NO.1 October 2022

SI: On the Road to Carbon Neutrality: Green Investment Needs in China

An Analysis of the Spatial and Temporal Distribution of Provincial Renewable Electricity Investment

Lou Jiehong, University of Maryland Center for Global Sustainability
Yu Sha, Pacific Northwest National Laboratory & University of Maryland
Adofoli Victoria, University of Maryland Center for Global Sustainability
Miller Andy, University of Maryland Center for Global Sustainability

SCHOOL OF PUBLIC POLICY
CENTER FOR GLOBAL SUSTAINABILITY
ENERGY FOUNDATION
能源基金会

NO.1 June 2022

SI: On the Road to Carbon Neutrality: Green Investment Needs in China

An Analysis of the Spatial and Temporal Distribution of Provincial Renewable Electricity Investment

Lou Jiehong, University of Maryland Center for Global Sustainability
Yu Sha, Pacific Northwest National Laboratory & University of Maryland
Adofoli Victoria, University of Maryland Center for Global Sustainability
Miller Andy, University of Maryland Center for Global Sustainability

SCHOOL OF PUBLIC POLICY
CENTER FOR GLOBAL SUSTAINABILITY

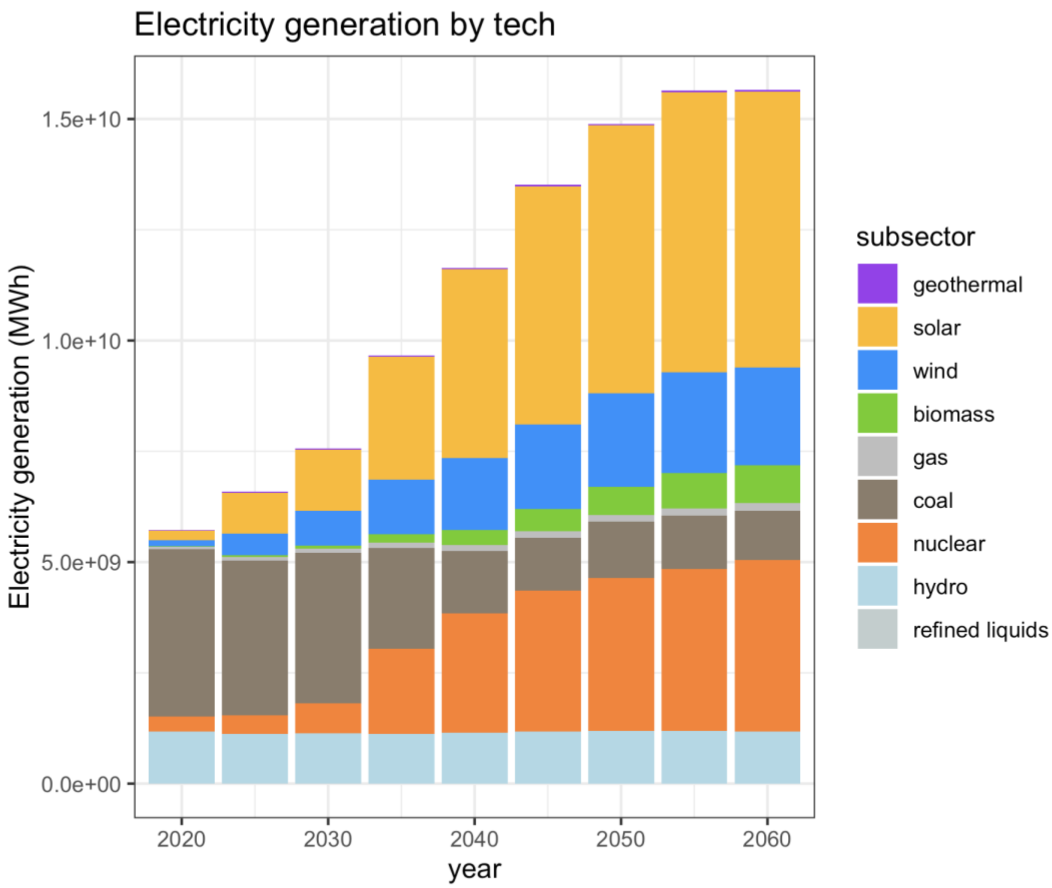
ENERGY FOUNDATION
能源基金会

TABLE OF CONTENTS

1. Figures and Tables

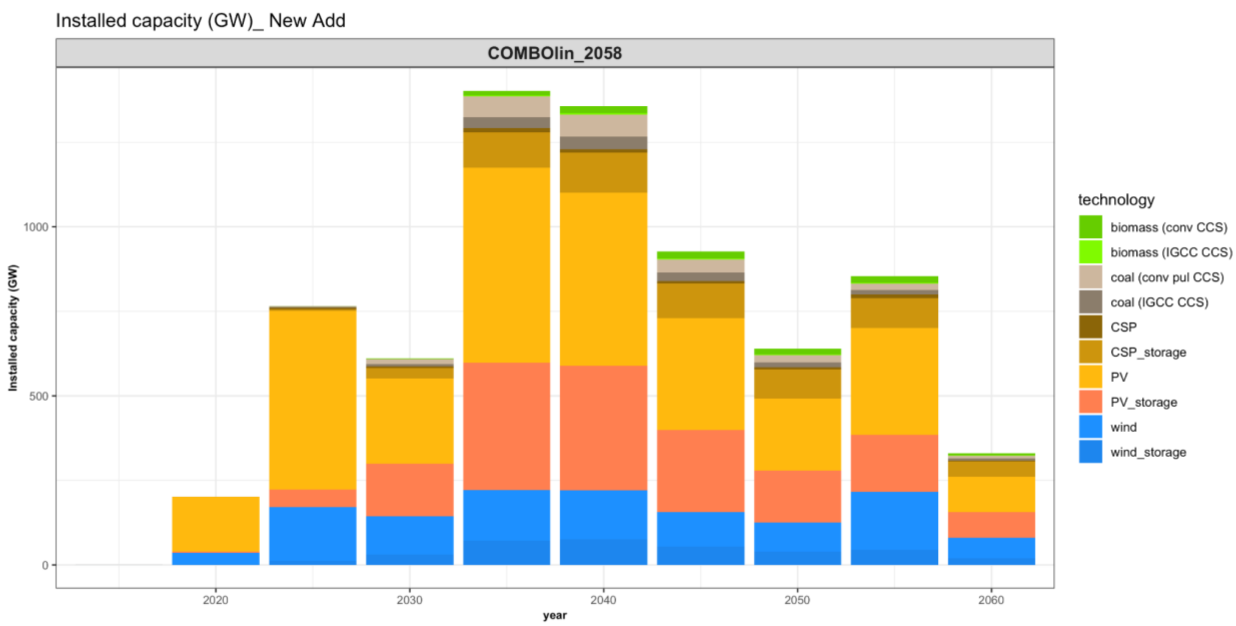
Supplemental Figure 1.

