-1990))*. At this stage there existed neither an overarching *goal for solar energy development* nor *specific measures* for the deployment solar policies and therefore solar policies during this stage do not really fit in to the categories of first, second or third order policy change. Despite this regulatory vacuum, these policies however, constituted an incremental and steady buildup of policy change, which paved the way for solar policies at a later stage.

6.2.2 Policy Punctuations during the Second Phase (1993-2002)

Figure 27 Policy Change and Policy Punctuations for the Period (1993-2002)



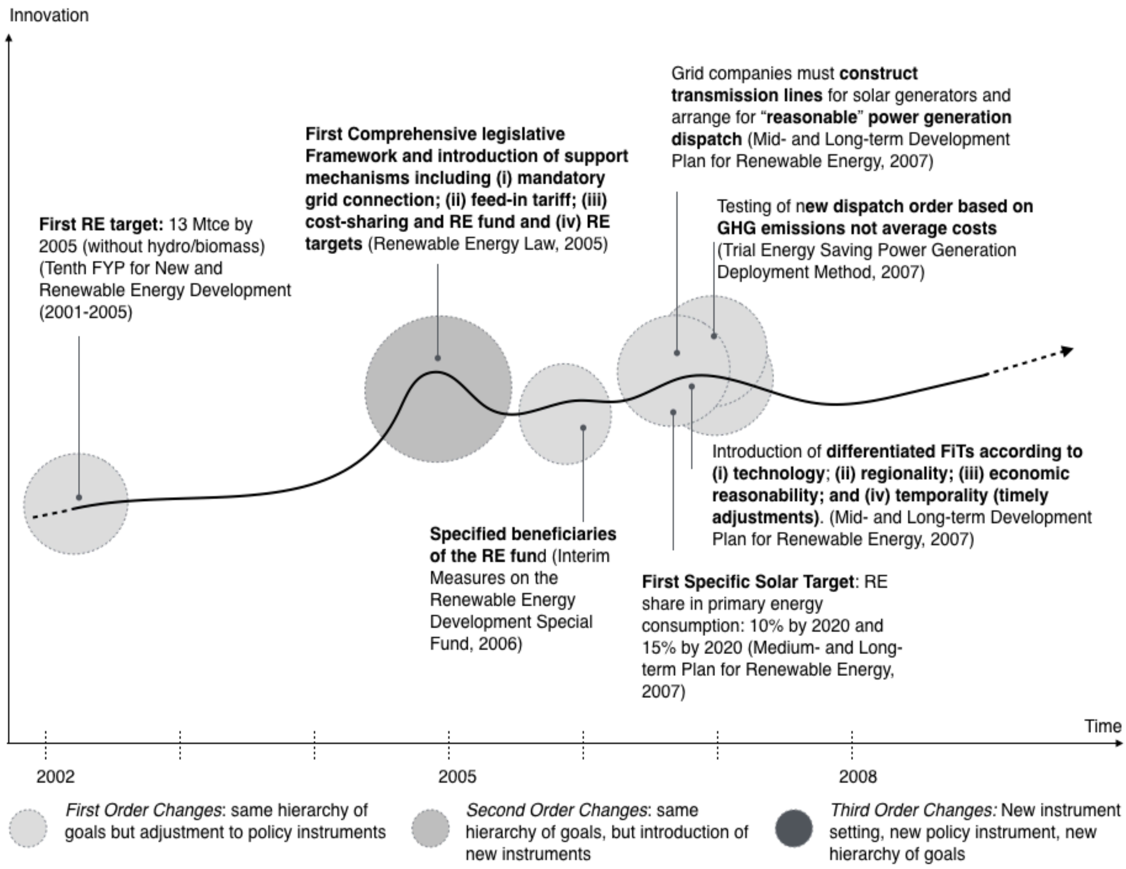
Source: Author

Starting from 1994, China's solar policy development gained increasing momentum, which eventually culminated into a radical shift in China's economic growth model and prevailing paradigm. The two landmark policies that led to this disjuncture in policymaking were China's *Agenda 21* and the *New and Renewable Energy Program* (1996-2010). Both policies represent a significant departure form the past because they entailed simultaneous changes in (i) the *instrument setting*, (ii) the *instruments themselves* and (iii) the *hierarchy of goals*. In terms of instrument settings, the *Agenda 21* and the *New and Renewable Energy Program* had both been the result of an unprecedented, collaborative effort among the central government, ministries, commission and more than 300 non-government experts. This unusual collaboration and the creation of a LSG and working group specifically designated to formulate China's Agenda 21 marked a historic step that underlined the government's commitment towards integrating sustainability into its long-term planning. As discussed in *Chapter 3.3.6 Policy Categories and Legal Framework*, China's political system is surprisingly document-oriented, placing extremely high value to signed documents, which are testimony of the approvability and achieved consensus among policymakers. Therefore, official documents such as the Agenda 21- approved and stamped by the collective leadership across various levels of government- were attached extraordinary importance by all levels of government. Agenda 21 therefore introduced an entirely, new "framework of ideas and standards that specify not only the goals of policy and the instruments that can be used to attain them, but also the very nature of the problems that they are meant to be addressing" (p.279). [738] Moreover, Agenda 21 was also the response to a "broad societal debate, in which various political actors (e.g. political parties and their representatives) play an important role, but in which significant pressure is also placed on the government from the media, as well as from (other) outside interests" (p.279).[739] Similarly, the *New and Renewable Energy Program,* which can be seen as part of the same punctuation, was also an innovation in the sense that it was the first document devoted explicitly to renewable energies. This policy also marked a departure form the existing status quo because it began to establish the notion of long-term targets (although these were mostly indicative) and delineating a vague yet comprehensive strategy of solar energy development for the coming decade. Both policy changes therefore introduced an entirely new *hierarchy of goals* much in favor of environmentalism and sustainability, both of which were perceived as indispensible prerequisites for China's continuous path towards economic prosperity and social wellbeing. It represented a fundamental shift from the previous 'pollute first, control later' (*xian wuran, hou zhili*) paradigm, which revolved around the idea of economic growth at all costs. The *Agenda 21* and the *New and Renewable Energy Development Program* therefore shifted the government priority towards solar energy and the integration of sustainability into all spheres of policymaking and can therefore be considered the type of wholesale change that are closely associated to *third-level change* and *punctuations*. They represent a clear discontinuation of previous policy ideas and the emergence of new paradigms, priorities and policy instruments.

[738] Ibid.
[739] Ibid.

6.2.3 Policy Punctuations during the Third Phase (2003-2008)

Figure 28 Policy Change and Policy Punctuations for the Period (2003-2008)



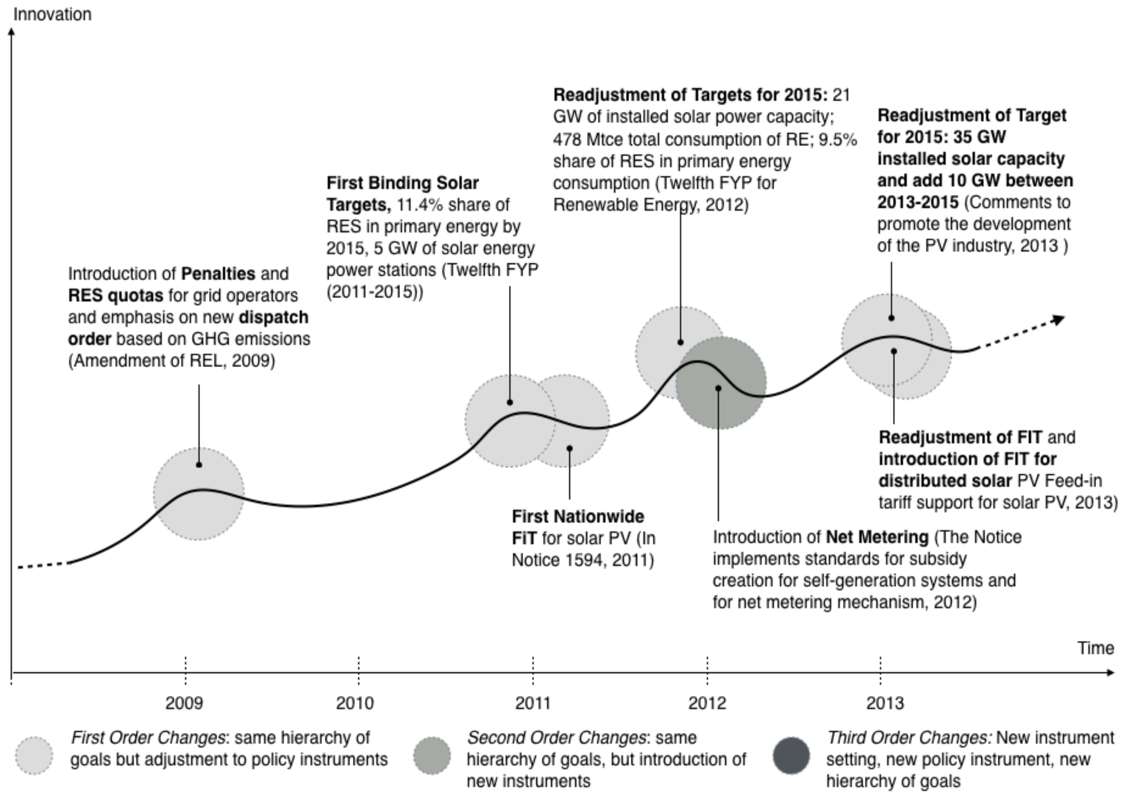
Source: Author

The third phase of solar policies (2003-2008) was mostly dominated by the release of the Renewable Energy Law in 2005, as in the figure above. The REL was an innovation and milestone in regard to several aspects. First, REL was the first policy to establish a comprehensive support framework for solar energies and the first policy to address issues such as (i) solar power remuneration and feed-in tariffs, (ii) specific targets, (iii) mandatory grid connection and purchase obligations and (iv) financing of solar energies through a special fund. Second, the REL established concrete measures and specific instruments required for large-scale solar energy deployment, which stood in stark contrast to the previous policies, which were mostly repetitive expressions of state interest and support. Last but not least, REL was also innovative in the sense that it led to a burgeoning of new policies. Despite such considerable innovations, the REL did not constitute the degree of innovation that is associated with third-order changes such as the Agenda 21, as it did not introduce any new *targets*, *agendas* or *paradigms*. The REL must therefore be considered a second-order change, because it complied with the overall goal and agenda that had previously been established by the *New and Renewable Development Program* (which had specifically called for more policies to be formulated on cost reductions, financing and research budgets, provision of subsidies and incentives, and so forth).

Therefore the REL can be considered a *second order change* that established the first comprehensive legislative foundation for solar energies and that paved the way for a plethora of first order changes (revolving around issues such as amendments to FITs, specification of beneficiaries of the renewable energy fund, and so on). All other policy changes that followed were *incremental*, as they merely adjusted existing instruments and measures specified in the REL (see figure above).

6.2.4 Policy Punctuations during the Fourth Phase (2009-2013)

Figure 29 Policy Change and Policy Punctuations for the Period (2009-2013)



Source: Author

In the fourth phase of solar energy development (2009-2013), policy change was predominantly *incremental* as most solar policies during this stage revolved around adjusting and modifying existing policy measures that had been established in the REL (such as feed-in tariffs, specifying the requirements of grid connection, channeling of funds, and so forth) as a result of dissatisfaction with past experience. Policy changes of this time reflect change both in the instruments of policy as well as alterations to their settings as a response to past experience, although the overall policy goals remained the same. The process was mostly *analytical* in the sense that the settings of fiscal and monetary instruments were adjusted to attain the predetermined set of goals. Specific episodes include the introduction of amendment to the REL Law in 2009, the establishment of binding solar targets in 2011 (*Twelfth FYP* (2011-2015), the introduction of penalties to grid operators and new dispatch sequences based on GHG emission rather than costs in 2009 (*REL Amendments*, 2009). There is one solar policy that fulfills the criteria of second-order change, as it introduces the new instrument *net metering* (one of the few instruments that had not been mentioned in the REL), which later paved the way for several solar policies on distributed solar energy use and self-consumption.

Therefore the fourth and last phase of solar policy development is marked by a frequent turnover of policies and solar energy targets, which however constitute only minor adjustments and changes to existing instruments (namely (i) feed in tariffs, (ii) solar targets, (iii) grid connection and (iv) renewable energy fund). This phase is therefore mostly *incremental*. However the frequency and swiftness of policy changes and adjustments (as for instance the target adjustment in three consecutive years) can be interpreted as what Baumgartner and Jones refer to as *extreme incrementalism*. Therefore the vast bulk of solar energy policies during this time are part of a rather stable and incremental policy process that preserve the broad continuities that had been established by the Agenda 21 and the New and Renewable Development Plan.

6.3 Institutional Venues

A key postulation of PET is that policy and paradigm changes are likely to be preceded by significant shifts in the locus of authority over policy.[740] Institutional venues and boundaries are important in shielding off external actors from entering the policy arena and introducing new sets of images and ideas that may challenge the dominant policy monopoly. This section takes a closer look at institutional venues to better understand how new paradigms emerged in favor of solar energies. As discussed in *Chapter 3.3.5 China's Two-Tier Policy Arena* and *Chapter 3.3.4 Policy Processes and Bargaining,* institutions in China have been notoriously weak due to (i) a historical absence of established institutions throughout China's history and (ii) China's ongoing transformation towards a market-oriented energy sector that continues to this day. The following three sections discuss pertinent examples that illustrate the institutional shortcomings and weaknesses that may have contributed to the three second- and third-order punctuations that occurred in the second, third and fourth phase of solar policy development.

6.3.1 Institutional Weaknesses during the First Punctuation (1990-1994)

Table 36 Overview of Major Institutional Change (1980-1994)[741]

Year	Institutional Change	Rationale
1981	Establishment of State Energy Commission	Coordinate energy development
1982-1983	Ministry of Petroleum is separated into three organizations: (1) CNOOC, for offshore oil (international); (2) Sinopec, for petroleum chemical industry and (3) CNPC, for onshore oil and gas (domestic)	Stimulate oil production and eliminate direct government interference
1983	Disbanding of the State Energy Commission; Merging of the Ministry of Electric Power Industry and Ministry of Water Resources Utilization into the Ministry of Water Resources and Electric Power	Simplify Institutional structure

[740] Ibid.
[741] Zhao, J. (2001). Reform of China's Energy Institutions and Policies: Historical Evolution and Current Challenges. *BCSIA Discussion Paper 2001- 20*, Energy Technology Innovation Project, Kennedy School of Government, Harvard University.

1985	Establishment of the Huaneng Electricity Generation Corporation (renamed the Huaneng Group, Inc. in 1988)	Promote electricity development
1988	Establishment of the Ministry of Energy (MOE); Abolishment of the Ministries of Coal Industry, Petroleum Industry, Water Resources and Electric Power, and Nuclear Industry; all of which are replaced by special state-owned corporations; Formation of the National Energy Investment Corporation	Encompass all energy sub-sectors; liberalization of production management of each sub- sector; increase in competition and efficiency in energy production, promotion of national investment in the energy sector; Facilitate foreign investment in joint ventures
Early 1980s-1992	Establishment of offices (divisions) of energy conservation in commissions, line ministries, and local bureaus; Setting up of more than 200 energy conservation technology centers	Manage and participate in energy conservation activities; Address shortage of energy supply; Promote energy efficiency
1993	The State Council Decree eliminating the Ministry of Energy and establishing the Ministry of Electric Power (MOEP) and the Ministry of Coal Industry.	Create more efficient policymaking and improve coordination
1994	Establish the State Economic and Trade Commission (SETC); Expand government ministries and energy corporation	Streamline, simplify, and centralize the apparatus of control in the energy industry; Strengthen government control in each energy sub- sector

Institutional weaknesses were especially pronounced during the first punctuation (1994-1996) since China was going through a transitional period that was guided by Deng Xiaoping's *open door policy,* which entailed a massive and all-encompassing restructuring of the state and economy (see Appendix IV for a comprehensive list of institutional transformations). In the 1980s, two major *reforms* periods swept the country aimed to commercialize energy production and distribution and to transfer responsibilities of power production to state-owned enterprises. China during this time underwent two major reform stages, the first from 1981 to 1983 and the later from 1985 to 1989. During this time energy policies and development agendas were mainly drafted by the individual industry Ministries (such as Ministry for coal, power, petroleum, petrochemicals and so forth), which were then forwarded and reported to the State Planning Commission (SPC) and the State Council. The national energy strategy was therefore composed of a series of individual industry plans that lacked coherence, consistency and foresight.[742] Moreover, each of China's six regions developed very different regional priorities and agendas: China's northeast concentrated on developing its oil and coal industries, the North concentrated on its coal industry and coal-fired power plants, the East and Central South regions developed their thermal power and nuclear power plants and the Southwest developed its large-scale hydropower plants and natural gas production. In order to create more institutional oversight, the state aimed to streamline all central government bodies under the State Council. During the course of these reforms, the Ministry of Energy (MOE) was established in 1988. The MOE was an attempt to fill the administrative void that had resulted from the abolishment of energy sector

[742] Lieberthal, K., & Oksenberg, M. (1988). *Policy Making in China: Leaders, Structures, and Processes.* Princeton, USA: Princeton University Press.

ministries (Ministry of Coal Industry, Ministry of Nuclear Energy, Ministry of Petroleum Industry, and so on). Its mandate was initially to coordinate the newly created corporations but it soon proved to be ineffective and powerless. Its role as thus confined to developing an energy strategy, planning long-term production, and overseeing major energy-development projects.[743] The MOE was eventually dissolved in 1993 and since then, there has been no single government authority responsible to draft and oversee the energy development and policy transposition in China. Instead the regulatory oversight has been distributed to a series of institutions, which however lacked the authority, capacity, autonomy, resources and tools to govern the energy sector effectively. After the abolishment of the MOE in 1993, the state continued with reforms aiming to corporatize, commercialize and restructure the energy sector and enhancing the economic and technical efficiency of the electricity industry.
During the time the first punctuation and paradigm shift, China's energy sector was therefore extraordinarily weak as the country and all major energy institutions were going through significant shifts from the previous state-planned and centralized systems to a more liberal and market-driven approach.

6.3.2 Institutional Weaknesses during the Second Punctuation (2003-2005)

Table 37 Overview of Major Institutional Change (2003-2007)

Year	Institutional Change	Rationale
2000	Unbundling of SPC into generation, transmission and distribution companies	Transition towards market-based system and market competition
2003	The State Council established the State Electricity Regulation Commission (SERC).	To create more efficient policymaking and improve coordination
2003	Dissolving of the State Development and Planning Commission (SDPC) into NDRC and its Energy Bureau	To create more efficient policymaking and improve coordination
2005	Energy Leading Group is set up within the State Council	To improve coordination among energy sector actors

The institutional weakness persisted around the second phase of solar energy development but a lesser extent than previously. China continued with its energy sector reforms aimed to (i) break up monopolistic structures and introduce market competition, (ii) improve allocation efficiency while decrease in power generation cost, (iii) rationalize the energy pricing and tariff structure, (iv) promote the development of the power industry and (v) establish a market-based system that allows for a separation of administration and enterprise and fair competition among power producers.[744] In 2000, China began to unbundle the SPC, separating it into generation, transmission and distribution companies (see *Chapter 4.3.4.2 Key Actors in China's Energy Arena*). Shortly thereafter in 2003, the government established the State Electricity Regulatory Commission (SERC, *Guojia Dianli Jianguan Weiyuanhui*) which served as a regulatory authority with ministry rank. Its mandate was to oversee the fledging market developments, competitive

[743] Zhao, J. (2001). Reform of China's Energy Institutions and Policies: Historical Evolution and Current Challenges. *BCSIA Discussion Paper 2001- 20*, Energy Technology Innovation Project, Kennedy School of Government, Harvard University.
[744] Xu, S., & Chen, W. (2006). The reform of electricity power sector in the PR of China. *Energy Policy*, *34*(16), 2455–2465. http://doi.org/10.1016/j.enpol.2004.08.040

structures and to further push power sector liberalization and market reforms. Yet SERC was only short-lived and soon replaced by the NEA and NEC in 2008. In 2003, the State Development and Planning Commission (SDPC) was dissolved and its functions transferred to an Energy Bureau within the newly established NDRC. This step aimed to streamline the energy functions and to create one single institution that would be in charge of drawing up plans for sector reform, as well as routine oversight of the country's energy sector. In 2005 and as a response to the massive energy crisis, the government set up the Energy Leading Group within the State Council, which is mandated to strengthen coordination among energy actors and to facilitate a coherent and streamlined energy sector governance.[745]

The institutional landscape during the second punctuation continued to exhibit frequent institutional restructuring and ineffective cooperation among scattered and increasingly heterogeneous group of state and semi-state institutions. Yet the weakness and restructuring were far less intense than during the reconfiguration of state power during the first punctuation.

6.3.3 Institutional Weaknesses during the Third Punctuation (2008-2011)

Table 38 Overview of Major Institutional Change (2008-2011)

Year	Institutional Change	Rationale
2008	Dissolving of SERC into newly-established National Energy Administration (NEA)	Improve coordination and re-establish Super-energy ministry, yet expectations fell short
2008	Dissolving of NDRC's Energy Bureau into NEA	

Institutional weaknesses persisted during the third punctuation as best illustrated in the case of NEA, NEC and NDRC. Repeated calls for the re-establishment of an Energy Ministry to improve coordination between energy actors, led to the establishment of two new major institutions in 2008, namely (i) the National Energy Commission (NEC) from the NDRC's former Energy Bureau and (ii) the National Energy Administration from the State Council's former Energy Leading Group.[746] Although it was anticipated that the establishment of these two new institutions would presume the responsibilities and functions of a full-state energy ministry, the NEA and NEC fell short of expectations and constituted instead a compromise between those that favored a full-state energy ministry and those that favored the status quo and scattered policymaking.[747] Moreover, the NEA has recently become a subject of major contention. With the administrative rank of a vice-ministry it is clearly more powerful than its predecessor (Energy Bureau) yet too powerless to effectively coordinate and manage energy institutions and SOEs that hold ministry and higher ranks. To allocate more weight to the NEA than to a regular vice ministry, the government has appointed Zhang Guobao, who is the second-highest ranking NDRC official and

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[745] Downs, E. (2006). Energy Security Series. The Brookings Foreign Policy Studies; Rosen, D. H., & Houser, T. (2007). China Energy: A Guide for the Perplexed. Center for Strategic and International Studies and the Peterson Institute for International Economics, 46(7), 49.

[746] Chen, A., & Graham-Harrison, E. (2008). China reshuffles energy, little change seen. *Reuters China Energy Update*.

[747] Burke, C., Jansson, J., & Jiang, W. (2009). Formulation of Energy Policy in China: Key Actors and Recent Developments. Johannesburg, South Africa: University of Stellenbosch, Centre for Chinese Studies.

holds two ministerial positions, as head of the NEA. With this appointment, the Chinese leadership has unofficially leveraged NEA's rank to that of a ministry, although it officially still holds a ministry-rank. This constellation is unique to China's bureaucratic structures and reflects the clashing interests and inherent weakness of the institutional landscape in China's energy sector.[748] Moreover, the NEA lacks power to carry out energy sector tasks because the energy sector management is spread among various agencies (such as NDRC and NEC). Although the NEA is officially the main governing body responsible for the entire energy sector, its effectiveness and power are limited by the fact that the key tools to effectively manage the energy sector (such as price setting) remain in the hands of the NDRC.[749] Here Downs (2008) notes:

> "NEA can make suggestions about energy price adjustments and should be consulted by the NDRC on any proposed changes, the shots are still being called by the NDRC (and ultimately the State Council, whose approval is needed for any major energy price changes). [...] The power to set prices is one of the NDRC's main instruments of macroeconomic control." (Downs (2008), p.2)[750]

In summary, China's institutional landscape continued to be extremely weak during the third punctuation. The institutional landscape of China's energy sector is and remains characterized by a contradictory juxtaposition of autonomy and clientelism, control and chaos.[751] Multiple centers of power, institution building and economic development prevail and political and economic rivalry exists at and between all levels of government.[752] The most important shortcomings of institutional settings are:

- A myriad of government actors and institutions that lead to scattered and overlapping responsibilities (see *Chapter 4.3.4 Institutional Landscape, Energy Actors and Processes*);
- A hybrid blend of central-state control mixed with market elements, which produces considerable tensions and frictions between the state and powerful, entrenched semi-state monopolies and SOEs;
- A continuous transition towards a market-based system that leads to an incessant reshuffling and dissolving of short-lived institutions (an ongoing process that has persisted for 20 years);
- The distorting influence of bureaucratic rank, which contributes to the weakness of formal institutional structures and facilitates a strong reliance on informal negotiation rather than rule-based decisions (although recent leader generations such as the Xi-Li Administration have sought to reinforce and strengthen institutional structures).

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748 Downs, E. (2006). Energy Security Series. *The Brookings Foreign Policy Studies*.
749 Downs, E. S. (2008). China's Energy Policymaking Structure and Reforms (Panel II). China's Energy Policies and Their Environmental Impacts. Washington D.C., USA: United State Congress.
750 Ibid.
751 Andrews-Speed, P. (2010). The Institutions of Energy Governance in China. Paris, France: Institut français des relations internationales (Ifri).
752 Xia, M. (2003). *The Dual Developmental State: Development Strategy and Institutional Arrangements for China's Transition* (1st ed.). London, UK and New York, USA: Routledge. http://doi.org/10.2307/3182205; McNally, C.A., & Chu, Y.W. (2006). Exploring Capitalist Development in Greater China: A Synthesis. *Asian Perspectives,* 30 (2), 31-64.

6.4 Emergence of new Images and Paradigms in China's energy sector

One of PET's key postulations is that policy changes and especially third order changes reflect emerging new paradigms that are able to rival and discredit the dominant policy monopoly. This section takes a look at the images and paradigms that have dominated and prevailed in China's energy sector from 1990 to 2013.

6.4.1 The Dominant Coal Paradigm and Energy Security

The policy monopoly and image that dominated China's energy sector since the inception of the PRC until the early 1990s was that of an economic growth model based on coal. For more than 60 years, cheap and easily accessible coal had consistently been the unrivaled source of primary energy. In 1952 coal supplied as much as 95% of China's primary energy demand[753] Despite China's transition and emphasis towards more diversified energy supply, the share of coal has never fallen below 65% of primary energy supply. The abundance and dominance of coal was therefore also seen as an ideological triumph that enabled China to remain energy self-sufficient for many decades. Coal was closely interwoven in China's "*pollute first, control later*" and "*getting rich first, clearing up later*" paradigm that dominated Chinese policymaking and strived for economic development at all possible cost. During this time China was also the world's leading coal producer, gradually developing exports of coal and mining equipment. Since the inception of the PRC, the image of coal had therefore established itself as the dominant policy monopoly, given the traditional nexus between GDP growth and energy. Coal was seen as a strategically important, reliable and ample resource that had been the key driver of the country's industrial development.

In the early 1990s, the image of coal began to bridle as a result of (i) concerns about resource availability and (ii) environmental repercussions from coal use. In 1993, coal accounted for roughly 77.1% of China's total primary energy production and 76.1% of the total primary energy consumption.[754] At this time, however, growing concerns about coal resource availability began to weaken the image of coal. In 1992, the former MOE[755] claimed that China possessed around 967 billion tons of theoretically recoverable coal resources. In 1993 however, the BP Review of World Energy estimated that China's coal reserves were only 115 billion tons, hence 852 billion tons short of what the government had proclaimed.[756] Although this was still significant placing China among the three countries with the largest coal reserves, it was by far lower than what the government had expected and insufficient to support China's increasing energy demands in the long-term. The image of coal began was therefore slowly overshadowed by energy security concerns which were further fueled by (i) a poor geographic distribution of energy sources in remote regions, (ii) insufficient transportation routes and infrastructure for energy transportation and (iii) scarce capital relative to labor along with (iv) obsolete and inefficiently installed technology infrastructure.[757]

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753 Zhang, K. (n.d.). Studying the Dominance of Coal in China's Energy Mix. *Cornerstone*, *2*(2), 15–20.
754 China National Burau of Statistics, http://www.stats.gov.cn/english/.
755 China Ministry of Environment, http://english.mee.gov.cn.
756 British Petroleum (BP). (1993). *BP Statistical Review of World Energy*. London, UK.
757 Liu, F., Davis, W. B., & Levine, M. D. (1992). *An Overview of Energy Supply and Demand in China*. Lawrence Berkeley Laboratory, Energy Analysis Program Energy & Environment Division. Berkeley, USA. Retrieved on 2 February 2014, from https://china.lbl.gov/sites/default/files/lbl-32275.pdf.

6.4.2 The New Environmental Paradigm

During the 1990s a new environmental paradigm emerged on the national arena, which had been the result of continuous and steady trends that started the late 1970s. The environmental paradigm was a gradual process, underpinned by many, small steps such as (i) the 1978 National Environmental Protection Research Conference held in Taiyuan, (ii) the 1989 Environmental Protection Law, and (iii) the launching of several national environment protection conferences in 1973, 1983, and 1989.

During the first punctuation (release of Agenda 21 in 1994), the environmental paradigm gained significant momentum from the increasing awareness about air pollution and acid rain, which had resulted form the widespread combustion of unscrubbed and unwashed coal especially in the residential sector.[758] Urban air pollution in most cities exceeded international standards by a factor of three to five and by 1996, it was estimated that air pollution from coal combustion was the main cause of chronic respiratory disease, cancer and premature illness and death, responsible for around nearly one-third (26%) of adult deaths in China.[759] Aside from that, water supply was also becoming an issue of national concern. An Asian Development Report form 1993 states:

> "In the late 30 years, industrialization, urbanization, and deforestation have threatened the availability of water supply. Severe water shortages have occurred in different areas of the PRC, both in cities and rural areas, with negative effects for industrial and rural production and for people's quality of life." (Capannelli; Omkar, 1993) [760]

Therefore, awareness about the worsening environmental crisis and the need for change were slowly trickling into China's official discourse. By the early 1990s, the dominant image of coal was no longer that of a reliable and endless power sources, but rather that of an environmental culprit and "chief source of air pollution"[761] made responsible for the country's massive environmental deterioration. This shift in government perception was reflected in *China's Agenda 21*, which connotes:

> "Energy shortages and severe environmental pollution caused by the burning of fossil fuels (particularly coal) are core problems, which constraint the development of China's economy. The use of solar energy would ease the pressure caused by the shortage of conventional energy resources, and would decrease the emission of harmful CO_2 into the atmosphere." (China's Agenda 21)

The environmental paradigm revolved mainly around the idea "prevention first and combining prevention with control",[762] as indicated in China's Agenda 21:[763]

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[758] Ibid.

[759] The World Bank. (1996). China Renewable Energy for Electric Power. Pre-2003 Economic or Sector Report. New York, USA.

[760] Capannelli, E., & Shrestha, O. L. (1993). *Environmental Challenges in the People's Republic of China and Scope for Bank Assistance*. Manila, Philippines: Asian Development Bank.

[761] Ibid.

[762] Zhen, Z. (2015). The Dynamic Evolution of China's Environment Policy. Retrieved on March 3, 2015, from http://ap.fftc.agnet.org/ap_db.php?id=506&print=1.

[763] Bradbury, I., & Kirkby, R. (1996). China's Agenda 21: A critique. *Applied Geography*, *16*(2), 97–107. http://doi.org/https://doi.org/10.1016/0143-6228(95)00030-5.

> "Given the pressures of these harsh realities, mankind has no choice but to re-examine its social and economic behavior and its path of development. Traditional ideas of considering economic growth solely in quantitative terms and the traditional development mode of 'polluting first and cleaning up later' are no longer appropriate when considering present and future requirements for development. It is now necessary to find a path for development, wherein considerations of population, economy, society, natural resources, and the environment are coordinated as a whole [...]." (China's Agenda 21)

By the time of the second punctuation (Renewable Energy Law 2003-2005), China had experienced a continuous deterioration of its environment, ranking among the countries with the worst urban air pollution in the world[764] Air pollution had become so acute, that the Ministry of Health declared cancer the leading cause of death in the country. An unpublished World Bank study from 2007 concluded that poor air quality was responsible for 350,000 to 400,000 premature deaths in China each year.[765] China's air pollution was also extending to other parts of the world.[766] Acid rain and enormous clouds of brown haze were beginning to affect countries and populations across Asia and even North America[767] The environmental degradation was also slowly taking its toll on the country's political and economic spheres. A 2004 study estimated that economic losses from environmental pollution accounted for roughly 3% of GDP.[768] Policymakers at this stage were slowly beginning to recognize that environmental degradation was "not only a major long-term burden on the Chinese public but also an acute political challenge to the ruling Communist Party."[769]Another important event that has likely contributed to the growing dominance of the environmental paradigm is the fact that in 2005 China was on its way to becoming the world's largest contributor to global climate change and in 2007 overtook the U.S. as the largest carbon emitter. Thus, China had come to the critical point where it not only needed to face the daunting challenges of sustainability within its own borders but it was also growing increasingly aware of the mounting pressures from the global community.

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764 Yang, T. (2007). Introduction: Snapshots of the State of China's Environmental Regulatory System. *8 Vt. J. Envtl. L. 145*. Retrieved on March 3, 2015, from https://digitalcommons.law.scu.edu/facpubs/726.

765 World Bank (2001). *China - Air, land, and water: environmental priorities for a new millennium (English*). Washington D.C., USA: The World Bank. Retrieved on 3 March 2015, from http://documents.worldbank.org/curated/en/166121468743733519/China-Air-land-and-water-environmental-priorities-for-a-new-millennium; Johnson, T. M., Liu, F., Newfarmer, R., & Johnson, T. M. (1997). *Clear water, blue skies: China's environment in the new century*. Washington D.C., USA: The World Bank. Retrieved on 3 March 2015, from http://documents.worldbank.org/curated/en/944011468743999953/Clear-water-blue-skies-Chinas-environment-in-the-new-century.

766 Schreurs, M. A., & Economy, E. (Eds.). (1997). *The internationalization of environmental protection* (Vol. 54). Cambridge, UK: Cambridge University Press.

767 Estimates from the U.S. Environmental Protection Agency, cited in Chea, T. (2006). Pollution from China Drifting East. *Associated Press*.

768 State Environmental Protection Administration of China (SEPA), & the National Bureau of Statistics of China (NBS) (2006). *China Green National Accounting Study Report 2004*, Retrieved on 2 March 2015, from, http://www.china.org.cn/english/environment/180850.htm.

769 Kahn, J. & Yardley, J. (2007, August 26). As China roars, pollution reaches deadly extremes. *New York Times*.

6.4.3 The New Scientific Development Paradigm

Prior to the 1990s, a second paradigm began to challenge the conventional coal model. The 'scientific development model' (*kexue fazhanguan*), was first instigated in 1986, when four of China's most eminent scientists sent a private letter to former General Secretary Deng Xiaoping, warning him that China after years of relentless focus on militarization that had crippled the country's civilian scientific establishment, needed to catch up on the world's 'new technological revolution' (*xin jishu geming)*, to prevent from being left behind.[770] Evan Osnos refers to this as China's "sputnik moment,"[771] as it marked the shift towards a fundamentally new government paradigm that is based on a coordinated, comprehensive, and sustainable development path.[772] The first time that "scientific development concept" was mentioned in the official discourse was during Hu Jintao's inspection trip to Jiangxi Province in 2003. Hu Jintao contended

> "It is necessary to solidly adopt the *scientific development concept* of coordinated development, all-round development, and sustainable development, [and to] actively explore a new development path that conforms to reality" (former General Secretary, Hu Jintao in 2003)[773]

The Scientific Development Model aimed to correct the presumed overemphasis in recent years on the pursuit of increases in gross domestic product (GDP), which encourages the generation of false figures and dubious construction projects along with neglect for the social welfare of those left behind in the hinterland."[774] The scientific paradigm was perhaps also the manifestation of a much larger trend and a general shift of policymaking from the revolutionary cadres towards technocrats[775]. Therefore, the paradigm shift towards the scientific development model was very much also testimony to the fundamental changes that were taking hold of China's ruling elite. The official adoption of the scientific concept of development in 2003 marked the government's shift away from the heretofore dominant image of coal and leaving behind the 'development at all costs' or 'getting rich first and cleaning up later' mentality. The image of coal had weakened considerably and was suddenly regarded as a hindrance to "a civilized development path,' a "well-

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[770] Osnos, E. (2009, December 21). Green Giant: Beijing's crash program for clean energy. *The New Yorker*.
[771] Ibid.
[772] Fewsmith, J. (2004). Promoting Scientific Development Concept. *China Leadership Monitor*, *11* (30), 1-10.
[773] Ibid.
[774] Ibid.
[775] Prior to 1985, technocrats were virtually non-existent among the ruling elite, as the power arena was dominated mainly by revolutionary cadres, such as "reds" and "experts" with a strong ideological background. In the beginning of the 1980s and due to the introduction of a new recruiting strategy of the Communist party titled "four-transformations", the CPC called for the appointment of official positions to persons who were: revolutionary (*geminghua)*, young (*nianqinghua)*, intellectual (*zhishihua)*, and professional (*zhuanyehua*). In terms of intellectual attributes, the CPC also shifted their focus towards the dynamic urban areas, which was where economic development was taking place and where the population was growing fastest. By 1996, 12 out of the 22 members of the Politburo members had academic backgrounds in engineering and technical sciences, and by 2000, between 50 and 75 % of top posts in China were filled by technocrats. This trend had become even more salient after the 16th National Party Congress in 2002: four of the nine members of the Politburo Standing Committee were now graduates of China's top engineering school, Tsinghua University, and the other five were also graduates of technical schools.

off life" and "good ecological environment".[776] At the same the Chinese leadership began to recognize that the two goals of growth and clean environment were no longer contradictory to each other, but that environmental protection and maintaining long-term growth could co-exist at the same time. This new paradigm was also borne out of the recognition that the path towards a low carbon economy could also provide China significant competitive advantages, which could open the door for new economic opportunities and markets.

6.5 Trigger and Window of opportunity

John Kingdon (1995)[777] developed the notion of "windows of opportunity" to help understand the importance of events or developments that discredit the status quo and serve as a key prerequisite for major policy change.