Electricity Generation by Technology (GWh)



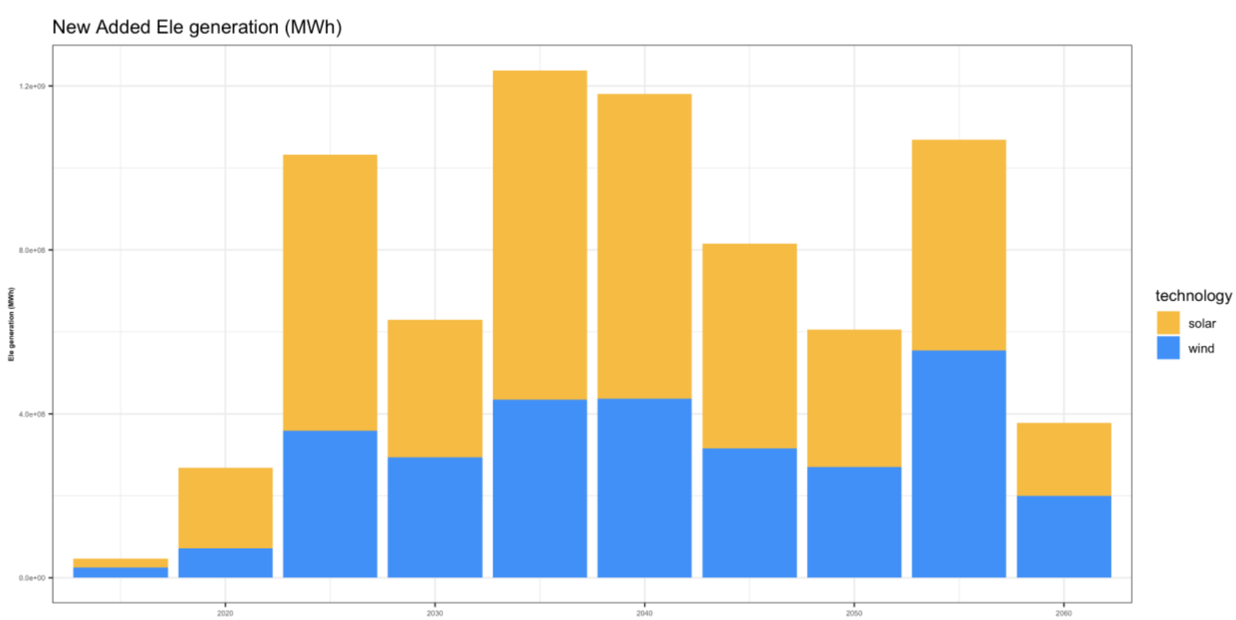
Supplemental Figure S2.

New Added Electricity Generation (MWh) by Technology.



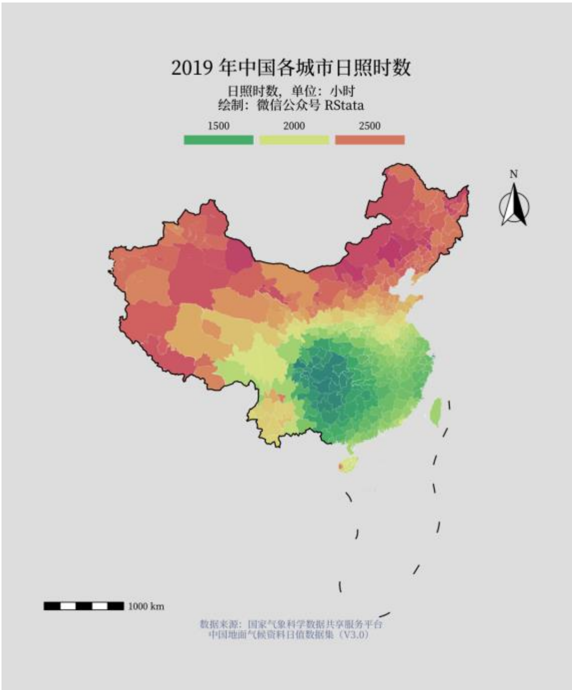
Supplemental Figure S3.

New Added Electricity Generation (MWh) from Wind and Solar.



Supplemental Figure S4.

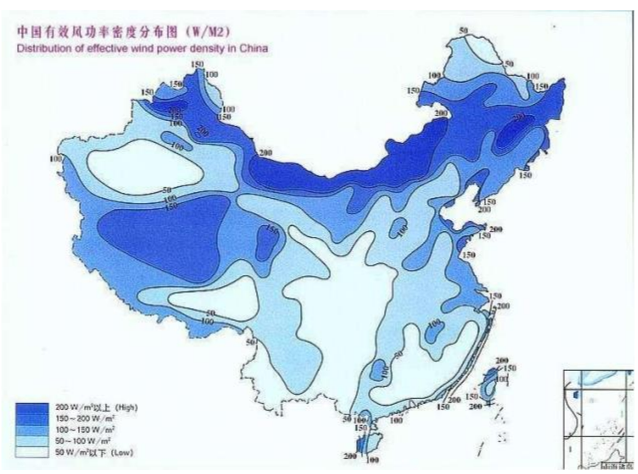
2019 Distribution of Daily Sunshine Hours in China.