6.5.1 Trigger of the First Punctuation (1994-1996)

The first punctuation (Agenda 21) was the result of multiple triggers. The most plausible explanation is that China's environmental pollution was becoming extremely severe leading to major social discontent. In 1992 the central government launched a survey named "China's Environment' (*Daluhuanbao*) with 2,000 officials in six provinces. The survey found that over 80% of those surveyed were unsatisfied with China's environmental situation and 60 % felt that all sources of pollution in backward regions should be dealt with now even if this was at the cost of slower economic growth.[778] Although Chinese environmentalists and researchers had repeatedly warned the government about the country's environmental degradation, this survey marked a tipping point because it signaled to the central government that consensus could be reached among extensive reforms and a paradigm shift.

Another narrative is that after years of political isolation, China was seeking a way to re-enter the international arena. The disintegration of the Soviet block in 1989 had left China as the only largest, remaining Communist Country in the world. China was practically isolated and the only way to regain recognition was through its "environmental diplomacy" and taking the lead in environmental governance.[779] In October 1971, the United Nations General Assembly voted to transfer the China's UN seat to the PRC in lieu of the Republic of China (Taiwan) and China became one of the five permanent members of the U.N. Security Council. This marked the beginning of China's efforts to reenter the international policy arena and soon after, China actively sought for opportunities to show its presence on the stage of world politics, as in the case of the first UN conference on the Human Environment held in Stockholm in 1972.

6.5.2 Trigger of the Second Punctuation (2003-2005)

The trigger that led to the second preconditions is mostly attributed to energy security concerns. At the time of the drafting the Renewable Energy Law in 2003 until when it was officially

[776] Hu Jintao speech 2003, during trip to Jiangxi, Xinhua News Agency, September 2, 2003. See Fewsmith, J. (2004). Promoting Scientific Development Concept. *China Leadership Monitor*, *11* (30), 1-10.

[777] Kingdon, J. W. (1995) *Agendas, Alternatives and Public Policies* (3rd ed.). New York, USA: Harper Collins College Publisher.

[778] Edmonds, R. L. (2012). Patterns of China's Lost Harmony: A Survey of the Country's Environmental Degradation and Protection. London, UK: Routledge.

[779] Cai, S., & Voigts, M. (1993). Development of China's Environmental Diplomacy. *Pacific Rim Law & Policy Association*, 3(17).

approved by the NPC in 2005, China was facing a serious energy shortage, which had been predicted in the Renewable Energy White Paper in 2000. In early 2000, China's energy use – for the first time in several decades- grew faster than its GDP, which caught the attention of the leadership because it essentially meant that their overall economy was becoming less efficient.[780] This trend was the result of changing leadership priorities and a resurgence of heavy industry, which eventually and inevitably culminated in a severe energy crisis in 2003-2004, resulting in massive power blackouts across the country. In 2004, the energy shortages were beginning to impinge on everyday life.

6.5.3 Trigger of the Third Punctuation (2011)

This second punctuation in 2011 was likely triggered by the growing pressures and overcapacities in China's domestic PV industry. In 2008 the financial crisis led to an elimination of important markets such as Spain (capping the installed capacity), Germany (lowering of the FITs) and Greece (bureaucratic obstacles impeding RE). This in turn created severe cutbacks in solar technology exports and produced a massive overcapacity in China's domestic solar industry. Moreover, in 2011 the manufacturer Solar World and a conglomerate of U.S. solar cell and module manufacturers filed a lawsuit against Chinese PV manufacturers, accusing Chinese manufacturers of unfair prices and price distortions. During this time, around 300 to 400 solar companies went bankrupt and around 100 factories had to shut down as the result of dwindling foreign markets and the repercussion of the financial market.[781] During this time China had no solar market to buffer the effects of the massive slowdown in solar technology exports and no vent to alleviate some of the growing pressures that could easily spark social unrests and mass unemployment.[782] Therefore the third punctuation was most likely the result of such external pressures (financial crisis, lawsuit, dwindling markets).

6.6 Summary

Development of a regulatory framework for solar energies. Since the 1990s, China developed a comprehensive regulatory framework and support mechanism for solar policies. The development of a regulatory framework progressed in four distinct phases. During the first phase (prior to 1990), the role of solar energy was mostly declarations of intent and the public encouragement of solar energy development and utilization. Solar policies during this time revolved mainly around establishing the overall guideline and direction for subsequent policy action (*fangzhen*). A major milestone during this phase was the encouragement of solar energy into China's Sixth Five-Year-Plans, which called for a *proactive* development of solar energy. During the second phase of solar policy development (1993-2008), policy support and strategic planning gained increasing attention. Decisionmakers at this stage encouraged the use and development of solar energies but eschewed from setting specific targets and putting forth any concrete measures. A milestone policy for solar energy at this time was the release of the 1994 *White Paper on China's Population, Environment and Development in the Twenty-First Century* (China's Agenda 21) and the subsequent 1995 *New and Renewable Energy Development Program* (1996-2010), which laid the groundwork and vision for solar energy development for the coming decade. The later policy

[780] Lewis, J. (2015). China's Role in Global Clean Energy Technology Development. In *China & Clean Energy Development*. Washington D.C., USA: Library of Congress in Washington D.C.
[781] Martin, K. (2011). Solarenergie in China. *China Analysis*, 87.
[782] Schmidt, D., & Heilmann, S. (2010). Dealing with Economic Crisis in 2008 -09: The Chinese Government's Crisis Management in Comparative Perspective. *China Analysis*, 77.

established a two-step development of solar energies, which the first phase (1996-2000) laying specific focus on establishing an industrial base for solar technology that would later ease the commercialization of solar technology. Parallel to this, the government proposed to launch pilot projects to test the feasibility and practicability of solar PV in the Chinese context. According to the plan, the second phase of solar energy development (2000-2010) should focus on scaling up solar technologies to the national level and to establish an industrial solar industry level comparable to that of industrialized nations. During this second stage, China also received substantial financial and capacity assistance from international donors and governments to pilot solar energies. The second phase of solar energy development also saw a first step towards specifying solar targets. The 2001 *Tenth Five-Year Plan for New and Renewable Energy Development* indicates that renewable energy sources without (hydropower and biomass) should contribute 13 Mtce of renewable energy source, equal to 10 Mt of CO_2 reduction and at least 0.6 Mt of SO_2 reduction. In the third phase of solar policy development (2003-2008), China saw a massive increase in the quantity and quality of solar policies. The burgeoning of new solar policy during this time are mostly attributed to the release of the 2005 Renewable Energy Law, which for the first time specified the concrete measures that would be necessary to achieve the goals and commitments that were stated in previous policies. In theory, the framework established a solid base for the promotion of solar energies establishing essential support measures such as (i) a mandatory grid connection and full purchase agreement; (ii) a renewable energy fund to finance solar application and research; (iii) feed-in tariffs and remuneration schemes; and (iv) the specification of solar energy targets. Although the *Renewable Energy Law* remained quite vague, it established the guideline for lower levels of government to draft subsequent policies. In the fourth phase solar energy development (2009-2013), significant attention was paid to improving the support mechanisms and policy framework. A distinct feature of this period is the adjustment of solar energy targets.

Solar Policies and Agenda setting. China's recent solar energy development and its apparently *sudden* shift towards solar energies is often mistakenly portrayed as *a new phenomenon*. This study found that solar energy issues have actually existed on China's national agenda for many decades. The first transition from being considered an issue that may or may not be taken up for action (*agenda universe*) to being considered an issue that merits public attention (*systematic agenda*) took place in 1975 with the first national conference on solar energy utilization held in Anyang, Henan Province in 1975 and the mentioning of solar energy 1979 *Environmental Protection Law.* The overall agenda at this time paid little attention to the issue of solar energies due to uncertainties regarding (i) costs, (ii) PV manufacturing industry and technology; (iii) lack of experience with piloting solar energies and (iv) the preoccupation of political decisionmakers with economic transitioning and China's open-door reforms. In 1981 solar energy began to surface on the *institutional agenda,* that is solar energy was considered an issue explicitly up for the active and serious consideration by decisionmakers. This transition was the result of the uptake of solar energy issues into China's Sixth Five-Year Plan (1981-1985), Seventh Five-Year Plan (1986-1990) and Eighth Five-Year Plan (1991-1995). Solar electricity fitted well into China's overall agenda determined by the long-term economic planning ("*Ten Year National Economic Development Plan Outline for 1976-1985")* and its strive towards a comparatively well-off level of society. In 1994 and with the promulgation of China's Agenda 21, solar energy issues became one of the few issues that are about to be acted upon by the government body or ruling elite. During this time, solar energy issues became an issue of vital importance as it was regarded a way of lessening the environmental pollution that had resulted from decades of rapid economic growth and to alleviate the growing social and economic divide between China's eastern and western provinces.

Solar Policymaking. A common orthodoxy among contemporary scholarly work is that solar energy policies in China are *erratic* and far from being *ideal.* Some scholars have even gone so far as to criticize China's *lack of consistency* and its *inability to govern.* This leads to the implicit assumption that China's recent efforts in solar policies are a sporadic and short-lived phenomenon, similar to what PET describes as punctuations. Such interpretation, however, ignore the fact that policymaking in China follows a very unique path in which protracted policy processes are in fact inherent features of a political system that is based on fragmented authority, consensus seeking and bargaining. This study has shown that solar policies in China have mostly been developed through a predominantly incremental and stable process and that the only actual punctuation and deviation from previous policymaking course occurred in the early 1990s. The seemingly sporadic flare-ups of solar policies that we see today are therefore outcomes of an incremental and stable policy processes that began in the early 1990s. Contemporary solar policies in China are therefore not at all *erratic* or *not ideal* but instead *continuous*, *incremental* and *resilient.*

Solar Energy Policy Trajectory from PET Perspective. China's solar policy trajectory has gone through phases of stability and incrementalism as well as punctuations. In the first phase of solar policy development (prior to 1990s), policy change towards solar energy were incremental, given that there was no coherent regulatory framework, law or even policy specifically dedicated to solar energies. Nonetheless there was an incremental and steady buildup of policy change towards solar energy. The second phase of solar policies (1993-2002) was marked by a radical shift in China's economic growth model that entailed simultaneous changes in all three components of policy: the *instrument settings* (the ad-hoc gathering of China's leading policymakers at central and ministerial rank together with leading scientists), the *instruments themselves* (The Agenda 21 Document, which was the first long-term visionary strategy plan of its kind), and the *hierarchy of goals* behind policy (the prioritization of sustainability and its integration into all spheres of government). It therefore reflects the type of wholesale changes that indicates third-level changes (*punctuations*) that lead to a discontinuation of previous policy ideas and the emergence of an entirely new paradigm across all levels of society. The Agenda 21 and the New and Renewable Energy Development Program therefore instigated a disjunctive process marked a discontinuity in policy. Aside from the third order changes, there were also several first order changes, that marked second order changes as they aligned to the overall policy goal. The third phase of solar energy development (2003-2008) was largely incremental despite the REL, which constituted a landmark policy. Nevertheless, the REL was not the type of policy change as experienced in the Agenda 21, as it did not establish new targets and paradigms. The solar policy changes that took place during this time were altered and amended to as a result to experience and social learning. These episodes of second order changes, which introduce new instruments while maintain the overall goal, included the amendments to the REL Law in 2009, the establishment of binding solar targets in 2011 (*Twelfth FYP* (2011-2015), the introduction of penalties to grid operators and new dispatch sequences based on GHG emission rather than costs in 2009 (*REL Amendments*, 2009) and the introduction of measures and support mechanisms (net metering) to support distributed solar application (*Notice on the Establishment of Demonstration Areas for Large-Scale distributed solar PV Power Generation*, NEA, 2012). The Fourth and last phase of solar policy development (2009-2013) was mostly incremental in the sense that policy changes revolved around amending and adjusting solar energy support mechanisms (FITs, Grid connection requirements, Renewable energy fund administration, and so forth) and did not deviate or challenge the conventional paradigm.

The Existing Power Monopoly and the Emergence of New Images. The punctuation in 1994 – and to a lesser extent the second order changes in 2005 and 2011- were predominantly the result of a new paradigm prevailing over the previous power monopoly. The power monopoly that had dominated the energy sector prior to the first punctuation was closely linked to the "*pollute first, control later*" and "*getting rich first, clearing up later*" way of thinking. It strived for economic growth at all cost. The image that was associated to this paradigm was that of cheap and abundant coal, which had been considered an ideological triumph and key to many decades of energy self-sufficiency. Given the traditional nexus between GDP growth and energy, coal was seen as a strategically important, reliable and ample resource that had been the key driver of the country's economic growth. In the early 1990s, the image of coal began to bridle due to massive concerns and debates over energy security and coal availability, that been sparked by the release of a BP Review of World Energy in 1993, which estimated China's theoretically recoverable coal resources to be only a fraction of what the government had claimed (merely 115 billion tons instead of 967 billion tons). Coal, which had previously served as a central pillar to China's economic rise was suddenly perceived as a *constraint* to China long-term and comprehensive economic development.

These doubts and uncertainties paved the way for the emergence of two new paradigms, both of which introduced a new set of perspectives and priorities in regard to economic growth. The new environmental paradigm had existed at the sub-policy level since the 1970 and its emergence was a steady and gradual process. It was closely linked to the idea of environmental protection and much in favor of a *green* and *sustainable* growth model. It marked a departure from the "*pollute first, control later*" and "*getting rich first, clearing up later"* mindset and pressed instead for a "prevention first" way of thinking. The *scientific development paradigm* on the other hand, was a more abrupt and sudden process that was sparked by the intervention of a small elite within the government and that drew is urgency from the collective fear of being unable to catch up on the world's 'new technological revolution' (*Xin jishu geming)*. This new scientific paradigm was also the discontinuation of the 'getting rich first and cleaning up later' mentality and suggested instead a well-balanced and more comprehensive development path.
With the emergence of the new paradigms, economic prosperity at all cost was therefore no longer viable and justifiable. The emergence of the new environmental and new scientific paradigm adoption of the scientific concept of development marked the government's shift away from the heretofore dominant image of coal and leaving behind the 'development at all costs' or 'getting rich first and cleaning up later' mentality. The image of coal had weakened considerably and was suddenly regarded as a hindrance to "a civilized development path,' a "well-off life" and "good ecological environment".[783] At the same the Chinese leadership began to recognize that the two goals of growth and clean environment were no longer contradictory to each other, but that environmental protection and maintaining long-term growth could co-exist at the same time. China's government began to acknowledge that as major economic power, it must accept a greater responsibility than in the past. This meant that China's policymakers needed to adopt a fundamentally new governance paradigm that would include criterions of economic growth, environmental health and social inclusion. This new growth model was less compatible with the

[783] Fewsmith, J. (2004). Promoting Scientific Development Concept. *China Leadership Monitor*, *11* (30), 1-10.

image of harmful and contaminating coal, but favored instead the image of clean and advanced energy technologies such as hydropower, wind power and other renewable energies. That said, the new 'green development model' was also borne out of the recognition that the path towards a low carbon economy could also provide China significant competitive advantages which could open the door for new opportunities and markets in regard to emerging green technologies.

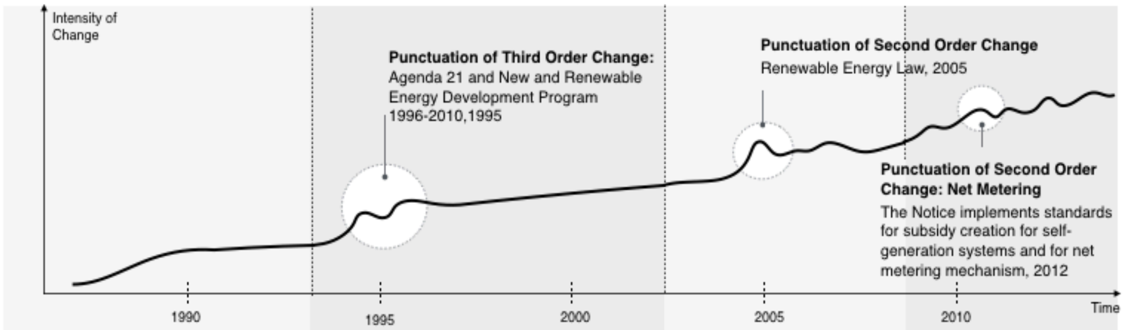
Triggers and drivers of policy change. The first punctuation in 1993 was the result of multiple triggers, the most important of which was the result of a nationwide survey among 2,0000 officials in 1992, that signaled to the central government a general consensus and approvability of the uptake of the new development path. The second and third punctuations were likely the result of internal factors, such as the (i) the severe energy crisis in 2003-2004; (ii) energy security concerns and a growing shortage between energy supply and demand and (iii) growing overcapacities in the solar industry that stemmed from dwindling foreign markets and the probability of trade sanctions on solar technology exports.

Institutional venues. China's institutional landscape has been notoriously weak throughout the entire trajectory of solar policies and has displayed ineffective institutions, strong vested interests, poor coordination, conflicting objectives and tension among policy actors. During the time of the first punctuation and paradigm shift, China's energy sector was extraordinarily weak as a result of the energy sector's transitions from the previous state-planned and centralized system to a 'socialist market economy'. A pertinent illustration hereof is China's first and last Energy Ministry, which was inaugurated in 1988 and dissolved 1993. This marked the beginning of an institutional void and highly fragmented energy bureaucracy that persists to this day. The institutional landscape during the second and third punctuations was similarly weak, albeit to a lesser degree, due to frequent institutional restructuring and ineffective cooperation among a scattered and increasingly heterogeneous group of state and semi-state institutions. Examples hereof are the establishment (and eventual abolishment) of two short-lived institutions in 2003, namely the State Electricity Regulation Commission (SERC) under the State Council (which was later replaced by the NEA in 2008) and the Energy Bureau under the NDRC (which was also replaced by the NEA in 2008). Therefore institutional venues appear to have not played a considerable role in creating significant policy change.

PART 7 Conclusion and Outlook

7.1 Summary of Analysis

Figure 31 Punctuations in China's Solar Policy Trajectory



Agenda	Institutional Agenda	Decision Agenda	Decision Agenda	Decision Agenda
Policy change	Incremental (adjustment of policy instruments)	Third order policy change (new instrument setting, new instruments, new hierarchy of priorities), paradigm shift	Second order policy change (Introduction of new instruments), Incremental	extreme Incremental
Triggers	n/a	1992: China's Environment Survey with 2,000 officials in six provinces shows that 80% are unsatisfied with China's environmental situation and 60% demand environmental restoration even at the cost of economic growth	Energy growth for the first time in decades higher than GDP growth, also energy crisis that led to nationwide power shortages	Overcapacity's in PV industry, dwindling foreign markets, financial crisis and lawsuits by U.S. solar manufacturers
Institutional Venue	Extremely weak due to reconfiguration of state power and general overhaul of the entire energy sector	Extremely weak due to reconfiguration of state power and general overhaul of the entire energy sector,	Weak: disintegration of SDPC and establishment of NDRC; disintegration of SERC and establishment of NEA	Weak: role, functions and administrative rank of NEA unclear
Paradigm	Dominance of "pollute first, control later" and "getting rich first, clearing up later" paradigm that favors economic growth at all possible costs	„Prevention first, combining prevention with control" Paradigm Emerging new paradigms revolving around environmental degradation, energy security, and scientific development	Emerging new paradigms revolving around environmental degradation, energy security, and scientific development	well-off life, and a good ecological environment

Source: Author

Tracing China's solar energy policies has shown that the development of solar policy has encountered only one major punctuation (*paradigm shift*) in 1994-1996 along with two smaller punctuations in 2005 and 2011 (*two-order changes*). Prior to 1993, solar energy issues had existed on the political agenda but were considered by policymakers only an issue that merits public attention but not necessarily government action (*systematic agenda*).[784] China's government during this time was preoccupied with recouping the economic losses that had been suffered during the previous years of political turmoil (e.g. Cultural Revolution and the Great Leap Forward). The overall agenda during this time thus revolved much around a series of major political and economic reforms that strived towards re-establishing China at the vanguard of global political (also referred to as China's opening-up policy). Despite these more urgent, macro-economic issues, policymakers at this time were nevertheless very much aware of the solar energy potential and the socio-economic benefits it could provide, particularly in context of greater energy efficiency and rural electrification. In 1981, solar energies were included for the first time

[784] Cobb, R. W., & Elder, C. D. (1983). *Participation in American politics: the dynamics of agenda-building*. Baltimore, USA: Johns Hopkins University Press.

into China's Sixth Five-Year Plan (FYP) which meant, the issue of solar energies was therefore explicitly taken up for the active and serious consideration of authoritative decisionmakers (*institutional agenda*).[785] With the release of the "White Paper on China's Population, Environment and Development in the Twenty-First Century" (Agenda 21) and the subsequent "New and Renewable Energy Program (1996-2010)", solar energy issues were finally taken up for consideration by the highest decisionmakers and therefore immediate government action (*decision agenda*). This transcendence into the decision agenda sphere was the result of a paradigm shift and punctuation that was beginning to gain momentum during the period 1994-1996. China's Agenda 21 and the subsequent "New and Renewable Energy Program (1996-2010)" constitute radical departures from the previous policymaking trajectory and ought to be considered third-order changes as they introduced several novel aspects: *instrument settings* (both policies had been the result of unusual, collaborative efforts across various layers of government and the non-government sectors), *new instruments* (both documents were the first of their kind to introduce a long-term and coherent strategy plan for renewable energy) and a new *hierarchy of goals and priorities behind policies* (both policies reflecting a shift in prioritization towards sustainability and sustainable growth). The *Agenda 21* and the *New and Renewable Energy Development Program* thus represented a *disjunctive* and *discontinuous* policy process and the venturing of a new policy path that was dominated by a new paradigm and policy image.

The policy punctuation reflected the emergence and growing influence of two new paradigms that were challenging the conventional policy monopoly. The dominant policy monopoly at that time was closely associated to the image of coal and prioritized a "*pollute first, control later*" and "*getting rich first, clearing up later*" way of thinking. It strived for economic growth at all cost. The image associated with this paradigm was that of cheap and abundant coal, which had been considered an ideological triumph and key to many decades of energy self-sufficiency. Given the traditional nexus between GDP growth and energy, coal had for many decades served as a strategically important, reliable and ample resource that had been the key driver of the country's economic growth. In the early 1990s, the image of coal began to bridle due to massive concerns and debates over energy security and coal availability, that been sparked by the release of a BP Review of World Energy in 1993, which estimated China's theoretically recoverable coal resources to be only a fraction of what the government had claimed (merely 115 billion tons instead of 967 billion tons). Therefore the image of coal began to bridle as coal, which had previously served as a central pillar to China's economic growth model, was suddenly perceived as a *constraint* to China long-term and comprehensive economic development.

These doubts and uncertainties paved the way for the emergence of two new paradigms, both of which introduced a new set of perspectives and priorities in regard to economic growth. The new environmental paradigm had existed at the sub-policy level since the 1970 and its emergence was the outcome of a steady and gradual policy process. It was closely linked to the idea of environmental protection and much in favor of a *green* and *sustainable* growth model. It marked a departure from the "*pollute first, control later*" and "*getting rich first, clearing up later"* mindset and pressed instead for a "prevention first" attitude. The *scientific development paradigm* on the other hand, was a more abrupt and sudden process that was sparked by the intervention of a small elite within the government and that drew is urgency from the collective fear of being unable to catch up on the world's 'new technological revolution' (*Xin jishu geming).* This new scientific paradigm was also the discontinuation of the 'getting rich first and cleaning up later' mentality and suggested instead a well-balanced, innovative and more wholesome development path.

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[785] Ibid.

With the emergence of these two new paradigms, economic prosperity at all cost was therefore no longer viable and justifiable. The emergence of the new environmental and new scientific paradigm adoption of the scientific concept of development marked the government's shift away from the heretofore dominant image of coal and leaving behind the 'development at all costs' or 'getting rich first and cleaning up later' mentality. The image of coal had weakened considerably and was suddenly regarded as a hindrance to "a civilized development path,' a "well-off life" and "good ecological environment". At the same the Chinese leadership began to recognize that the two goals of growth and clean environment were no longer contradictory to each other, but that environmental protection and maintaining long-term growth could co-exist at the same time. China's government began to acknowledge that as major economic power, it would have to accept a greater responsibility than in the past. This meant that China's policymakers needed to adopt a fundamentally new governance paradigm, one that would include criterions of economic growth, environmental health and social inclusion. This new growth model was less compatible with the image of harmful and contaminating coal, but favored instead the image of clean and advanced energy technologies such as hydropower, wind power and other renewable energies. That said, the new 'green development model' was also borne out of the recognition that the path towards a low carbon economy could also provide China significant competitive advantages which could open the door for new opportunities and markets in regard to emerging green technologies.
The final trigger that led to relinquishment of the already weakened coal-paradigm was presumably a nationwide survey among 2,0000 officials in 1992, that signaled to the central government a general discontent with the existing paradigm and the collective consent and approvability for the venturing new development path towards sustainable, innovative and more inclusive economic growth. Such collective consent has particular importance in China's political system where *approvability* of new policy innovations trumps *feasibility*. Last but not least, the paradigm change was also enabled through an institutional void and highly fragmented energy bureaucracy. China's energy sector was extraordinarily weak as a result of the energy sector's transitions from the previous state-planned and centralized system to a 'socialist market economy'. China's institutional landscape was extremely weak during this time due to periodic restructurings of the energy bureaucracy and inefficient and short-lived institutions that lacked the authority, autonomy, resources, and tools to govern the energy sector. The first punctuation and paradigm shift therefore occurred during a time of extreme institutional weakness, as China's Energy Ministry was just recently dissolved 1993 and left an institutional and administrative void.

From 2003 to 2005, another minor punctuation (*second-order change*) occurred, namely the release of the *Renewable Energy Law* in 2005, which led to the introduction of new instruments and measures while maintaining the overall goal and paradigm. The second order punctuation was mostly triggered by growing energy security concerns. These concerns had resulted from a change in leadership priorities and the resurgence of a heavy industry, which eventually and inevitably culminated in a severe energy crisis in 2003-2004, resulting in massive power blackouts across the country. In 2004, the energy shortages were beginning to impinge on everyday life and China was facing the most severe energy crisis for decades. Aside from that there was growing evidence that – for the first time in several decades - energy consumption was outstripping economic growth, which caught the attention of the leadership because it essentially meant that China's overall economy was becoming less efficient. This heightened attention therefore triggered the introduction of a comprehensive and innovative framework (consisting of measures such as amendments to FITs, specification of beneficiaries of the renewable energy fund, and so on).

During the second punctuation, the institutional landscape remained similarly weak, albeit to a lesser degree, due to frequent institutional restructuring and ineffective cooperation among a scattered and increasingly heterogeneous group of state and semi-state institutions. Examples hereof are the establishment (and eventual abolishment) of two short-lived institutions in 2003, namely the State Electricity Regulation Commission (SERC) under the State Council (which was later replaced by the NEA in 2008) and the Energy Bureau under the NDRC (which was also replaced by the NEA in 2008). The overall reasons for China's persisting institutional shortcomings were mostly the result of (i) a myriad of government actors and institutions that lead to scattered and overlapping responsibilities (see Chapter on *Institutional Landscape, Energy Actors and Processes*); (ii) a hybrid blend of central-state control mixed with market elements and commercial interests, that produce considerable tensions and frictions between the state and powerful, entrenched semi-state monopolies; (iii) China's continuous transition towards a liberalized energy market that leads to an incessant reshuffling and dissolving of short-lived institutions (an ongoing process that has persisted since 20 years); and (iv) the distorting influence of bureaucratic rank, which contributes to the weakness of formal institutions and facilitates instead a strong reliance on informal negotiation rather than rule-based decisions (although recent leader generations such as the Xi-Li Administration have sought to reinforce and strengthen institutional structures). Multiple centers of power, institution building and economic development prevail and political and economic rivalry exists at and between all levels of government.[786] In 2011, another minor punctuation (second-level change) occurred which lead to new instruments as well as the adjustments of existing instruments while preserving the overall continuation of the policy path, which was triggered by growing overcapacities in the solar industry that stemmed from dwindling foreign markets and the probability of trade sanctions on solar technology exports. During this stage, the institutional landscape continued to be notoriously weak. Both second-order punctuations (2005 and 2011) that followed the first punctuation in 1994 were by far less intense than the type of policy change experienced in the Agenda 21, which had led to an entirely new set of *targets* and *priorities*. The period that followed the first punctuation in 1994 was therefore mostly *incremental*. However due to the frequency and swiftness of policy changes and adjustments (for instance readjusting the solar target in 2011, 2012 and 2013) can be interpreted as what Baumgartner and Jones (1993)[787] refer to as *extreme incrementalism.* The vast bulk of solar energy policies since 1996 are therefore part of a stable, continuous and mostly incremental policy process that preserved the broad continuities that had been earlier established by the *Agenda 21* and the *New and Renewable Development Plan*.

China's recent solar energy development and its apparently *sudden* shift towards solar energies is often mistakenly portrayed as *a new phenomenon*. This study found that solar energy issues have actually existed on China's national agenda for many decades. The first transition from being considered an issue that may or may not be taken up for action (*agenda universe*) to being considered an issue that merits public attention (*systematic agenda*) took place in 1975 with the first national conference on solar energy utilization held in Anyang, Henan Province in 1975 and the mentioning of solar energy 1979 *Environmental Protection Law.* The overall agenda at this time paid little attention to the issue of solar energies due to uncertainties regarding (i) costs, (ii) PV manufacturing industry and technology; (iii) lack of experience with piloting solar energies

[786] Xia, M. (2003). *The Dual Developmental State: Development Strategy and Institutional Arrangements for China's Transition* (1st ed.). London, UK and New York, USA: Routledge. http://doi.org/10.2307/3182205; McNally, C.A., & Chu, Y.W. (2006). Exploring capitalist development in Greater China: A Synthesis. *Asian Perspectives*, *30*(2), 31-64.

[787] Baumgartner, F. R., & Jones, B. D. (1993). *Agendas and instability in American politics* (1st ed.). Chicago, USA: University of Chicago Press.

and (iv) the preoccupation of political decisionmakers with economic transitioning and China's open-door reforms. In 1981 solar energy began to surface on the *institutional agenda,* that is solar energy was considered an issue explicitly up for the active and serious consideration by decisionmakers. This transition was the result of the uptake of solar energy issues into China's Sixth Five-Year Plan (1981-1985), Seventh Five-Year Plan (1986-1990) and Eighth Five-Year Plan (1991-1995). Solar electricity fitted well into China's overall agenda determined by the long-term economic planning ("*Ten Year National Economic Development Plan Outline for 1976-1985")* and its strive towards a *comparatively well-off level* of society. In 1994 and with the promulgation of China's *Agenda 21*, solar energy issues became one of the few issues that are about to be acted upon by the government body or ruling elite. During this time, solar energy issues became an issue of vital importance as it was regarded a way of lessening the environmental pollution that had resulted from decades of rapid economic growth and to alleviate the growing social and economic divide between China's eastern and western provinces.

7.2 Evaluation of Analytical Concepts

Jones and Baumgartner (2012) have argued that the most important aspect of a theory or framework is not whether it is right or wrong, but the extent to which it is fruitful and able to stimulate further research.[788] The application of PET to the Chinese context has generated many questions that join the more general discourse on whether or not western theories of policymaking can develop sufficient explanatory power to understand policy processes in China. The PET is no exception in this sense, as its underlying presumptions are rooted in policy context of a parliamentary democracy with a proportional electoral systems, action and multiparty governing coalitions, all of which are implicitly interwoven into is explanations and assumptions about policymaking. There are thus certain elements of the PET that do not entirely comply with the Chinese system of policymaking.

PET is insensitive to policies that gradually pave the way for innovative policies. As seen in the Chinese context (particular those that occurred prior to the punctuation in 1993) there is a distinct group of policies that are important in paving the way for paradigm changes and punctuations (such as those gradual policies that mention a greater use of solar energies prior to the Agenda 21 and that fill a certain policy void). These policies neither fit in the category of punctuation or incremental change. Nevertheless, they are important in steering the overall policy process and paving the way for more substantial policy changes.

The absence of "sudden changes" in China's policymaking. The PET model serves only to a certain extent as a plausible explanation for the trajectory of China's energy development, as there are certain specifics unique to the Chinese model that conflict with the assumptions underlying the PET model. The likeliness of "*sudden*" change is comparably low given the fragmented nature of authority. Therefore "sudden changes" in the Chinese context are rather policy processes that have been subject to many months and perhaps years of extensive bargaining, negotiations, side-haggling and consensus-seeking at all levels of government – invisible to the public and policy outsiders. This needs to be taken into consideration in China, especially when examining the dynamics and triggers that prompt policy punctuations. An example hereof is the Renewable

[788] Jones, B. D., & Baumgartner, F. R. (2012). From There to Here: Punctuated Equilibrium to the General Punctuation Thesis to a Theory of Government Information Processing. *Policy Studies Journal*, *40*, 1–20. http://doi.org/10.1111/j.1541-0072.2011.00431.x

Energy law, which was initiated in 2003 but only approved in 2005. Therefore the actual stimulus for this innovative policy change was most probably sometime in 2000.

PET's focus on institutional venues: One of PET's key postulations is that punctuations emerge as the result of institutional weaknesses that allow for the entry of new actors and rivaling images. Yet China's example of solar energy policies has demonstrated that notoriously weak institutions in China are indeed capable of maintaining the overall policy monopoly and paradigm. According to the PET such weak institutional boundaries would imply that a multitude of new actors are able to access the policy arena and influence the predominant policy monopoly and implying a leading to a constant turnover in political agenda and policy directions. As mentioned earlier, the presumption of focusing on institutions stems from the western notion of policymaking and seems incompatible with the Chinese way of policymaking (that is if we understand institutions in the formal sense and not as shared *concepts*, *ideas* and *values*). The study of institutions is therefore not very insightful in the Chinese context, and can only partly explain why new paradigm emerge. More importantly and as discussed in Chapter *China's Two-Tier Policy Arena*, policymaking in China occurs not only at the official and formal level, but also on the social, informal level (which is often invisible to policy outsiders).

Therefore, several aspects and presumptions of the PET are not necessarily applicable to the Chinese context as it is insensitive to China's idiosyncratic way of policymaking, which revolves mostly around consensus-building and overcoming the fragmented bureaucratic structures. On the other hand, this study found that models originating specifically from the Chinese context have been much more conducive to understanding energy choices behind policies (such as the *Fragmented Authoritarianism Model* and the *Consultative Leninism*). In particular the FA Model has been conducive in understanding better the interactive processes and the bureaucratic structures behind policy developments that shape political decision-making. The FA Model is highly sensitive to the idiosyncratic nature of policymaking in China, with its ubiquitous influence of the Communist party, substantial power fragmentation and distorting influence of bureaucratic ranks. This study therefore affirms that the FA Model remains the most durable heuristic through which to study Chinese politics.

7.3 Policy implications, Outlook and Recommendation

China has recently announced to massively cut down its GHG emission and drastically increase its share of renewable energies. Carbon emissions are thus expected to peak by 2030 or before and non-fossil fuels including solar energy will make up one-fifth of China's primary energy consumption. To achieve these goals, China will have to drastically scale-up its clean energy sources, including solar energy. There have been repeated doubts as to whether or not such energy targets are realistic and to weather there is genuine interest behind such policies or whether they are just short-lived political and opportunistic maneuvering.

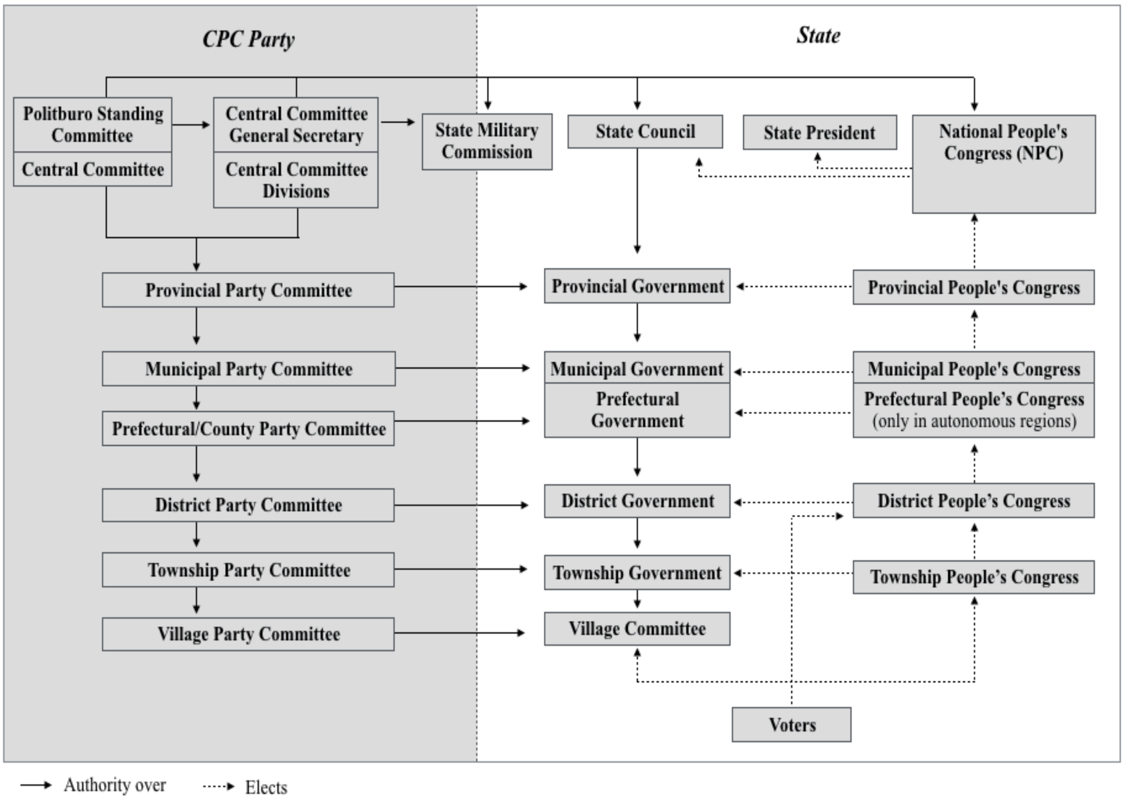
The implications of this study are that China's recent venturing towards a low-carbon economy and the seeming reversal of previous coal-based energy policies are in fact manifestations and corollaries of a transformational shift that took place in China as early as the mid 1990s. This new policy path revolves around the ideas of a wholesome and more inclusive economic growth based on the principles of sustainability, scientific development and harmonious society. This transition which serves as the ideological justification and blueprint for many of the ambitious policies that we see today, was not the decision by a small political elite or the outcome of a rigid centrally-planned system, but rather the consequence of collaborative efforts and social learning across many levels of government and the entire society. As such, we can expect that the ambitious policies and targets that are heralded by China's top leaders today actually reflect the consensus and the overall trajectory aim which China has been venturing for many years. Moreover, they are outcomes of a long-term, incremental and stable process that are likely to continue and the medium- and long-term.