Source: Hourly Data From Surface Meteorological Stations In China for each province, Chinese Meteorological Administration, https://data.cma.cn/data/index/6d1b5efbdcbf9a58.html

Supplemental Figure S5.

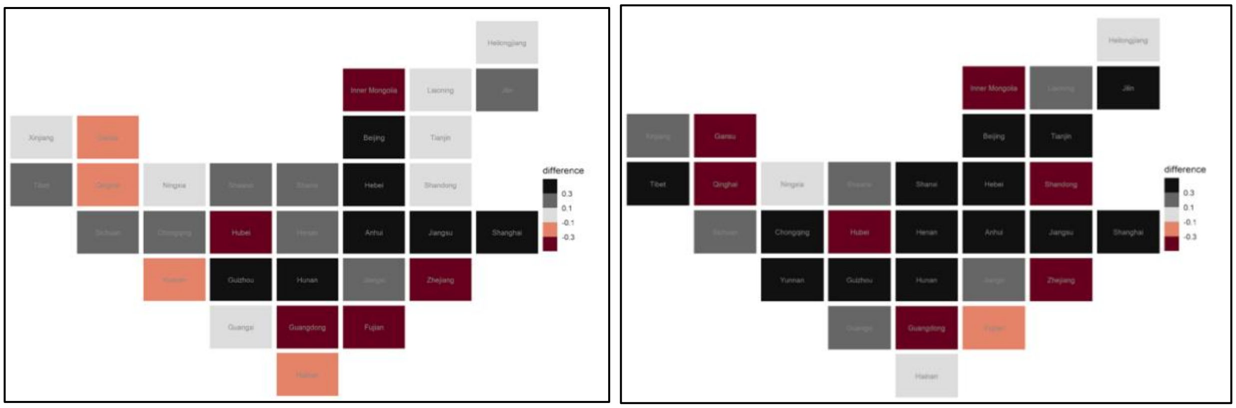
2017 Distribution of Effective Wind Power Density in China.



Source: Wind Energy Source, Chinese Meteorological Administration, http://www.xn121.com/xkp/nyqh/nyqhzy/2017/11/1890742_f_r.shtml

Supplemental Figure S6.

The Exporters and Importers Provinces of Electricity.



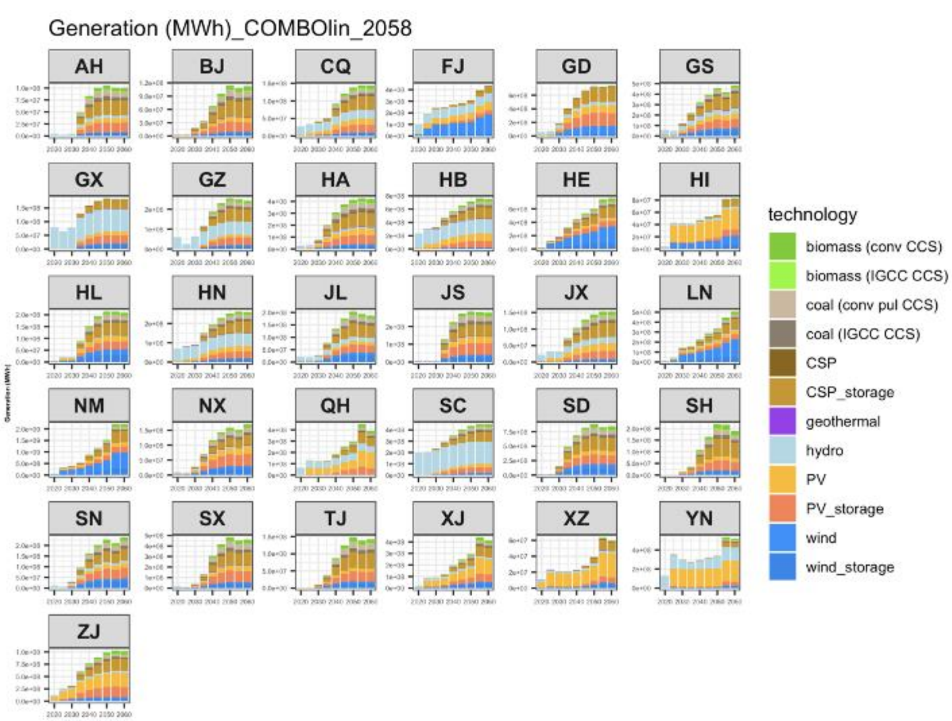
Panel A. Electricity demand and supply of year 2030