This study concludes with the following recommendations:

- *Stronger collaboration on clean energies to speed up innovation.* Despite the ongoing trade tensions and political disputes in the WTO between U.S. and Chinese solar manufacturers, China can offer many lessons and experience to other countries. China has applied a very innovative way of testing policy innovations within pilot areas at provincial level and then scaling up those that prove feasible to national level. Such experimental policymaking has also been observed in the solar sector (for instance regarding the adjustments to solar feed-in tariffs). Therefore such innovative and flexible policymaking could serve as valuable lessons for other countries that face similar challenges of developing a comprehensive solar framework.
- Solar policies in China have been a major success story that is reflected in the considerable increase in installed solar capacity. Many countries including China itself would substantially benefit from an increase in international collaboration on R&D issues, sharing the lessons of the past and developing best experience. Such an effective collaboration among scientific and technical bodies at international level could significantly speed up the rate of innovation and contribute greatly to an accelerated decrease of carbon emissions.
- *Stronger government efforts to facilitate partnerships among China and industrialized economies*. China is now the largest investor in clean technologies (such as Beijings recent call for electric vehicles). This could create important business opportunities for providers and manufacturers of such technologies and could be a win-win situation for both Chinese consumers and foreign producers of high-end and clean technologies. As shown in this study, Chinese move towards a low carbon path is here to stay and will likely lead to an increase in low-carbon technologies and appliances in many other sectors.

Appendix

Annex I: Diagram of Political-Administrative System of PRC[789]



[789] Author, based on Heilmann, S. (2009). Das politische System der Volksrepublik China. *China Analysis*, 70, 1-19.

Annex II: List of Interviewees

Organisation	Recommended by
CREIA	GIZ
Energy Research Institute, NDRC (ERI)/ CNREC	GIZ
NEA/CREIA	GIZ
Energy Research Institute (NDRC)	GIZ
China Photovoltaic Society (CPVS)	GIZ
AZURE International	GIZ
Freie Autorin	GIZ
European Union Chamber of Commerce in China	GIZ
China Electricity Council (CEC)	GIZ
China Greentech Initiative	GIZ
Frank Haugwitz Organization	GIZ
WIRSOL Solar Technology	GIZ
Greenpeace Beijing	GIZ
China National Renewable Energy Center	GIZ
Representatives from Electric Power Research Institute (Grid Company)	Mr. Wang
Representatives from China Southern Electric Grid (Grid Company)	Mr. Wang
China Policy	Internet
The China Sustainable Energy Program	Internet
Independent Author	Laura Gruß
Energy Expert	Laura Gruß
CEO of Suncorepv	Annie Liu
Consulting company	Annie Liu
JA solar company (Shanghai)	Annie Liu
Energy Expert	Annie Liu
China Renewable Energy Society (CRES)	Annie Liu
Energy Expert	Annie Liu
China Growth Leader	Bill Dodson
Jiangsu Energy Expert	Hurunqing/ Annie Liu
Tsinghua Professors and Scholars	Helen
Independent Experts and Consultants in Jiangsu	LiJun
The Climate Group	GIZ
National Bureau of Statistics	GIZ
World Bank	GIZ
Bloomberg China New Energy Finance	Internet
China Macroeconomic Research Center	Internet
China International Capital Corporation	Internet
Energy Consultant with CIConsulting	Internet
Secretary-general of the China PV Alliance	Internet
Chief analyst Solarzoom	Internet
Director, Power Quality Bureau Jiangsu Electric Power Company	Internet
National Energy Bureau	Annie Liu
Chief Analyst, Minsheng Securities	Annie Liu

NPD Solarbuzz analyst	Internet
Energy policy analyst with NSBO	Website
Climate Policy Initiative (CPI) Tsinghua Office	Website
Tsinghua University	n/a

Annex III: China's Leader Generations: Members, Ideology and Vision

Year	Leader Generation
5th Leader Generation, *Xi-Li Administration (*2013-2018)	
Party General Secretary	Xi Jinping
Premiers	Li Keqiang; Zhang Gaoli; Liu Yandong; Wang Yang; Ma Kai
Ideology/Vision	• many leaders owe their position to Jiang Zemin (change of political course will be hard) • Formative experience included Cultural Revolution (1966) • Xi has made a high-profile anti-corruption campaign one of his administration's key missions Ideology/Vision: "The Chinese dream" popularized after 2013, describes a set of personal and national ideals connected to Chinese prosperity, collective effort, socialism, and national glory.
4th Leader Generation, *Hu-Wen Administration (*2002-2012)	
Party General Secretary	Hu Jintao
Premiers	Wen Jiabao; Wu Bangguo; Jia Qinglin; Zeng Qinghong; Li Changchun
Ideology/Vision	• all born between 1939-1944 (World War II) • Hu and Wen were among the first leaders who acquired their education primarily in Chinese universities. What they also have in common is that their studies were disrupted by the Cultural Revolution. • Their work is characterized by a less centralized and more technocratic political system, founded on the principles of scientific development and harmonious society" Ideology/Vision: The principles of "scientific development and harmonious society" as a response to the increasing social injustice and inequality emerging in China's society as a result of unchecked economic growth, which has led to social conflict. The governing philosophy was therefore shifted around economic growth to overall societal balance and harmony.
3rd Generation Leader *Jiang-Peng Administration* (1993-2001)	
Party General Secretary	Jiang Zemin

Premiers	Li Peng; Zhu Rongji; Qiao Shi; Li Ruihuan (later Zhu Rongji as 1st Premier)
Ideology/Vision	• born from 1924 to 1934 (before the revolution), • The third generation of Chinese leaders was essentially different from their predecessors. The members of the government led by Jiang Zemin acquired their leadership skills in the Soviet Union, and most of them had a background in engineering. This generation was also the first one to separate the political and military leaderships • formative experience includes Sino-Japanese war and Korean war • Although Deng Xiaoping resigned from official posts in 1989, he was still influential in this era"
2nd Leader Generation, *Deng Era (*1976-1993)	
Party General Secretary	Hua Guofeng; Hu Yaobang; Zhao Ziyang; Li Peng
Premiers	Hu Yaobang, Zhao Ziyang, Jiang Zemin, Chen Yun, Li Xiannian, Ye Jianying, Peng Zhen
Ideology/Vision	• Leaders were all born between 1897 to 1921 (btw Qing Empire and Xinhai Revolution) • The leading figure of the period was Deng Xiaoping, a politician denounced and rehabilitated several times. Politicians from this period had a lot in common with the first generation. Many of them had a foreign education, primarily acquired in France, and some of them played an important role in the Cultural Revolution. In terms of political thinking, the second generation was sharply different from Mao's: instead of mass movements and class struggle, Deng's primary focus was on reforms in the economy.
1st Leader Generation, *Mao Zedong Era (*1949-1976)	
Party General Secretary	Mao Zedong
Premiers	Zhou Enlai; Liu Shaoqi (1949- 1966); Zhu De (1949-1959); Chen Yun (1949- 1969); Peng Dehuai (1949-1959); later Lin Biao and the Gang of Four (led by Mao's wife Jiang Qing)
Ideology/Vision	• born between 1886 and 1907, except for the 'Gang of Four', a distinct subgroup born 1914 to 1935 • Guided by general principles of Marxism and Mao Zedong thoughts • The leaders of the first period were born around the turn of the 20th century. They saw the rise and fall of the Republic, and they were the founders of the People's Republic. • Formative experiences included the Long March, the Chinese Civil War, the Second Sino-Japanese War, and a study abroad. • High fluctuation of Premier positions • The era can be divided into two periods (Pre-Cultural Revolution and Cultural Revolution)

Annex IV: Energy Actors in China: Abbreviations and Profile Descriptions

Abbr.	Institution	Description of responsibilities
NDRC	National Development and Reform Commission	NDRC functions as super-ministry concerned with the macroeconomic management under the State Council, mandated to develop the country's macroeconomic and social strategies and to translates these into annual plans, mid- and long-term plans, sector specific plans and national support programs. NDRC has sole authority to set ad adjust energy prices.
NEC	National Energy Commission	NEC serves as overarching government agency that brings together 23 senior ministers from all energy-relevant agencies to strengthen overall energy decision-making procedures and coordination
NEA	National Energy Administration	NEA has mandate to develop and draft policy instruments, standards, laws and regulations, coordinate energy development and energy reforms, approve foreign energy investments and monitor and regulate the energy sector
ERI	Energy Research Institute	ERI is a national energy think-tank of NDRC that conducts comprehensive studies on China's energy issues.
CNREC	China National Renewable Energy Centre	CNREC is a joint non-profit think tank established with support form Danish government to develop and advocate the RE technology and capacities in China. On the same hierarchical level as the ministries. Closely linked with ERI, as CNREC director (Wang Zhongying) is concurrently Deputy director general of NDRC's Energy Research Institute (ERI).
MIIT	Ministry of Industry and Information Technology (*Gongye He Xinxihuabu)*	Established in 2008 mandated with the responsibility (i) to determine China's industrial planning, policies and standards; (ii) to monitor the daily operation of industrial branches; (iii) to promote the development of major technological equipment and innovation concerning the communication sector; (iv) to guide the construction of information system and (v) to safeguard China's information security.
MoF	Ministry of Finance *(Caizhengbu)*	MOF administers macro-economic policies, the national annual budget, fiscal policy, economic regulations and state expenditure and records macroeconomic data on China's economy. MOF plays a key role in the solar energy sector as it decides upon and allocates solar energy subsidies[790].

[790] Chinese Ministry of Finance, see official website http://www.mof.gov.cn/index.htm.

MoST	Ministry of Science and Technology (*Kexue Jjishubu*)	MOST formulates and implements laws that pertain to science and technology[791] and is considered the backbone of China's technology innovation and the central planning body for China's technology sector.[792] MOST is especially important to the solar energy sector because it is responsible for Research and Development (R&D) of solar PV technology.
MoHURD	Ministry of Housing, Urban & Rural Development (*Zhufang Chengxiang Jianshebu*)	MOHURD is responsible for housing policy, distribution of housing space and plays a key role in solar energies, particularly for BIPV and BAPV. MOHURD is mandated to increase the energy efficiency of buildings and lower the overall emissions of the housing sector; to which ends solar energy technologies could contribute significantly.[793]
MLR	Ministry of Land and Resources (*Guotuziyuanbu*)	MLR is responsible for the planning, administration, management, preservation and exploitation of natural resources, including land, mineral and marine resources.[794]
MEP	Ministry of Environmental Protection (*Huanjing Baohubu*)	MEP (established in 2008 and formerly known as State Environment Protection Administration (SEPA, *Guojia huanbaozongju*) has become increasingly important for the energy sector due to environmental pollution associated with fossil fuels.
MofCom	Ministry of Commerce (*Shangwubu*)	Formerly known as Ministry of Foreign Economic Relations and Trade (MOFERT, 1982-1993) and Ministry of Foreign Trade and Economic Cooperation (MOFTEC, 1993-2003). MofCOM. It is responsible for: drafting policies and regulations to discipline market performance and commodity circulation; facilitating the establishment and improvement of the market framework; furthering the distribution system restructuring; monitoring and analyzing market performance and commodity supply and demand; organizing international economic cooperation; coordinating anti-dumping and anti-subsidiary issues and arranging industry damage survey. The State Economic and Trade Commission (now part of the Ministry of Commerce) has decision-making power in terms of investment in important technology renovation projects

[791] Ministry of Science and Technology, see official website http://www.most.gov.cn/index.htm.
[792] Hofem, A. (2009). Staatliche Förderung von Umwelttechnologie in der VR China. *China Analysis*, 71.
[793] Ministry of Housing and Urban and Rural Development (MOHURD), see official website http://www.mohurd.gov.cn/.
[794] International Crisis Group. (2008). *China's Thirst for Oil (Report No. 135)*. Seoul, South Korea and Brussels, Belgium.

SASAC	State-owned Assets Supervision and Administration Commission (*Guowuyuan Guoyou Zichan Jiandu Guanli Weiyuanhui*)	SASAC was established in June 2003 and is subordinate to the State Council and serves as the technical owner and shareholder of China's 150 State Owned Enterprises (SOEs).[795] SASAC is responsible for decisions related to investment, restructuring, reforms and strategically adjusting SOEs.[796] Despite SASAC's importance as the owner of all SOEs, the institution's power is de facto extremely limited, as it neither has control over budgets nor the authority to collect earnings from SOEs (this is instead responsibility of the Ministry of Finance)[797]
SGCC	State Grid Cooperation of China	
CSG	China Southern Power Grid Cooperation	
IMG	Inner Mongolia Power Group	IMG provides electricity integrated services, operates and manages electricity networks, offers electricity generation, transmission, distribution services. The company was founded in 1965 and is based in Hohhot, China.
CHNG	China Huaneng Group	China Huaneng Group operates as a power company. The Company develops, operates, manages, and invests in coal fired power, hydropower, wind power, solar power, and other related businesses. China Huaneng Group also operates coal, finance, energy, science and technology, transportation, and other projects.
CDC	China Datang Corporation	China Datang Corporation primarily engages in the power generation business in China. It is involved in the investment, development, construction, operation, and management of electric power; production and sale of organizational heat power; manufacture of electricity equipment, equipment maintenance, and debugging; and development of power technology and the provision of consulting services. The company also engages in power engineering, electrical contracting, and consulting environmental engineering; development of new energy; development and production of coal resources for electricity; and import and export of various commodities and technologies.

[795] Naughton, B. (2007). *The Chinese Economy: Transitions and Growth*, Cambridge, USA: Massachusetts Institute of Technology.
[796] People's Daily (2003, May 22). SASAC's Responsibilities & Targets. *People's Daily.*
[797] Burke, C., Jansson, J., & Jiang, W. (2009). Formulation of Energy Policy in China: Key Actors and Recent Developments. Johannesburg, South Africa: University of Stellenbosch, Centre for Chinese Studies.

CGC	China Guodian Corporation	
CHDC	China Huadian Corporation	
CPIC	China Power Investment Corporation	
CREIA	China Renewable Energy Industries Association (Zhongguo Ziyuan Zongheliyong Xiehui kezaishengnengyuan Zhuanye Weiyuanhui)	CREIA is a think tank and knowledge center, developed in 2002 with support from the UNDP and the China State Economic and Trade Commission (SETC) and the Global Environmental Facility (GEF), and China Renewable Energy Society (CRES). Its mandate is to (i) mediate between policy, economy and science, (ii) serve as renewable energy forum that brings together regulatory authorities, research institutes, industry professionals, international project developers and investors and (iii) serve as policy advisor to the government[798] . It has around 6-25 staff.
n.a.	China Renewable Energy Society (Zhonggou Kezaisheng Nengyuan Xuehui Guangdian Zhuanye Weiyuanhui)	The China Renewable Energy Society (formerly known as the China Photovoltaic Association (Zhongguo Taiyangneng Xiehui) founded in 1976.) developed in 1979. It has 2000 members and deals specifically with PV policy issues.[799] Its main functions are evaluation of PV projects, representation of civil interests, and lobbying for solar PV energy.

Annex V: Energy Sector Reforms

Date	Decrees (State Council) or Regulations (State Planning Commission and Ministries)
Feb 1979	This State Council Decree separated the Ministry of Water Resources and Electric Power into two ministries: The Ministry of Electric Power and the Ministry of Water Resources.
May 1979	State Council Decree on the "Principle of Power Sector Development: Adaptation, Reform, Consolidation and Improvement." The decree identifies the power sector development as a "prerequisite" for economic development and affirmed its vertical and centralized management.

[798] For more information, see official website of CREIA: http://www.creia.net
[799] Martin, K. (2011). Solarenergie in China. *China Analysis*, 87.

Mar 1982	Merger of the Ministry of Electric Power and Ministry of Water Resource into Ministry of Water Resources and Electric Power. The stated purpose of this institutional change was to "improve management efficiency and overcome bureaucracy."
Sep1983	End of the "one investor" model. This State Council Decree launched the "joint investment" approach in the sector. The central government reduced budget investment allocations. It encouraged regions, provinces, and industrial consumers to invest in the power sector to speed up its development.
Dec 1984	The Ministry of Water Resources and Electric Power issued the regulation on "Simplification and Decentralization of Administration Procedures in the Power Sector" to encourage investment from multiple sources.
Dec 1984	The State Planning Commission issued "temporary provisions to change budget allocations to loans for all infrastructure projects."
First Wave of Reforms	
May 1985	The State Council issued "temporary provisions to attract multiple financial sources in power sector investment and applying multiple types of electricity tariff." "The investors get paid" principle was applied and different types of tariff were adopted for different types of power projects.
Sep 1987	The State Council issued the power reform principle of "separation of administration from enterprises function, enhancement of provincial level enterprise bodies, unification of provincial power grids, unification of power dispatch, and multisource for power investment" and "adaptation to the specification situation of each region and power grid."
Dec 1987	The State Council issued the temporary provisions to collect a fen/kWh power construction fee collected by provincial power companies mainly for grid development.
Apr 1988	The State Council Decree eliminating several ministries, including the Ministry of Water Resources and Electric Power, and establishing the Ministry of Energy. Establishment of China Electricity Council (in December 1988).
Oct 1988	The State Council issued the "Institutional Management Reform of Electric Power Sector" authorizing the Ministry of Energy to pilot the decided measures in East China in 1988.
Dec 1988	Enactment of the Law of the People's Republic of China on Industrial Enterprises Owned by the Whole People introducing the concept of semi-independent management and allowing more operational autonomy.
Mar 1993	The State Council Decree eliminating the Ministry of Energy and establishing the Ministry of Electric Power (MOEP) and the Ministry of Coal Industry.
Apr 1993	Enactment of China's first Company Law.

Sep 1993	MOEP and other government agencies issued the “Reform of National Power Enterprises” allowing equity investment in generation enterprises.
Dec 1995	Approval of the “Electric Power Law,” with effectiveness on April 1, 1996.
Second Wave of Reforms	
Apr 1996	The State Council issued the “Electric Power Supply and Utilization Decree” followed by five MOEP implementation regulations.
Dec 1996	Establishment of the State Power Corporation of China (SPC) by the State Council.
Mar 1998	Elimination of the Ministry of Electric Power by the State Council and allocation of the functions as follows: The government regulation functions were allocated to the State Economy and Trade Commission (SETC). The sector coordination function was transferred to the China Electricity Council. Operation and commercial functions were transferred to the SPC.
Oct 1998	The State Council issued the “Notification to retrofit rural power network, reform rural power institutional management, and realize a uniform tariff in rural and urban area.”
Dec 1998	The State Council issued “Opinions to deepen the institutional reform in power sector by SETC” focusing on (a) the separation of the power grid from generation, introduction of competition and establishment of a sound power market; (b) the continuation of “separation of government functions from enterprises, deepening the reform of provincial power companies and improving their management capabilities”; (c) strengthening the interconnection of the national power network to optimize the utilization of regional resources; and (d) speeding up reform of the rural power sector to reduce rural electricity prices and promote economic development in rural areas.
Jan 1999	The State Council issued several decrees to accelerate rural power sector reform
Oct 2000	The State Council issued the “Notification on Power Sector Reform Issues.” A Power Sector Coordination Group was established under the leadership of NDRC.
Apr 1996	The State Council issued the “Electric Power Supply and Utilization Decree” followed by five MOEP implementation regulations.
Dec 1996	Establishment of the State Power Corporation of China (SPC) by the State Council.
Third Wave of Reform	
Feb 2002	The State Council issued Decree No. 5, “Implementation of Power Sector Reform.”
Dec 2002	The State Council Decree restructured the State Power Corporation to form 11 independent companies: 2 grid companies, 5 generation companies, and 4 auxiliary service companies.
Mar 2003	The State Council established the State Electricity Regulation Commission (SERC).
Jun 2003	The SERC issued decrees to pilot the regional competitive power markets in Northeast China and East China.

Jul 2003	The State Council issued the "Scheme of Electric Tariff Reform" to establish a normative and transparent tariff regulation system in which (a) tariffs were classified as on-grid, transmission, distribution, and end-user sales tariffs; (b) the on-grid tariffs were defined as the clearing prices of competitive markets; and (c) the transmission tariff and distribution tariffs were to be regulated by the government.
Feb 2005	SERC issued the "Electric Power Regulation Decree." Approval of the "Renewable Energy Law."
Mar 2005	The NDRC issued implementation decrees of electricity tariff reform, including on-grid, transmission and distribution, and end-user tariffs.
Apr 2005	The NDRC issued an implementation decree to adjust the electricity tariff in response to a change in the price of coal
Dec 2005	The SERC issued a "Power Business Certification Management Decree," "Power Market Operation Rules," and a "Power Market Regulation Decree."
Apr 2006	The NDRC and other government agencies issued a "notification to speed up the restructuring and promote the healthy development in power sector." It mentioned the structure change, optimal generation dispatch (energy savings, environmentally friendly, and economic dispatch), and close down of small thermal power plants.
Nov 2006	The State Council issued "Implementation Decree of Power Sector Reform during the 11tFive-Year Plan
Mar 2008	Establishment of the National Energy Administration.
2015	Electricity Market Reforms

Annex VI: Major Historical Events in China from China's Communist Party Perspective

Year	Incident/ Trends	Remark
1921	1st National Party Congress in Shanghai	The first platform (*Gangling*) of the Party passed; Mao Zedong attends (as Hunan representative); Zhang Guotao acts as top party official; Chen Duxiu becomes first leader of CPC 'Secretariat', attended by two Comintern representatives (during Shanghai meetings).
1922	2nd National Party Congress in Shanghai	Mao Zedong absent from Congress; Party continues purging anarchists, tries to maintain an independent stance from Sun Yat-Sen's Kuomintang (KMT)
1923	3rd National Party Congress in Guangzhou	CPC formally ratifies the "bloc within" strategy of cooperation with the KMT as demanded by the KMT.
1925	4th National Party Congress in Shanghai	CPC Party Center continues efforts to bring semi-independent regional Party branches under its control.
1927	5th National Party Congress in Wuhan	Congress followed Chiang Kai-shek's crackdown on Communists in Shanghai and elsewhere; CPC continues to "support the KMT Left and oppose the KMT Right".
1928	6th National Party Congress in Moscow	First and only Party Congress held outside China (due to Chiang's anti-CPC crackdown); sanctioned creating armed forces controlled by CPC but still to be used "under the KMT flag"; Mao Zedong absent, stays in China at the CPC's Jinggangshan base.
1945	7th National Party Congress in Yan'an (Shaanxi)	Party constitution is passed; CPC Chairman Mao Zedong is named leader of CPC; Mao Zedong Thought enshrined in CPC Party Constitution for first time; Mao retells the fable of "the old fool who moves a mountain" (Yugongyíshan) in his closing address.
1949	Beginning of PRC	CPC seizes power
1956	8th National Party Congress in Beijing	first Congress to be held in 11 years; Mao Zedong Thought is taken out of CPC Party Constitution; Party technocrats Liu Shaoqi and Deng Xiaoping assume higher profiles
19??	"The Great Leap Forward"	
1966-76	Cultural Revolution	
1969	9th National Party Congress in Beijing	Held at the culmination of the "Great Proletarian Cultural Revolution," Mao's Party is decimated from infighting; People's Liberation Army (PLA) influence on Party administration pronounced; few members appointed to power during the previous Party Congress survive the 9th Congress politically; former State Chairman and second-ranking Liu Shaoqi (arrested 1966) and former CPC General Secretary Deng Xiaoping labelled "traitorous scabs and renegades"; Defence Minister Lin Biao becomes CPC Vice Chairman and Mao's "closest comrade-in-arms", and is designated

		constitutionally as Mao's successor; Mao's "thought" reinserted into CPC Party Constitution
1971	Lin Biao, Mao's designated successor dies in an airplane crash	
1971	China joins UN and becomes one of the five permanent members of the U.N. Security Council	This marks the beginning of China's opening up strategy
1973	10th National Party Congress in Beijing	"Gang of Four" led by Mao's wife Jiang Qing reach paramount power; first CPC Congress after US President Richard Nixon's visit to PRC.
1976	Conflicts with the Gang of Four is ended	
1977	11th National Party Congress in Beijing	First Party Congress following Mao's death and after the fall of the Gang of Four; Deng Xiaoping wins power struggle and is reinstated to all of his previous posts.
1977 - 1979	New era of economic reforms ("Open Door Politics") is initiated by Deng Xiaoping	- 1977 Hua Guofeng starts "Open Door" policy, which is later incorporated in Deng Xiaopings "Four Modernizations" program - 1978 Hu Yaobang, Deng Xiaoping's first successor is removed from office - Reforms to separate government and business activities; gradual decentralization of central-level control through the devolution of responsibilities to provincial governments - 1978-1990: Introduction of Pragmatism in China's political and economic system. Promotion of market elements. - 1979 Deng's initiates 'open door politics' - Deng Xiaoping introduces stepwise economic reforms: "The Four Modernizations" - Since 1980s: Begin of partial market economy and private small and medium enterprises
1978	1978 Constitution	PRC's Constitution guarantees freedom of religion with a number of restrictions.
1982	12th National Party Congress in Beijing	Central Advisory Commission (CAC) and Central Discipline Inspection Commission were created; CPC Party Chair position abolished, CPC General Secretary position becomes (on paper) paramount position; former CPC leader Hua Guofeng loses formal power (except his Central Committee membership) as Hu Yaobang, not Hua, gives keynote Party address.

1978	13th National Party Congress in Beijing	Deng Xiaoping and all other "Second Generation" CPC leaders retire from active positions in the Party (again, on paper); "Third Generation" members (led by Zhao Ziyang) dominate the CPC Politburo Standing Committee
1989 (Apr-Jun)	Student Protests at Tiananmen Square	Led to inner-party conflicts and stressed the need for a new political orientation
1989	Promulgation of Environmental Protection Law	Enshrines idea of 'harmonious development'
1989	Zhao Ziyang, Deng Xiaoping's second successor is removed from office	
1990	SOEs are slowly replaced by private small- and medium enterprises	
1990	Jiang Zemin (Deng's 3rd successor) consolidates his power position	
1992	14th National Party Congress in Beijing	First Party Congress after the 1989 Tiananmen Square protests and the violent crackdown of 3–4 June 1989; Jiang Zemin's position as CPC General Secretary, Chairman of the (CPC) Central Military Commission ratified; Hu Jintao makes first appearance on Politburo Standing Committee. With the decision on establishing the socialist market economy, it was the first time that the central government officially and explicitly decided to adopt a market system in China.This was followed by new and stronger wave of market-driven reform.
1995	Power Law and Reforms	Major reforms began with the introduction of the Electricity Law and the affiliated Regulations for the Supply and Utilization of Power in the end of 1995
1995	Death of Deng Xiaoping	
1997	15th National Party Congress National Party Congress	First Party Congress following death of Deng Xiaoping and the reversion of Hong Kong to China on 1 July 1997; Jiang Zemin forces party rival Qiao Shi to retire; Inclusion of Deng Xiaoping's philosophy into Party constitution; Jiang Zemin announced plans to sell, merge, or close the vast majority of SOEs in a program which included some privatization.
1998	Major Government Restructuring	May 1998, Chinese Premier Zhu Rongji announced a major restructuring of the Chinese government, eliminating 11 ministries.
2001	China joins WTO	Begin of economic growth

2002	16th National Party Congress; new leadership (4th generation)	Hu Jintao elected General Secretary; "Fourth Generation" of CPC leadership assumes control of the Party and the country; Jiang Zemin the CPC Politburo Standing Committee with supporters, holds on to CPC CMC Chair; Jiang's "Three Represents" theory enshrined in CPC Constitution.
2007	17th National Party Congress in Beijing	Hu Jintao's Scientific Development Concept is entrenched in the party's constitution as an official guiding ideology; Vice-President Zeng Qinghong retires.
2012	18th National Party Congress in Beijing	Vice president Xi Jinping is promoted to General Secretary, chairman of Central Military Commission and leader of the ruling communist party. As the head of the party is usually the de facto President of the People's Republic of China, former General Secretary Hu Jintao is expected to step down this position in the months following the 18th Congress. Other elected members of the Politburo Standing Committee of the Communist Party of China are Li Keqiang, Zhang Dejiang, Yu Zhengsheng, Liu Yunshan, Wang Qishan and Zhang Gaoli. Bo Xilai was expelled from the politburo before the 18th National Congress due to the Wang Lijun incident and other violations.
2013	New leadership with Xi Jinping as President and Li Keqiang as Premier	
Nov 2013	Third Plenum (major policy meeting held every five years)	Chinese government outlined broad principles for economic reform in China. The government has proposed incremental policy and economic reforms to create more balanced economic growth and to shift away from an economy driven primarily by excessive investments and exports toward one characterized by greater domestic consumption. In the energy sector, the government is moving toward more market-based pricing schemes, energy efficiency measures, and competition among energy firms, as well as making greater investments in upstream hydrocarbon plays and renewable energy projects. China announced in late 2013 that it is assessing ways to attract more private investment in the energy sector by streamlining the project approval processes, implementing policies to foster more energy transmission infrastructure to link supply and demand centers, and relaxing some price controls.

Annex VII: List of Five-Year Plans approved by National's People's Congress (NPC)

Five-Year Plan	Priorities	Energy Targets
7th FYP (1986-1990)	Economic reforms	- Establish a groundwork for the new socialist economic system with Chinese characteristics - Make economic growth continuous and stable
8th FYP (1991-1995),	Modernization and opening-up	- Marked the beginning of a the reform and opening phase in China under Deng's Leadership - Overlapped with"the Ten-year Layout for National Economy and Social Development and 8th Five-Year Plan" (approved in March 1991, during 4th session of NPC)
9th FYP (1996–2000)	Modernization, reduce poverty, economic prosperity	- First medium-length plan made under a socialist market economy - Build the socialist market economic system - Establish modern enterprise system - Cap population growth at 300 million by 2000; - Quadruple per capita GNP as compared to 1980; - Double 2000 GNP by 2010 - Eliminate poverty - Speed up establishment of a modern enterprise system - Build the socialist market economic system
10th FYP (2001–2005)	Economic prosperity and growth, environment,	- Emphasis on growth and overhauling industrial structures to strengthen world competitiveness - Per capita GDP to reach 9,400 CNY - Increase forest coverage to 18.2% - Raise the urban green rate to 35% - Reduce urban and rural pollutants by 10% compared (to 2000)
11th FYP (2006–2010)	Economic growth, environment, energy security, domestic energy supply	- Growth still important but new emphasis on environment - Optimize and upgrade industrial structures - Prioritize securing domestic energy supplies - Promote energy conservation through: economic efficiency, reduction of poverty, and environmental preservation - Annual GDP target should be 7.5% (for 2006-2010) - 20% reduction in energy consumption per unit of GDP - 10% reduction of major pollutants
12th FYP (2011-2015)	Sustainable growth,	- Stresses "higher quality growth" (referring to sustainability) and "inclusive growth" (referring to growing income gaps)

	Industrial upgrading; and domestic consumption promotion	- Sets annual GDP target to 7% (for 2011-2015) - Raise share of non-fossil energies to 15% of the energy mix by 2020 - Increase non-fossil fuel to 11.4% - Reduction of CO2 emission per GD by 17% - Solar PV among “high-priorities” - Develop China’s Western regions - Protect the environment and improve energy efficiency - Focus on domestic consum rather than export

Annex VIII: Overview of Solar Policies in China from 1990-2013

Overview of Selected Solar Policies from 1990-2005

Year	Issuing Authority and Policy	Category
1971	Solar cells are successfully applied to four satellites, namely “Shijian-8 satellite”; “East Red Satellite (*dongfanghong*) No.2”; “East Red Satellite (*dongfanghong*) No.3”; East Red Satellite (*dongfanghong*) No.4”.	Application/ Piloting
1975	The “First National Solar Energy Utilization Working Exchanges Conference" is held in Anyang, Henan Province to exchange experience on energy research and deployment.	Strategic Planning
1979	The Standing Committee of NPC approves the Environmental Protection Law of The People's Republic Of China (for trial implementation) which states “Develop and use on a large-scale […] solar energy” (Article 19)	Law
1981	State Planning Commission issues Sixth Five-Year Plan (1981-1985), which indirectly covers solar energy in its Renewable Energy Programs (as part of the National Science and Technology Development Program) and calls for “*proactive development of solar energy”*	Strategic Planning
1983	State Council’s issues “Suggestions to reinforce development of rural energy with recommendations for promoting the development of rural energy” which leads to rapid electrification policies and programs	Strategic Planning
1986	State Planning Commission issues Seventh Five-Year Plan (1981-1985), which indirectly covers solar energy in its Renewable Energy Programs (as part of the National Science and Technology Development Program)	
1986	State Council issues “Provisional Regulations on The Control Of Energy Conservation” in which it states “[…] Areas with the necessary conditions will actively develop and make positive use of new energy sources such as methane, solar energy.” (Article 33)	Provisional Regulations
1991	State Planning Commission issues Eighth Five-Year Plan (1991-1995), which indirectly covers solar energy in its Renewable Energy Programs (as part of the National Science and Technology Development Program)	Policy Support Strategic Planning

Overview of Selected Solar Policies from 1990-2002

Year	Issuing Authority and Policy	Category
1992	Ten Strategies on China’s Environment and Development	Strategic Planning
1994	SDPC, SETC and Ministry of Electricity Industry jointly initiate “Electricity for poverty alleviation project”	
1994	The State Council approves “China’s Agenda 21: White Paper on China's Population, Environment and Development in the Twenty-First Century”	Strategic Planning

1995	The State Science and Technology Commission (SSTC) issues the "Blue Paper No.4: China Energy Technology Policy"	Strategic Planning
1995	State Council issues 'Interim Provisions On Guiding Foreign Investment Direction' emphasizing "Projects adopting new technology and equipment for comprehensive utilization of resources and renewable resources, and for prevention of environment pollution" (Article 5)	Foreign Economic Relations and Technological Cooperation
1995	Revision of the Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution adopted at the 15th Meeting of the Standing Committee of the Eighth National People's Congress	Law Amendment
1995	SPC, SSTC, SETC issue ')	Strategic Planning
1996	The NPC's Standing Committee approves the "Electric Power Law", which confirms "the state encourages and supports the use of renewable and clean energy resources for electricity generation." (Article 5) and "the state encourages and supports the rural electric power source construction through the utilization of solar energy […] to increase the rural electricity supply" (Article 48)	Law
1996	The SPC launches the Brightness Program (1996-2010)	Pilot Project
1996	Guidelines for the Ninth Five-Year Plan and 2010: Long Term Objectives on Economic and Social Development of China	Strategic Planning
1996	Ninth Five-Year Plan for Industrialization of New and Renewable Energy by SETC	Strategic Planning
1996	Ninth Five-Year Plan and 2010 Plan on Energy Conservation and New Energy Development by the State Power Corporation (SPC)	Strategic Planning
1996	State Energy Technology Policy	Policy Support
1997	NPC Standing Committee approves "Energy Conservation Law" which emphasizes the "development and utilization of new energy resources and renewable energy resources" (Article 4) and highlights the establishment of financial funds "in support of […] new energy resources and renewable energy resources"(Article 11); "People's governments at all levels shall, pursuant to the policy of adapting to the local conditions, multi-energy complementarity, integrated utilization and seeking benefits, strengthen energy construction in the rural areas, develop and exploit such renewable energy and new energy resources as methane, solar energy" (Article 38)	Strategic Planning
1997	State Council issues "Current Catalogue of Key Industries, Products and Technologies the Development of Which Is Encouraged by the State (Provisional)", declaring solar energy as a 'key industry'	State Council
1997	The State Council issues a draft from SPC, SETC, and the MOFTEC titled "Catalogue for the Guidance of Foreign Investment Industries […] Construction and management of new energy power station" which emphasizes use of solar energy	
1998	SDPC and MOST issue "Incentive Policies for Renewable Energy Technology Localization"	
1999	The Notice on further support for Renewable Energy Development	

1999	China launches its Western Development Strategy with focus on rural electricity through renewables	
2000	Government issues "Key Points of Development Planning of New Energy and Renewable Energy Industry 2000–2015"	Strategic Planning
2000	NPC's Standing Committee approves 'Law on Meteorological Services', which states "competent meteorological agencies at different levels shall organize the feasibility demonstration to the exploitation of […] large-scale solar energy and wind energy" (Article 34)	Law
2000	NPC's Standing Committee 'Law on The Prevention And Control of Atmospheric Pollution', which states that "the State […] encourages and supports the development and utilization of clean energies such as solar energy" (Article 9)	Policy Support
2001	SETC issues Tenth FYP for New and Renewable Energy Commercialization Development	Strategic Planning
2002	Township Electrification Program (2002-2003)	
2002	NPC issues "Cleaner Production Promotion Law" which makes governments are made responsible for taking initiative to promote cleaner production and increase efficiency	

Overview of Selected Solar Policies from 2003-2008

Year	Issuing Authority and Policy	Category
2003	Renewable Energy Law	Strategic Planning, Policy Support
2003	SDPC issues "Power Supply Plan for Rural Areas without Electricity in the Western Provinces and Regions"	Strategic Planning, Policy Support
2003	Preferential Tax Policies for Renewable Energy including solar	Fiscal/financial incentives
2005	NDRC issues Catalogue for Developing Renewable Energies	Policy support
2005	Eleventh Five-Year Plan for National Economic and Social Development	Strategic Planning, policy support
2004	NDRC issues Medium- and Long Term Plan of Energy Conservation (approved by State Council)	
2004	State Development and Reform Commission and the MOFCOM issue 'Catalogue for The Guidance Of Foreign Investment Industries (Amended In 2004) (Solar energy is listed as foreign investment industry)'	Fiscal/financial incentives
2005	Standing Committee of NPC issues "Renewable Energy Law', which represents a landmark policy and outlines mid-range policy goals of the government surrounding renewable energy. It provides only general guidance and so does not set prices.	
2005	NDRC approves 'Circular on Printing And Distributing Catalog For The Guidance Of The Industrial Development Of Renewable Energy' with instructions for lower level bureaucracies on how to implement Renewable Energy Law	Policy Support