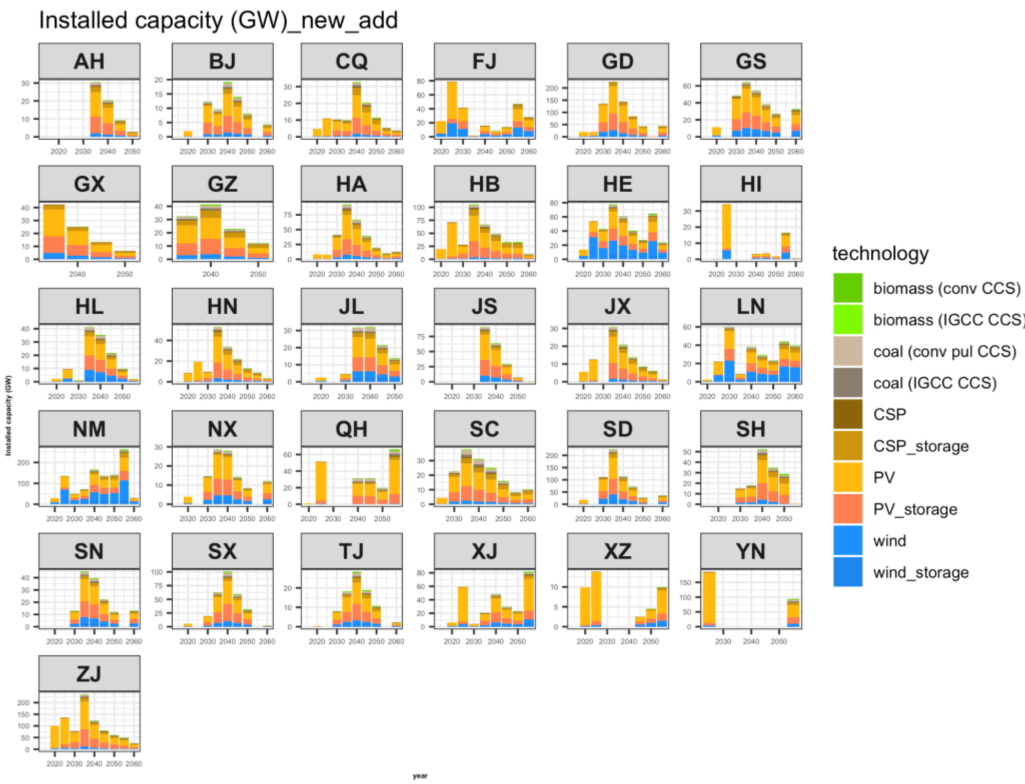
Panel B. Electricity demand and supply of year 2060

Note: Values plotted on the maps are electricity demand minus the electricity supply. Therefore, values above 0 means electricity importer, and values below 0 means electricity exporters.

Supplemental Figure S7.

Generation Mix

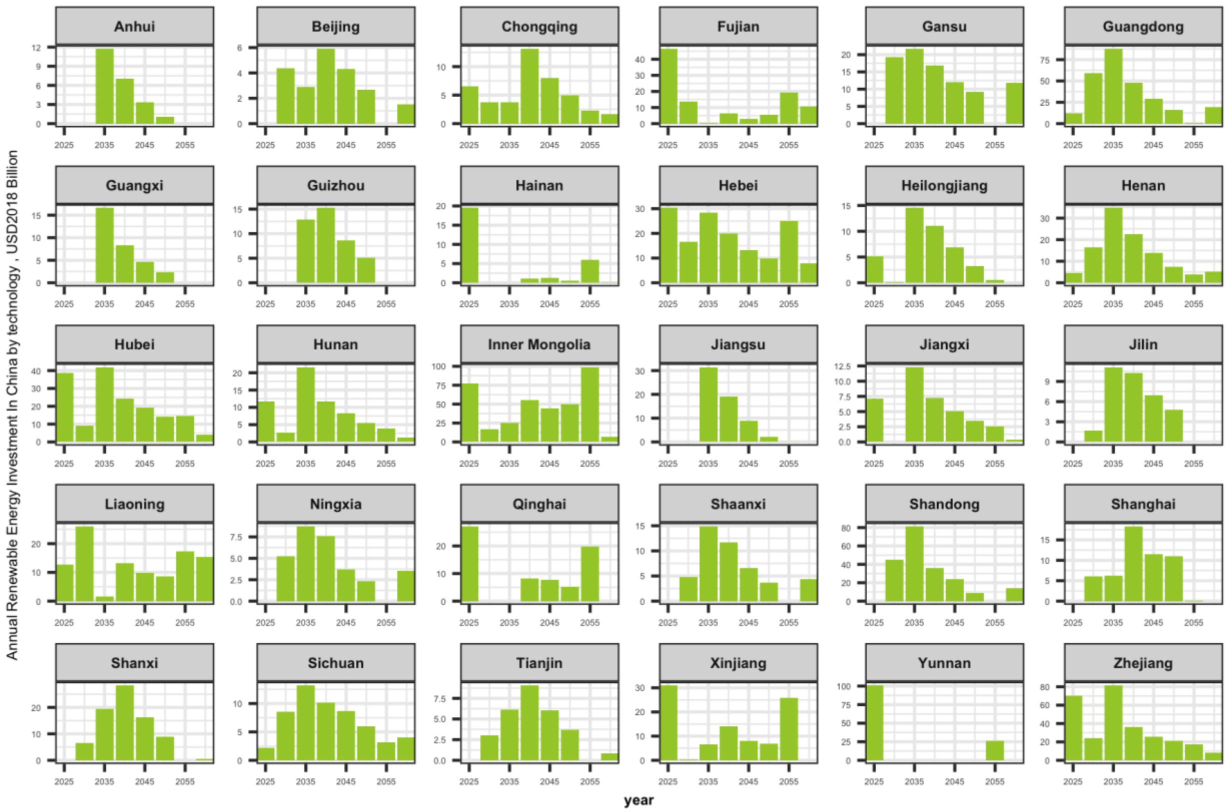




Installed capacity (GW)_new_add
AH
BJ
CQ
FJ
GD
GS
GX
GZ
HA
HB
HE
HI
HL
HN
JL
JS
JX
LN
NM
NX
QH
SC
SD
SH
SN
SX
TJ
XJ
XZ
YN
ZJ
Installed capacity (GW)
year
technology
biomass (conv CCS)
biomass (IGCC CCS)
coal (conv pul CCS)
coal (IGCC CCS)
CSP
CSP_storage
PV
PV_storage
wind
wind_storage

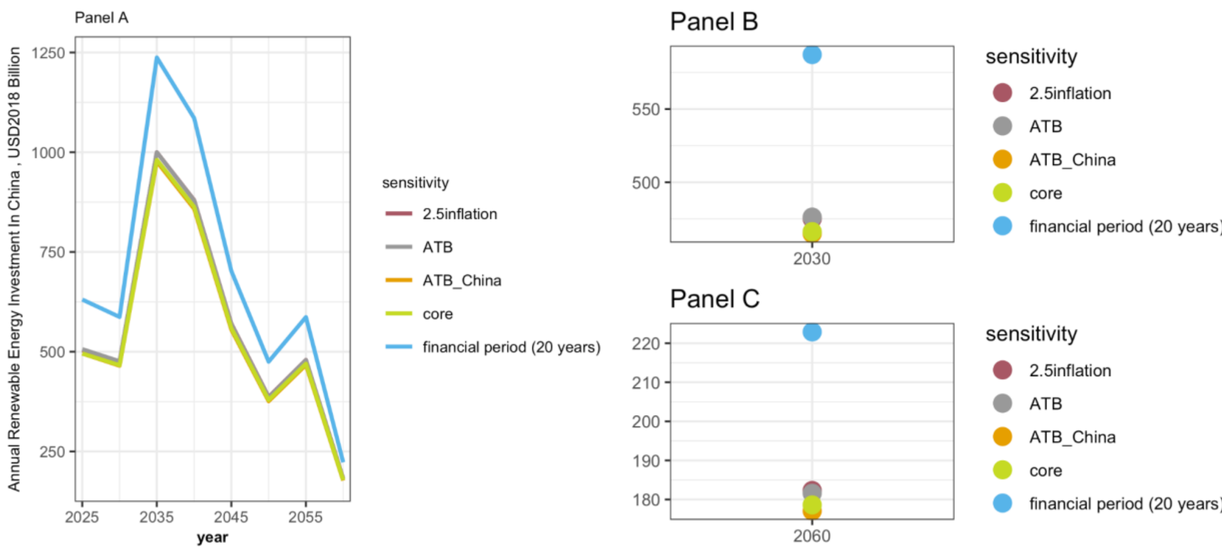
Supplemental Figure S8.

Investment Needs by Province and Timeline



Supplemental Figure S9.

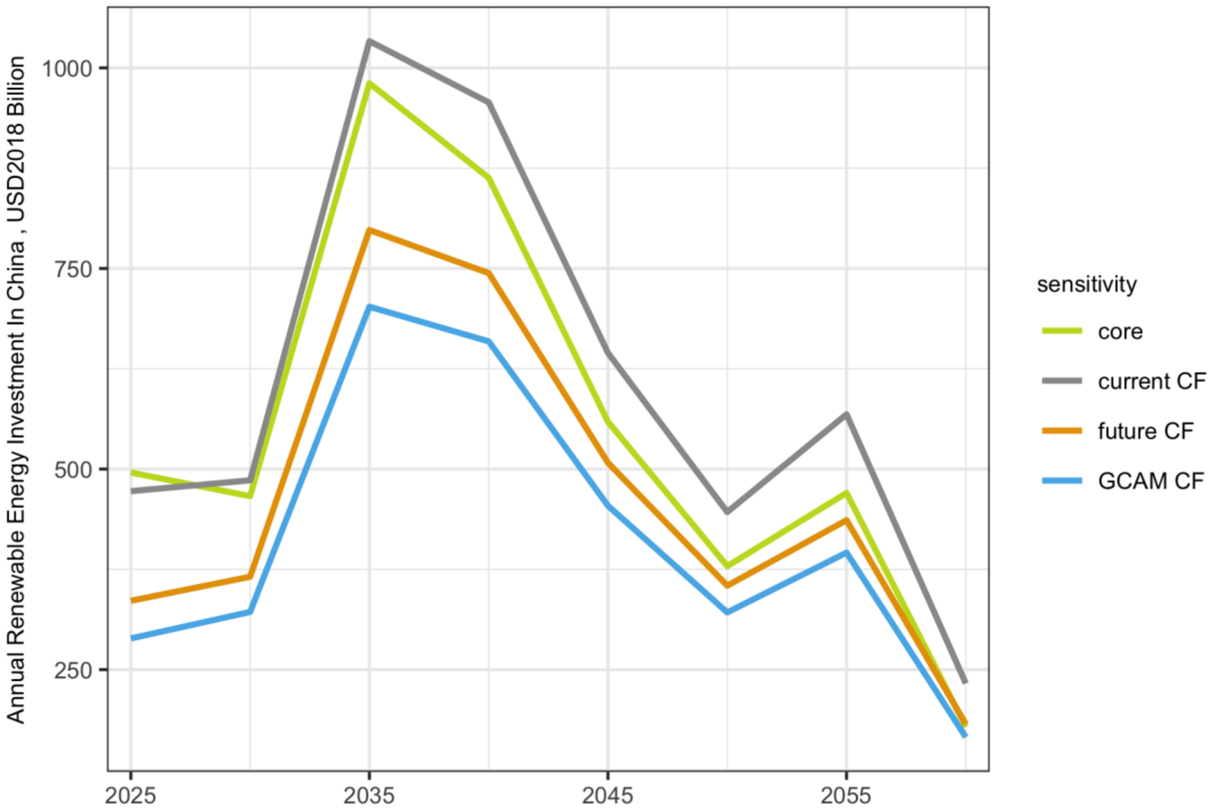
Annual Average Energy Investments Needs for 5 Year Periods in China from 2025–2060 According to Different Financial Indicators.



Note: Related to Figure 7.

Supplemental Figure S10.