2005	State Council issues 'Temporary Provisions On Promoting Industrial Structure Adjustment', which states "we shall actively support and develop new energy and renewable energy industries, encourage the development and utilization of substitute resources for petroleum and clean energy, and actively propel the industrialization of clean coal technology, and speed up the development of wind power, solar energy, and biomass energy, etc."	
2005	Eleventh Five-Year Plan for Science and Technology Development	Strategic Planning, Policy Support
2005	Village Program (2005-2010) (Brightness Program Phase 2)	Policy Support, RD&D, Research program, Technology deployment and diffusion
2006	Outline of National Medium- and Long-term Science and Technology Development Plan (2006-2020)	
2006	NDRC issues 11th FYP (2006-2010) contains a number of measures designed to increase the share of renewable energy in Chinas energy portfolio.	
2006	Eleventh FYP sets renewable energy targets: increase the share of energy from renewable sources in the total primary energy consumption to 15% by 2020, up from 7.5% in 2005	
2006	Mid- and Long-term Development Plan for Science and Technology	Policy Support, Strategic planning
2006	Interim Measures on Pricing and Cost Sharing for Renewable Energy Power Generation	Fiscal/financial incentives
2006	Interim Measures on the Renewable Energy Development Special Fund	
2007	Measures on Grid Company Full Purchase of Electricity from Renewable Energy	
2007	Interim Measures on Revenue Allocation from Renewable Surcharges	
2007	National Climate Change Program	Policy Support, Strategic planning
2007	Energy Conservation Law	Policy Support
2007	NDRC releases 'Medium and Long-term Plan for Renewable Energies' which establishes targets for the development of various sources of renewable energy up to 2020, calling for the percentage of renewable energy to rise to 10% of total energy consumption by 2010 and 15% by 2020. An investment of CNY 2 trillion (approximately USD 263 billion) before 2020 on renewable energy development in China is envisaged to reach this goal. By 2020, the plan calls for the development of a total of: -1800 MW of solar power . In addition, the plan generally establishes that the government will adopt a variety	Policy Support, Strategic planning

	of measures to encourage and stimulate the development and use of renewable energy. These include preferential financial and tax policies, including specialized funds subsidizing the development of renewable energy sources, and the reduction or elimination of taxes for certain qualified renewable energy development activities.	
2007	White Paper on Energy	
2007	Amendment of the 2003 Preferential Tax Policies for Renewable Energy, which proposes a series of preferential tax policies to encourage the development of energy conservation and renewable energy. The new incentives include income tax cuts for the producers and consumers of renewable energy, as well as a reduction of the import tax for "green" equipment	Fiscal/financial incentives
2007	Notice of Requirements on the Buildings of Large Scale Grid-connected PV Project	
2008	Utility scale PV promotion through NEA	
2008	NDRC and MOST initiate the International Science and Technology Cooperation Program in Renewable Energy to boost Chinese technological development. The program aims to introduce cutting-edge technologies in the national market, attract overseas scientists and develop exchange programs with international research centers. In 2010, slightly more than 103 agreements on technology sharing, transfer and trading were concluded with 97 countries. Specific attention is devoted to research in the fields of solar power generation and solar powered building structures, among others.	Information and Education, Information provision, Economic Instruments, Fiscal/financial incentives, Grants and subsidies, RD&D, RD&D, Research program

Overview of Selected Solar Policies from 2009-2013

Year	Issuing Authority and Policy	Category
2009	State Council releases “Renewable Energy Law amendments”, which: legally binds electricity grid companies to buy the whole renewable electricity generation and guarantees priority power dispatching to power produced from renewable sources. Grid compani are simultaneously expected to improve transmitting technologies and enhance grid capacity to further facilit the integration of electricity from renewable sources. In case of non-compliance with the imposed electricity purchasing mandate, the regulation initiates a penalty system. Responsive companies are required to pay a fin an amount equal to double the economic lost undergone renewable electricity producers. Second, the amendmen entitles the State Council energy and finance departmen in collaboration with the state power regulatory agency, with the design of annual renewable energy power generation targets. Third, the amendment to the 2006	Research, Development and Deployment (RD&D), Research program, Technology deployment and diffusion, Policy Support, Institutional creation, Economic Instruments, Direct investment, Economic Instruments, Direct investment, Infrastructure investments

	Renewable Energy Law initiates the Special Fund for Renewable Energy that will finance research and development and support mini and off-grid renewable electricity generation projects in rural and remote areas. addition, the Special fund will act as a central mechanisı allocating government funding and redistributing the Renewable Energy Premium, a subsidy set up in 2006 tc balance the extra cost of integrating renewable-sourced power.	
2009	Renewable Electricity Surcharge (amended in 2011 and 2013)	Economic Instruments, Fiscal/financial incentives, Feed-in tariffs/premiums
2009	NDRC releases Golden Sun Program (revised 2011): The 2009 Golden Sun Program provides subsidies to grid connected and off-grid solar PV power generation projects and calls for 500 MW of installed PV capacity by 2012 China-wide. Subsidy schemes have been designed both at the national and provincial levels and apply to 2011. At the national level, developers of off-grid PV systems are eligible for a subsidy covering 70% of the installation cost. Grid-connected projects of a 300 kW minimum peak capacity are eligible for a subsidy covering 50% of the cost of installation, transmission and distribution of generated electricity. The subsidy is applicable to a maximum installed capacity of 20MW in each given Province. Developers must make sure that the solar plant components-panels, batteries, invertors- are certified by authorized institutions and that the whole PV system meets the requirements issued by the National Grid Company to benefit from such financial support. At the provincial level, the Program expects each Province to set up preferential tariffs for PV generated electricity individually. To date, Zheijiang and Jiangsu are the only two provinces doted with a tariff policy. Moreover, the Golden Sun project reforms the solar electricity market structure. Access to state-owned concessions is now submitted to a competitive bidding process in which the best offer determines the approved price levels.	Economic Instruments, Fiscal/financial incentives, Grants and subsidies
2010	Building Integrate Solar PV Program	Economic Instruments, Fiscal/financial incentives, Feed-in tariffs/premiums

2011	NDRC releases "Solar PV feed-in tariff": As of July 2011, non-tendered solar PV projects set up in China will be able to apply for a benchmark feed-in tariff. In Notice 1594 of July 2011, the National Development and Reform Commissions (NDRC) guarantees solar PV projects approved before July 1st, 2011 and put in operation by December 31st of the same year, with a 1.15 CNY/kWh tariff (18 USD cent equivalent). This tariff also applies to solar PV projects situated in Tibet and approved on July 1st or afterwards and approved before July 1st but not in operation by December 31st 2011. For solar PV projects in other regions, a CNY 1/kWh (USD cent equivalent) tariff will apply. For solar PV projects approved through concessionary bidding, the applying bidding price can not be higher than the above mentioned benchmark feed-in tariff for solar PV. All tariffs will be adjusted periodically by the NDRC in accordance with future investment, cost changes and technological advancement.	Economic Instruments, Fiscal/financial incentives, Feed-in tariffs/premiums
2011	The Twelfth Five-Year Plan for National Economic and Social Development	Policy Support, Strategic planning
2011	Beijing Municipality releases "The Twelfth Five-Year Plan for Renewable Energy of Beijing"	Policy Support, Strategic planning
2011	MOF releases Amendments to Golden Sun Tariffs: In June 2011, the Chinese Ministry of Finance adjusted the solar PV subsidy framework under the Golden Sun Program. Instead of subsidizing 50% of the cost of installation, transmission and distribution of generated electricity in grid-connected PV projects, the new rule includes a fixed tariff. Polysilicon-based modules will receive a subsidy of CNY 9/W (USD 1.40) and thin-film modules of CNY 8/W (USD 1.24)	
2012	MoF; MOST; NEA release "Golden Sun" demonstration project 2012: The "Golden Sun" program was established in July 2009 and announced by the Ministry of Finance, Ministry of Science and Technology and the National Energy Administration of the National Development and Reform Commission (NDRC). The Golden Sun Program 2012 announced the demonstration projects approved in this year.	Policy Support, Research, Development and Deployment (RD&D), Research Program, Technology deployment and diffusion
2012	NEA release the 12th FYP for Renewable Energy: According to The Twelfth Five-Year Plan for Renewable Energy, the total consumption of renewable energy will reach 478 Mtce by the end of	Policy Support, Strategic planning, Regulatory Instruments

	2015, what accounts for 9.5% of the total energy consumption. Also development indicators for different types of renewable energy are outlined: the installed capacity of hydropower will reach 290 GW, including 260 GW conventional hydropower and 30 GW pumped storage power station; grid-connected wind power will reach 100 GW, including 5 GW offshore wind power; solar power 21 GW, solar thermal 400 million square meters; biomass 50 Mtce per year; geothermal energy 15 Mtce; ocean energy 50,000 KW.	
2012	MIIT releases "Solar Industry 12th Five Year Development Planning": According to the industry plan announced by the ministry, the country will reduce the cost of solar power to CNY 0.8 per KWh by 2015 and CNY 0.6 per KWh by 2020 and increase production of solar panels. The plan requires China's leading polysilicon manufacturers to reach annual production capacity of 50,000 tons by 2015. Solar panel makers will have to reach 5GW annual production capacity by the same year. China will put more effort into the production technology for BIPV in the coming years. According to the plan, China aims to increase the conversion efficiency of monocrystalline silicon solar cells to 21%, polysilicon cells to 19%and amorphous silicon cells to 12% by 2015 Above was established in Feb 2012 and announced by Ministry of industry and Information Technology	Policy Support, Policy Support, Strategic planning, Regulatory Instruments
2012	MOF, NDRC, NEA release "Interim Measures on Renewable energy development fund Imposition and Management": Policy outlines funding measures, management, supervision and inspection mechanism of Renewable Energy Development Fund. Scheme will continue to support scientific and technological research. Additionally, it will also finance a pilot project for exploiting renewable energy, construction of renewable energy projects for domestic use in rural areas as well as independent power systems in remote areas and islands, localized equipment production and exploiting renewable energy, among other projects, says the draft amendment.	Economic Instruments, Fiscal/financial incentives, Grants and subsidies
2012	State Council releases 12th Five Year Plan for National Strategic Emerging Industries: In July 2012 the 12th Five Year Plan for National Strategic Emerging Industries for China has been announced by the State Council. The plan sets a goal to further	Policy Support, Policy Support, Strategic planning, Regulatory Instruments

	develop new energy technologies such as: nuclear power, wind, solar PV, geothermal, biomass electricity generation and methane gas in order to actively advance the industrialization of renewable resource technology. Multiple goals have been established: Solar industry: Draft and implement standards and regulations overseeing solar power and solar heat utilization; Establish efficient grid operation and management mechanism for distributed power generation for solar photovoltaic technologies and suitable pricing mechanism.	
2012	MoF, NDRC, NEA release 2012 Renewable Energy Electricity feed-in tariff: To promote renewable energy development and utilization of the specification renewable energy tariff surcharge fund management, improve capital efficiency. Renewable energy power generation projects connected to the grid system occurred in project investment and operation and maintenance costs, according to Internet power to grant appropriate subsidies: less than 50 kilometers per kWh 1 cent, 50-100 km 2 cents per kilowatt-hour, 100 km and more than 3 cents per kilowatt-hour. Investment or subsidies for the construction of public renewable energy independent power systems, perform the same geographical segment sales price, its reasonable operating and management costs beyond the part of the sales price by renewable energy power Price additional to provide appropriate subsidies, subsidy standards is tentatively set at CNY 4,000 CNY/kW per year.	Economic Instruments, Fiscal/financial incentives, Feed-in tariffs/premiums
2012	MoF, NDRC, NEA release “The Renewable Energy Tariff Surcharge Grant Funds Management Approach”: To promote renewable energy development and utilization of the specification renewable energy tariff surcharge fund management, improve capital efficiency. Renewable energy power generation projects connected to the grid system occurred in project investment and operation and maintenance costs, according to Internet power to grant appropriate subsidies: less than 50 kilometers per kWh 1 cent, 50-100 km 2 cents per kilowatt-hour, 100 km and more than 3 cents per kilowatt-hour.	Economic Instruments, Fiscal/financial incentives, Feed-in tariffs/premiums

	Investment or subsidies for the construction of public renewable energy independent power systems, perform the same geographical segment sales price, its reasonable operating and management costs beyond the part of the sales price by renewable energy power Price additional to provide appropriate subsidies, subsidy standards is tentatively set at CNY 4,000 CNY/kW per year.	
2012	MOST releases "Solar Power Technology Development 12th Five Year Special Plan": Solar Power Technology Development 12th Five Year Special Plan aims to increase China's solar large scale production and to lower costs of electricity generation from solar installation so they will be competitive with conventional power production. Planning underlines importance of further technology research on crystalline silicon cells, thin film batteries and new types of batteries to be developed by 2015. The goal is to increase energy efficiency of: • crystalline silicon cells by 20% • silicon thin-film cell efficiency above 10%, and • cadmium telluride, copper indium gallium selenide thin-film batteries to the level of commercial application; Currently, a cost of electricity generation from grid-connected PV systems is CNY 1.2-1.3 per KWh. It is planned to lower this costs to CNY 1.2-1.3 per KWh or less. Further goals for reduction of production costs: • polysilicon materials by 30%, • supporting materials by 50% In order to ensure smooth implementation of decisions embodied in the planning as well as to reach established goals and targets, the Ministry of Science and Technology will take steps to encourage investments as well as inform clearly interested parties on available in China financial and fiscal incentives. The Ministry will act to solve major technical problems in the industrial development, and to break a monopoly of foreign technologies protectionist behaviour of the PV markets	Policy Support, Policy Support, Institutional creation, Regulatory Instruments
2012	NEA releases "Notice on New Energy Demonstration City and Industrial Park": China plans to construct demonstration city relaying extensively on renewable energy sources for heating and electricity needs. Project will be backed with financial support from governmental budget. In order to facilitate and	Policy Support, Policy Support, Strategic planning, Regulatory Instruments, Policy Support, Institutional creation

	manage the project New Energy Demonstration City Fund will be created. In order to benefit from the support from the Fund, renewable energy consumption of projects must be higher than 3% of total energy demand. There are detailed specifications and requirements for the utilization of wind, solar, biomass and geothermal that were established by the National Energy Administration in May 2012.	
2012	State Council releases "China's Energy Policy 2012": Actively making use of solar energy. China is rich in solar energy, which boasts immense room for development and has a promising future. During the 12th Five-Year Plan period, China will promote diverse patterns of solar-power development by integrating intensive exploitation with distributed utilization. It will construct large on-grid photovoltaic power stations and solar power generation projects in Qinghai and Gansu provinces, and the Xinjiang Uygur and Inner Mongolia autonomous regions, which boast abundant solar energy and scattered plots of unutilized land, for the purpose of increasing local supplies of electricity. It will encourage the central and eastern regions to construct distributed photovoltaic power generation systems linked to local buildings. Intensified efforts will be made to popularize solar water heaters, and promote the development of solar central hot-water supply, solar heating and cooling, and medium- and high-temperature industrial applications of solar energy. It will spread solar water heaters, solar cookers and solar houses in the countryside, border areas, and small cities and towns. China's installed generating capacity of solar energy is expected to exceed 21 million kw by 2015, with a total solar heat collection area of 400 million sq m.	
2012	State Council releases "China Energy White Paper 2012": The China Energy White Paper was announced in October 2012. The Paper is a strategy document identifying problems in Chinese energy sector and providing plan to further develop its energy supply system in order to meet ever growing energy demand. The White Paper consists of nine chapters. Chapter number four is devoted to the new and renewable energy development. Target: China plans to increase the share of non-fossil fuels in primary energy consumption to 11.4 % and increase	Policy Support, Regulatory Instruments, Policy Support, Strategic planning

	that of installed generating capacity from non-fossil fuels to 30 % by the end of 2015. Vigorously developing new and renewable energy is a key strategic measure for promoting the diversified and clean energy development and for fostering new strategic industries, China will actively develop hydropower, solar power and wind power generation, seek safe and efficient ways of developing nuclear power, as well as utilize biomass energy and other types of renewable energy. China aims to large on-grid photovoltaic power stations and solar power generation projects in Qinghai and Gansu provinces, and the Xinjiang Uygur and Inner Mongolia autonomous regions, which boast abundant solar energy and scattered plots of unutilized land, for the purpose of increasing local supplies of electricity. By 2015, the nation is aiming to establish a total of 200 green-energy counties and 1,000 villages using solar energy as demonstrations. (http://www.iea.org/media/pams/china/ChinaEnergyWhitePaper2012.pdf)	
2012	Interim Measure of Distributed Solar Power Generation On-grid Service Agreement: Target: China plans to increase installed generation capacity for solar power to over 21GW by 2015. State Grid Cooperation for China (SGCC) announced a plan to allow small-scale distributed solar power generators to connect to its power lines and allow solar power generators with less than 6 MW of installed capacity and lower than 10,000 kV to be connected to the grid. SGCC will also provide technological assistance and waive charges associated with connecting to the grid, Distributed solar power generation will allow the industry to develop, as long as the grid-connection problems can be solved was established on Oct 2012 by State Grid.	Policy Support, Policy Support, Strategic planning, Regulatory Instruments
2012	NEA releases “The Notice on the Establishment of Demonstration Areas for Large-Scale distributed solar PV Power Generation”: The Notice mandates provinces to establish demonstration areas for large-scale distributed solar photovoltaic installations in order to further upscale solar generation and utilization in China. Provinces are obliged to select urban area and create large-scale deployment of solar technologies Program for their territory. The generation capacity of solar installation should fully meet power demand of the	Policy Support>Strategic planning, Policy Support, Regulatory Instruments

	selected area. Smart-grid technologies should be encouraged. The Notice implements standards for subsidy creation for self-generation systems and for net metering mechanism. Grid companies will be responsible for metering calculation and subsidiary payments. Each province can establish maximum of three demonstration areas within its territory. Installed generation capacity per province can not exceed more than 500MW of generation capacity from demonstration all demonstration areas combined over a period of next five years (2012 - 2017).	
2013	NEA releases The Interim Measures for the management of photovoltaic power plant project: Regarding plan guidance and scale management, State Council authorities in charge of energy determine the scale and layout of photovoltaic power plant construction on the national level, and annual development scales on the province (autonomous region and municipality) level with reference to national energy development plans, renewable energy development plans, and argumentation of solar power resources in regions, economics of the photovoltaic power plant technology, electricity demand, and grid conditions, etc. Regarding project record management, works e.g. location planning, resource evaluation, construction condition argumentation, and market demand analysis, are required before the building of new PV power plants.	Policy Support, Institutional creation
2013	NEA releases Comments on support of PV power financial services: In order to maximize leverage to effectively stimulate distributed photovoltaic investments made this comment. Country opened line support various to "self-use priority surplus goes grid national grid control" method for construction and operations of distributed PV power project, established and place cooperation of voted financing institutions, special for distributed PV power project provides financial service; country opened line to financing platform provides award letter, financing platform to commissioned loan, effective of funds operation way, to meet conditions of object provides financing support; country opened behaviour distributed PV power project to provides medium-and long-term loan mainly, and Short term loans and working capital loan, supplemented by a wide range of credit products, loan term of up to 15 years for key	Policy Support, Institutional creation