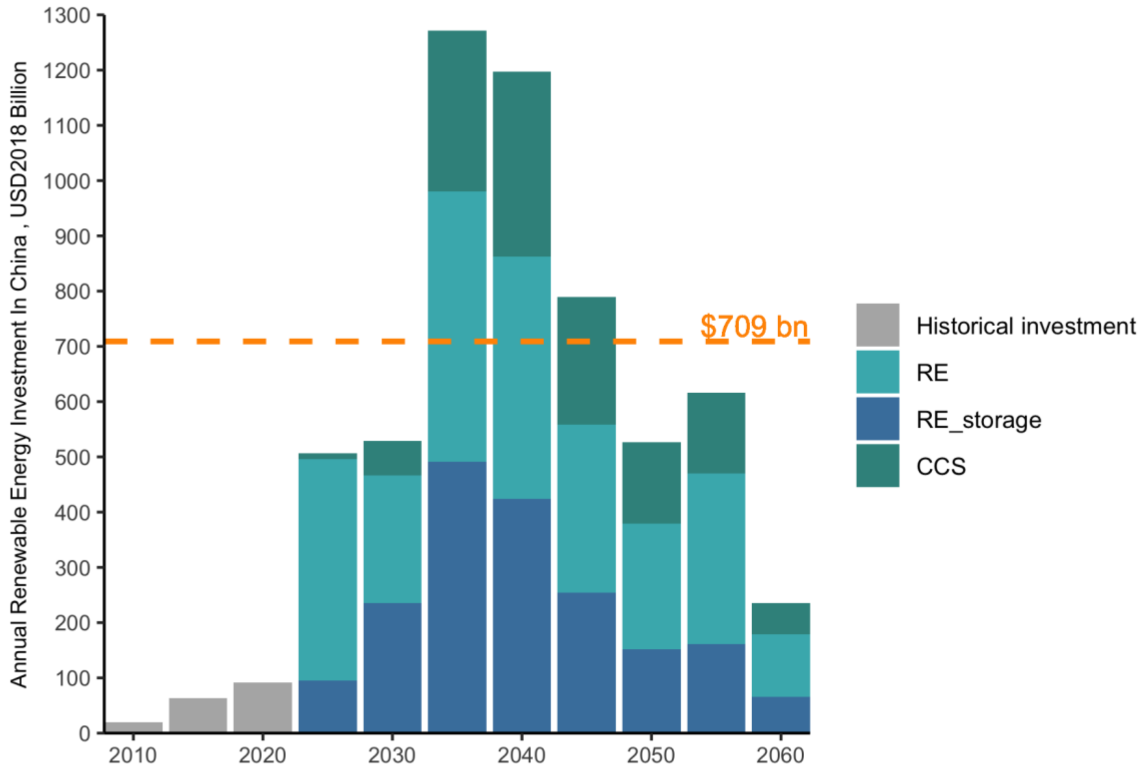
Annual Average Energy Investments Needs for 5 Year Periods in China From 2025–2060 According to Different Capacity Factors.



Note: Related to Figure 7.

Supplemental Figure S11.

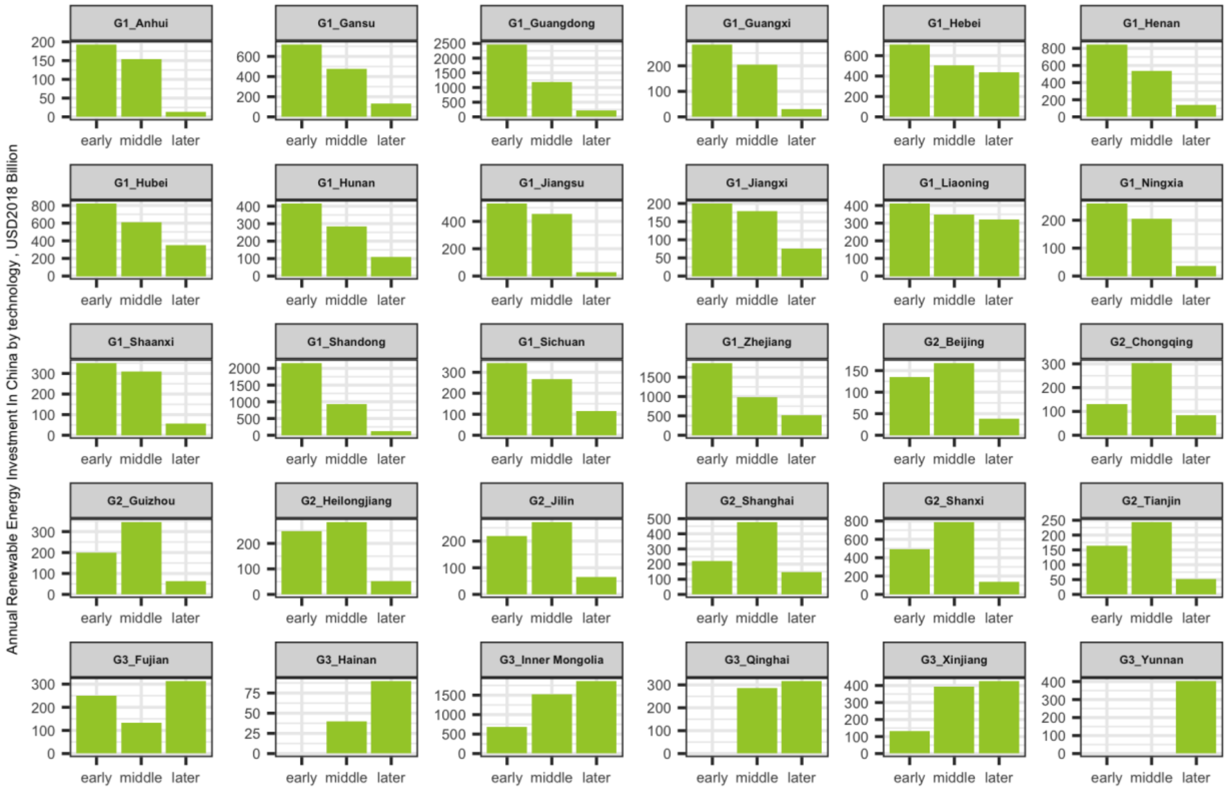
Annual Average Energy Investments Needs with CCS Technologies for 5 Year Periods in China from 2025–2060.



Note: The grey line indicates the historical annual investment between 2016 to 2020. ($ 483 Billion with CCS)

Supplemental Figure S12.

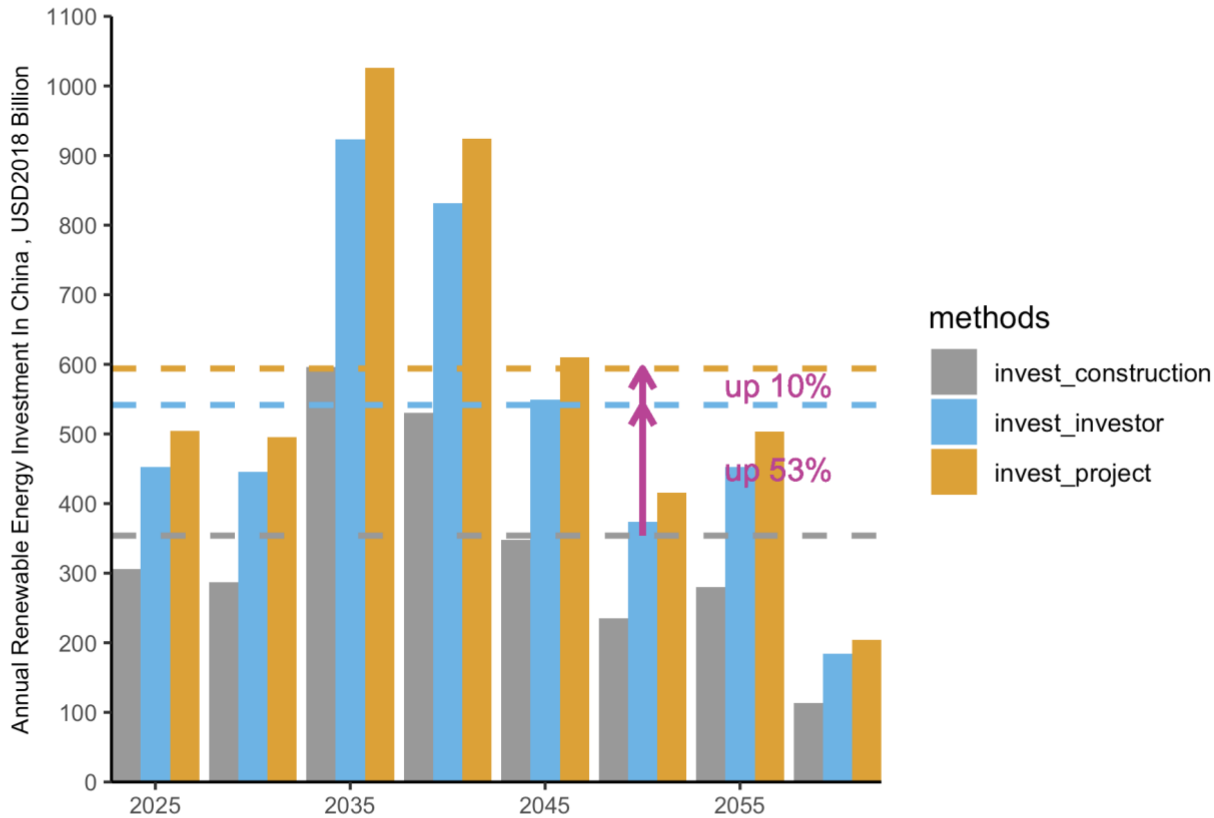
Investment Timeline by Province in Detail with Temporal Trend.



Note: Related to Figure 8.

Supplemental Figure S13.

Investment Needs Based on Different Perspectives.



Supplemental Table 1.

WACC by Technology.

	Assumption							Calculated
technology	Equity and Debt ratio	Cost of debt	Cost of equity	Real WACC	Inflation rate	Tax rate (National and Provincial)	Captial period	WACC
wind	80.00%	6.21%	8%	3.26%	2.00%	25%	30	5.33%
wind_storage	80.00%	6.21%	8%	3.26%	2.00%	25%	30	5.33%
PV	80.00%	4.00%	8%	1.96%	2.00%	25%	30	4.00%
PV_storage	80.00%	4.00%	8%	1.96%	2.00%	25%	30	4.00%
CSP	80.00%	4.00%	8%	1.96%	2.00%	25%	30	4.00%
CSP_storage	80.00%	4.00%	8%	1.96%	2.00%	25%	30	4.00%
coal (conv pu	80%	5.90%	8%	3.08%	2.00%	25%	60	5.14%
coal (IGCC C(	80%	5.90%	8%	3.08%	2.00%	25%	60	5.14%
Biomass (con	80%	5.90%	8%	3.08%	2.00%	25%	30	5.14%
Biomass (IGC	80%	5.90%	8%	3.08%	2.00%	25%	30	5.14%

2. Renewables Policy Deep Dive

2.1 Commonly Used Policies Tools

Here we focus on six commonly used policies to promote renewable energy generation and discuss their roles in promoting renewable energy in China. The following policies are, production tax credit, government procurement purchasing, feed-in-tariffs, renewable portfolio standards (renewable energy targets), bidding system, and cap and trade. In the current development stage, China is moving towards market-based policies such as cap and trade and the auctioning bidding systems that provide various incentives such as cost reduction to reduce gas emissions, generate government revenue, stimulate competition and technological innovation.

2.1.1 Production Tax Credit (PTC)

The Production Tax Credit (PTC) offers a production incentive in the form of a tax credit to urge firms to produce particular energy, and investors to invest in clean energy (investment tax credit, ITC)[1], such as wind, solar, geothermal, and closed-loop biomass (CDFA, 2021; J. Liu et al., 2022; Palmer & Burtraw, 2005). The mechanism of this tax incentive was first introduced in the United States, and adopted in many countries, such as Belgium, Spain, South Korea, and China (Ogunlana & Goryunova, 2017). Despite that the tax credit can be applied either to income tax (e.g., the U.S.), property tax (e.g., Italy, Spain, Belgium, Poland), or value added tax (e.g., China, UK, Malta); it intended to achieve the same goal - to stimulate high-risk investment by creating a tax parity between renewable energy and traditional technologies (Lu, 2019; Ogunlana & Goryunova, 2017).