	clients to invest in the project and the national planning and construction of the demonstration project may apply differential pricing	
2013	NDRC releases Feed-in tariff support for solar PV: The National Development and Reform Commission has set the benchmark on-grid power tariff at CNY 0.9, CNY 0.95 and CNY 1 per kwh according to the solar power resources and construction costs in different resources zones nationwide. Distributed PV power generation projects will be given a standard subsidy of CNY 0.42 per kwh. The feed-in tariff support is granted for period of 20 years. Tariffs for the new PV installations will be gradually lowered over the time in order to promote technology development, technology efficiency and competitiveness of the PV sector.	Economic Instruments, Fiscal/financial incentives, Feed-in tariffs/premiums
2013	NEA's Notice on the development of construction of distributed PV power grid demonstration park: For the expansion of distributed PV Application market, according to the relevant provincial (district, municipal) submitted to the demonstration area implementation plan, identified a first list of distributed PV demonstration area. The 18 demonstration areas Are: Beijing Haidian District, Zhongguangcun Haidian Park, Shunyi of Beijing, Songjiang (Shanghai), Wuqing (Tianjin), Gaobeidian (Hebei), Yingli Corporation in Baoding (Hebei), Wixu (Jiangsu), Nantong (Jiangsu), Shaoxing (Zhejiang), Hangzhou (Zhejiang), Hefei (Anhui), Xinyu High-End and Newly-Developing Technology Park (Jiangki), Taian Technology Park (Shandong), Zibo technology Park (Shandong), Sanshui Industry Park (Guangdong), Conghuamingzhu Industry Park (Guangdong), Conghuamingzhu industry Park (Guangdong), ShenzhenQianhai (Guangdong), and Hangzhou Bay New District (Ningbo).	Policy Support
2013	NEA releases "The Notice of further improvement of New Energy Demonstration implementation": National Energy Administration (NEA) is responsible for formation of assessment criteria, planning guiding, evaluation and acceptance management. Provincial energy department is responsible for city initial assessment, and then make the short list of applicant. Municipal energy authority is	Policy Support, Policy Support, Strategic planning, Regulatory Instruments

	responsible for project organization and implementation. NEA also divided 100 demonstration cities quota into each province. NEA also encouraged the qualified city or interested city to apply for new energy demonstration zone.	
2013	NDRC releases "Interim procedures of the management of distributed power grid": Method" exempted distributed power generation projects electricity generation business license, encourage enterprises, professional Energy Service Companies and including individuals, all kinds of electric power customer investment in building and operating distributed generation projects. For distributed power generation, power grid enterprises should be based on the access mode, power range, provide grid services and efficiency. "Approach" that, given the construction funds subsidies or subsidies for distributed power generation unit generating capacity to meet the conditions, construction funds subsidies are limited to the scope of the power universal service.	Policy Support, Institutional creation, Economic Instruments, Fiscal/financial incentives, Grants and subsidies
2013	State Council releases "Comments on promoting the development of the PV industry: In order to deal with the current problems the PV industry is facing, and further regulate and promote the healthy and sustainable development of this industry, a target that an average annual increase of approximately 10 million kilowatts in PV power installed capacity during 2013-2015 with a total PV power installed capacity being more than 35 million kilowatts in 2015 is developed. Opinions on how to regulate industrial development order, to improve the management and service of grid connection, to strengthen organizational leadership, etc are specified in this file.	Policy Support, Strategic planning
2013	MIIT releases "Code of practice of the PV manufacturing": In order to lead to the accelerating improvement in the PV manufacturing industry, make sure the PV industry in China grow constantly, this regulation is made according to the principle of improve structure, quantity control, innovation first, application first. The establishment of the production, distribution and project photovoltaic manufacturing industry production scale and technology and comprehensive utilization of resources, etc. to make the provisions.	Regulatory Instruments>Codes and standards
2013	NDRC releases Notice on promotion of PV industry by expert the price leverage effect: In order to	Economic Instruments>Fiscal/financial

	promote the development and utilization of renewable energy, since September 25, 2013, to other electricity levy charge renewable energy tariff except for residents living and agricultural production to 1.5 cents / kwh.	incentives>Grants and subsidies
2013	MOF releases “Notice on the policy of PV electricity VAT” In order to encourage the use of solar power, and promote the healthy development of related industries, MOF develop photovoltaic power generation value-added tax policy. From October 1, 2013 to December 31, 2015, 50% VAT will be refunded to the user of self-used solar power.	Economic Instruments, Fiscal/financial incentives, Tax relief
2013	NDRC releases “Adjustments of surcharge of renewable electricity generation”: From 25 September 2013, the surcharge for the renewable electricity generation is increased from CNY 0.008/kWh to CNY 0.015/ kWh. Upgraded subside for coal-fired plants with technology to lower emissions of nitrogen oxide from CNY 0.008/kWh to CNY 0.01/ kWh.	Economic Instruments; Fiscal/financial incentives; Feed-in tariffs/premiums, Economic Instruments; Fiscal/financial incentives
2013	NDRC releases “Feed-in tariff support for solar PV”: The National Development and Reform Commission has set the benchmark on-grid power tariff at CNY 0.9, CNY 0.95 and CNY 1 per kwh according to the solar power resources and construction costs in different resources zones nationwide. Distributed PV power generation projects will be given a standard subsidy of CNY 0.42 per kwh. The feed-in tariff support is granted for period of 20 years. Tariffs for the new PV installations will be gradually lowered over the time in order to promote technology development, technology efficiency and competitiveness of the PV sector.	Economic Instruments>Fiscal/financial incentives>Feed-in tariffs/premiums
2013	China Southern Power Grid releases “Distributed photovoltaic generation service guide of China Southern Power Grid Company Limited (interim)”: In order to strengthen services for distributed solar power projects and promote orderly development of photovoltaic industry coordinating, enactment of this service guide. Guide distributed in photovoltaic grid-connected applications, program formulation and review, engineering design and construction of access systems and network elements such as settlement and subsidies to pay details.	Policy Support; Institutional creation, Regulatory Instruments; Codes and standards; Product standards

Annex IX: Review of Recent Scholarly Work on Solar Policies in China

Title	Year	Author
Current status of distributed energy system in China	2016	Han, J. ; Ouyang, L. ; Xu, Y. ; Zeng, R. ; Kang, S. ; Zhang, G.
How will diffusion of PV solar contribute to China's emissions-peaking and climate responses?	2016	Duan, Hong-Bo ; Zhang, Gu-Peng ; Zhu, Lei ; Fan, Ying ; Wang, Shou-Yang
China's photovoltaic power development under policy incentives: A system dynamics analysis	2015	Guo, Xiaodan ; Guo, Xiaopeng
China's path to innovation	2015	Xiaolan Fu
Cultural factors influencing domestic adoption of solar photovoltaic technology: perspectives from China	2015	Liu, Xiangrong ; Sun, Yaqin ; Kaloustian, Talar S.
Distributed solar photovoltaics in China: Policies and economic performance	2015	Zhao, Xingang ; Zeng, Yiping ; Zhao, Di
Overview of the photovoltaic technology status and perspective in China	2015	Song, Dongdong ; Jiao, Hongtao ; Fan, Chien Te
Powering China's Sustainable Development with Renewable Energies: Current Status and Future Trend	2015	Jia, Yw ; Gao, Y ; Xu, Z ; Wong, Kp ; Lai, Ll ; Xue, Ys ; Dong, Zy ; Hill, Dj
Is the "Sun" still hot in China? The study of the present situation, problems and trends of the photovoltaic industry in China.(Report)	2015	Ming, Zeng ; Shaojie, Ouyang ; Hui, Shi ; Yujian, Ge
Scientific relatedness in solar energy: a comparative study between the USA and China	2015	Zhang, Jingjing ; Yan, Yan ; Guan, Jiancheng
Distributed solar photovoltaics in China: Policies and economic performance	2015	Zhao, Xingang ; Zeng, Yiping ; Zhao, Di
From mercantile strategy to domestic demand stimulation: changes in China's solar PV subsidies	2015	Chen, Gang
Examining Solar Energy Policy in China and India.: A Comparative Study on the Potential for Energy Security and Sustainable Development	2015	Kok, Sarah ; Swain, Ashok ; Gallardo, Gloria ; Rönnbäck, Patrik;
Wind and solar power in Brazil and China: Interests, state–business relations, and policy outcomes	2015	Hochstetler, Kathryn ; Kostka, Genia
Analysis of Distributed-Generation Photovoltaic Deployment, Installation Time and Cost, Market Barriers, and Policies in China	2015	Zhang, F.; Deng, H.; Margolis, R.; Su, J.
A real option model for renewable energy policy evaluation with application to solar PV power generation in China	2014	Zhang, Mingming ; Zhou, Dequn ; Zhou, Peng

The economy of distributed PV in China	2014	Yuan, Jiahai ; Sun, Shenghui ; Zhang, Wenhua ; Xiong, Minpeng
China's solar photovoltaic policy: An analysis based on policy instruments	2014b	Zhi, Qiang ; Sun, Honghang ; Li, Yanxi ; Xu, Yurui ; Su, Jun
The erratic path of the low-carbon transition in China: Evolution of solar PV policy	2014	Zhang, Sufang ; Andrews-Speed, Philip ; Ji, Meiyun
Renewable energy policy Comparison between EU and China - An empirical analysis with experience curve on EU and Chinese Solar industry	2014	Gao, Jiabin; Sand, Jan Yngve
China's solar photovoltaic industry development: The status quo, problems and approaches	2014	Sun, Honghang ; Zhi, Qiang ; Wang, Yibo ; Yao, Qiang ; Su, Jun
Impacts of public policies on China's solar photovoltaics industry	2014	Yu, Yunwen;
Solar photovoltaic energy policy and globalization: A multiperspective approach with case studies of Germany, Japan, and China	2014	Yu, Hyun Jin Julie ; Popiolek, Nathalie ; Yu, Hyun Jin Julie ; Geoffron, Patrice
A real option model for renewable energy policy evaluation with application to solar PV power generation in China	2014	Zhang, Mingming ; Zhou, Dequn ; Zhou, Peng ; Zhang, Mingming ; Zhou, Dequn ; Zhou, Peng
Diverse and uneven pathways towards transition to low carbon development: The case of diffusion of solar PV technology in China	2014	Iizuka, Michiko
Interactions between renewable energy policy and renewable energy industrial policy: a critical analysis of China's policy approach to renewable energies	2013	Zhang, Sufang ; Andrews-Speed, Philip ; Zhao, Xiaoli ; He, Yongxiu
The Co-evolution of policy, market and industry in the solar energy sector: a dynamic analysis of technological innovation systems for solar photovoltaics in Germany and China	2013	Rainer Quitzow
Development of photovoltaic power generation in China: a transition perspective	2013	Liu and Shiroyama[800]
The development trajectories of wind power and solar PV power in China: A comparison and policy recommendations	2013	Zhang, Sufang ; Zhao, Xiaoli ; Andrews - Speed, Philip ; He, Yongxiu
Overall review of renewable energy tariff policy in China: Evolution,	2013	Ming, Zeng ; Ximei, Liu ; Na, Li ; Song, Xue

[800] Liu, D., & Shiroyama, H. (2013). Development of photovoltaic power generation in China: A transition perspective. *Renewable and Sustainable Energy Reviews*, *25*(0), 782–792. http://doi.org/http://dx.doi.org/10.1016/j.rser.2013.05.014.

implementation, problems and countermeasures		
Development of photovoltaic power generation in China: A transition perspective	2013	Liu, Dawei ; Shiroyama, Hideaki
	2013	Liu and Goldstein[801]
Analysis on the development and policy of solar PV power in China	2013	Zhang, Sufang; He, Yongxiu
The emergence of the solar photovoltaic power industry in China (Report)	2013	Zhao, Zhen - Yu ; Zhang, Shuang - Ying ; Hubbard, Bryan ; Yao, Xue
The development trajectories of wind power and solar PV power in China: A comparison and policy recommendations	2013	Zhang, Sufang ; Zhao, Xiaoli ; Andrews-Speed, Philip ; He, Yongxiu
China Solar PV Power Policy Report: Differential Feed-in Tariffs (in Chinese)	2013	Li et al.[802]
Overall review of renewable energy tariff policy in China: Evolution, implementation, problems and countermeasures	2013	Ming , Zeng ; Ximei , Liu ; Na , Li ; Song , Xue
	2013	Lv et al.,[803]
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New energy bases and sustainable development in China: A review	2013	Ming, Zeng ; Song, Xue ; Mingjuan, Ma ; Xiaoli, Zhu
Rural electrification program with renewable energy sources: An analysis of China's Township Electrification Program	2012	Chian-Woei Shyu
The Co-evolution of policy, market and industry in the solar energy sector: a dynamic analysis of technological innovation systems for solar photovoltaics in Germany and China		
China's Energy Reform and Climate Policy: The Ideas Motivating Change	2012	Boyd, Olivia
Economical assessment of large-scale photovoltaic power development in China (Report)	2012	Zhang, Da ; Chai, Qimin ; Zhang, Xiliang ; He, Jiankun ; Yue, Li ; Dong, Xiufen ; Wu, Shu

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Rural electrification program with renewable energy sources: an analysis of China's Township Electrification Program	2012	Shyu[806]
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Technology transfer, indigenous innovation and leapfrogging in green technology: the solar-PV industry in China and India	2011	Fu, Xiaolan ; Zhang, Jing
Economic Impact of the Photovoltaic Industry in China After the Financial Crisis of 2009	2011	Ng, Mark
The analysis on photovoltaic electricity generation status, potential and policies of the leading countries in solar energy	2011	Dincer, Furkan
Solar industry development and policy support in China	2011	Zhong, Shuiying ; Liu, Chi ; Liu, Chi ; Qin, Liqiong
Present status and prospects of photovoltaic market in China	2011	Zhao et al.,[807]
The present status and future of photovoltaic in China	2011	Zhao, Ruirui ; Shi, Guang ; Chen, Hongyu ; Ren, Anfu ; Finlow, David
	2011	Yuan and Zuo
Energy policies for sustainable livelihoods and sustainable development of poor areas in China	2011	Fan, Jie ; Liang, Yu-tian ; Tao, An-jun ; Sheng, Ke-rong ; Ma, Hai-Long ; Xu, Yong ; Wang, Chuan-Sheng ; Sun, Wei
Solar Industry Development and Policy Support in China	2011	Shuiying, Zhong ; Chi, Liu ; Liqiong, Qin
China rationalizes its renewable energy policy	2010	Su, Jack H. ; Hui, Simone S. ; Tsen, Kevin H.

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Effective policies for renewable energy—the example of China's wind power—lessons for China's photovoltaic power	2010	Wang, Qiang
Cost and optimal feed-in tariff for small scale photovoltaic systems in China	2010	Rigter, Jasper ; Vidican, Georgeta
	2009	Liu et al.,[809]
Subsidy Policy Design for Increasing Solar Photovoltaic Installed Capacity in China -A System Dynamics Based Study	2009	Yan, Hai Yan
The Chinese silicon photovoltaic industry and market: a critical review of trends and outlook	2007	Marigo, Nicoletta
PV status report 2009: research, solar cell production and market implementation of photovoltaics.	2007	Jäger-Waldau, Arnulf

Annex X: International Collaborations on PV Deployment in China (1990-2013)

Year	Program Name	Description
1995	U.S.-China Protocol for Cooperation in the Fields of EE and RE Technology Development and Utilization	This Protocol was signed February 1995 by the U.S. Department of Energy and the State Science and Technology Commission and renewed for five years in April 2000. One of its goals is 1) to help China diversify its energy resources and thereby reduce its future demand for oil and 2) to mitigate environmental damage associated with energy consumption through deployment of RE and EE efficiency. In terms of renewable energy, particular focus is placed on (i) rural energy, (ii) business development, (iii) and policy and planning.
1996	Brightness Programm	
1997	Technology Cooperation Agreements Pilot Project (TCAPP)	CAPP is an initiative of the U.S. government aimed to assist developing countries in attracting clean energy investments that will meet their development needs and reduce GHG emissions. In 1997, TCAPP was initiated in China and launched in 1999 in collaboration with the State Development Planning Commission of China (SDPC) and the U.S. Environmental Protection Agency signed a Statement of Intent for a three-year effort (Clean Air and Clean Energy Technology Cooperation project). The National Renewable Energy Laboratory (NREL) leads the TCAPP implementation for the U.S. government and SDPC is the lead organization for this project in China. Teams have been formed to work on the following six fields: wind resource assessment; wind

[808] Liu, L. Q., Wang, Z. X., Zhang, H. Q., & Xue, Y. C. (2010). Solar energy development in China - A Review. *Renewable and Sustainable Energy Reviews*,14(1), 301-311. https://doi.org/10.1016/j.rser.2009.08.005.
[809] Ibid.

		turbine testing for certification; wind business partnerships; motors training; motor testing, labeling, standards, and certification; and motor financing and business partnerships. (www.nrel.gov/china)
1999	World Bank/Global Environmental Facility (GEF) Renewable Energy Program: China-Renewable Energy Development Project	This project aims to establish sustainable markets for wind and PV technologies so as to supply electricity in an environmentally sustainable manner and to provide modern energy to remote rural populations. The World Bank and GEF will provide $100 million and $35 million in funding, respectively. The project was approved in June 1999 and is now underway. (http://www.worldbank.org.cn/english/content/702q1225506.shtml)
1999	UNDP/GEF Capacity Building for the Rapid Commercialization of Renewable Energy Program	Launched in April 1999, this five-year program consists of capacity building, technical assistance, and technology transfer activities that address the challenges to the commercialization of renewable energy in China. It couples capacity building activities in the fields of resource assessment, standards development, and business and finance, with work in specific market sectors (bagasse, biogas, hybrid village systems, and large-scale wind). This project led to the establishment of the Chinese Renewable Energy Industries Association (CREIA). This project is jointly financed by the Chinese, Australian and Dutch governments and GEF and implemented by UNDP in partnership with the SETC and the Chinese State Environmental Protection Administration. (http://www.ccre.com.cn)
2005	World Bank China Renewable Energy Scale-Up Program (CRESP) (Phase I-III)	The objective of the CRESP program (three phases) is to enable commercial renewable electricity suppliers to provide energy to the electricity market efficiently, cost-effectively and on a large scale. CRESP Phase I: aims to create a legal, regulatory, and institutional environment conducive to large-scale, renewable- based energy generation. The first phase of the China Renewable Energy Scale-Up Program (CRESP), financed with a GEF grant of US$40.22 million and a Bank loan of US$159 million, was completed in December 2011 and made significant contributions to the scale-up of renewable energy in China and triggered government investments on a large scale during the 11th Five-Year Plan. CRESP Phase II is to support the ambitious renewable energy scale-up program in China with a focus on efficiency improvement and reduction of incremental costs. Second Phase of the Renewable Energy Scale-Up Program will support developing and implementing renewable energy legislation and policies to achieve cost reduction, efficiency improvement, and smooth grid integration. It will organize targeted studies on grid integration and grid access, and strategic and optimal deployment of key technologies to enhance efficiency and reduce costs. The project will assist in technology improvements by increasing efficiency of existing grid-connected wind and solar PV farms, and improving quality and reducing costs of new renewable energy technologies

		such as off-shore wind. It will support piloting and exploring new ideas relating to the scale-up of renewable energy and optimization of wind in the power system in Inner Mongolia, and piloting renewable energy distributed generation in selected New Energy Cities. CRESP Phase III: The objective of the program is to enable commercial renewable electricity suppliers to provide energy to the electricity market efficiently, cost-effectively, and on a large scale.
2002	Township Electrification Program	

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