In China, offering tax incentives to renewable energy developers is a major tool of the government to incentivise the development of renewable energy in the period of 2005-2015. The Ministry of Finance (MOF) and State Taxation Administration (STA) jointly announced “Notice on the Value-added Tax (VAT) Policy of PV Power” (2013), “Notice on the Value-added Tax Policy for Large Hydropower Enterprises” (2014), “"Notice on Value-

1 The PTC and ITC differ in that the PTC is calculated based on the amount of electricity produced as output (measured in kilowatt-hours), and ITC is measured based on the capital investment volume (measured in monetary units) (Ogunlana & Goryunova, 2017).

added Tax Policy of Wind Power" (2015), "Notice on Continuing the VAT Policy for Solar Power Projects" (2016), consecutively (Fan et al., 2018). However, at present, this tax incentive policy has not been renewed or replaced by a new policy (Lu, 2019; C. Zhang et al., 2021).

In general, the production tax credit is the least cost-effective way to reduce carbon emission. It promotes new renewable technologies, but it does not stimulate the dynamic learning process required to bring down costs. The credit reduces the average cost of energy with lower electricity prices, but it comes at the expense of the taxpayer (Sherlock, 2020). This policy is also not politically feasible as there are differing ideas on the appropriate amount of tax credits issued to firms. The production credit does not necessarily provide a comparable incentive for all emissions reduction alternatives (discussed in depth in following paragraphs) because it reduces tax revenues (Sherlock, 2020).

In conclusion, PTC was phased out in China at this stage, because it contributes to revenue loss for the government, it is not cost effective, and does not provide enough incentive for the firms to commit to the emission reduction (Zhu & Song, 2020)[2]. Instead of production credits or subsidies, China opted in for tax reduction or exemption, preferential pricing, and among other types of support which has contributed greatly to renewable energy development in China (Zhu & Song, 2020).

2.1.2 Feed-in -tariff (FIT)

Feed-In-Tariff (FIT) is a policy and a price-based approach system where electric utilities are obliged to purchase electricity, at a set price, from green power generators. It can also be seen as set payments per kilowatt hour to renewable electricity producers, either independent of, or in addition to, the market price of electricity (Ma et al., 2021; Rowlands, 2005). The cost savings and price stability for the tariffs may depend on the program structure and term. Quantity targets for emission reduction cannot be achieved without appropriate tariff levels, thereby average application of this policy is from 10-20 years. This policy has been effective in promoting the expansion of renewable electricity capacity

2 U.S. Department of Energy Office of Energy, Efficiency and Renewable Energy, National Renewable Energy Laboratory, "Renewable Energy Policy in China: Financial Incentives," https://www.nrel.gov/docs/fy04osti/36045.pdf;

around the world. By the end of 2020, FIT was used in 113 jurisdictions around the world, which is mainly represented by Germany, Denmark, Spain, and China, with African countries playing an active role recently (REN21, 2020).

FIT has been more successful than RPS in generating renewable energy capacity and there are several reasons why. This policy offers lower risk which translates into lower financing cost for renewable energy projects for investors (Xu & Ma, 2021; Wüstenhagen & Menichetti, 2012). For instance, the guaranteed payments over a period of years provide investors with sufficient confidence to invest the large sums of money that are initially required in order to construct a renewable electricity facility (Rowlands, 2005). The benefits of FIT include fast and easy installation of generators, a simple payment structure, lower transaction costs, and high political acceptability (Mah et al., 2021). FIT helps to cover wide geographic locations and promotes technological learning (Du & Takeuchi, 2020; Rowlands, 2005).

However, FIT has resulted in very high public costs, which laid a high social burden on the public (Yang et al., 2021). It lessens competition because of the safeguard of long term guaranteed payments which discourages producers from competing with each other. This policy limits the incentive to reduce costs below a certain break-even level, where in some countries, the promotion effect is overestimated (Yang et al., 2021).

China started the FITs of renewable energy electricity right after the 2005 Renewable Energy Law (REL), which has far-reaching implications for China's commitment to renewable energy development (Fan et al., 2018). Over the years, renewables development in China has mainly been driven by feed-in-tariffs because FIT made it easier to have a robust and sustainable renewable energy infrastructure in China. For instance, it brought electricity to the most rural villages of China (Zhu & Song, 2020). FIT policy even aggravates industry-wide resource misallocation, thereby limiting productivity in the renewable industry and exacerbates the problems of wind curtailments (Yu et al., 2021). This policy led to remarkable growth in renewable energy in China, but lacked sufficient flexibility to respond to cost changes, and provided limited incentives for further cost reduction (Zhu & Song, 2020). More and more studies indicate that FIT performs better when the cost of renewable energy is high, thus, it is suitable for the early stage of the development of the renewable energy industry. Starting from 2016, China's development of renewable energy has entered a new period, where the trend of development tends to be stabilized, and the renewable energy industry is mature. In this new stage, China began to pay more attention to the point of promoting energy transformation by quota or auction mechanism, which has proven to reduce production cost and promote subsidize-free projects (Fan et al., 2018; Zhu & Song, 2020).

2.1.3 Auctioning or bidding system

Competitive auctions and tenders' mechanism, is used continuously by many countries in lieu of feed-in policies to deploy large scale, centralized renewable energy projects (REN21, 2020). This policy operates from a quantity-based approach where the public authorities set a target and organize competitive bidding processes. A utility can place bids to supply renewable energy up to 20 years into the future at the minimum price bid of electricity (per kilowatt-hour). This market based competitive bidding system has attracted more than 109 countries by the year of 2019 (REN21, 2020).

The benefits of the auction systems include the acceleration of the green energy through increased competition among bidders, cheap electricity prices for consumers, and reduced costs and scale up deployment on the supply side (Auffhammer et al., 2021; Wiser et al., 2003). Some of the unique strengths of the bidding system are that it allows for flexibility in its design elements to meet deployment and development objectives and has the ability to cater to different jurisdictions reflecting their economic situation, the structure of their energy sector, and the maturity of their power market (IRENA & CEM, 2015). Compared with only FIT, the auction scheme also can reduce the financial burden on governments, control the incentives to overinvest in new capacity, ease the issue of information asymmetry and alleviate equity concerns (Roberts, 2020). The socio-economic benefits of the bidding system ensure greater participation from developing countries (IRENA, 2013). Success bidding process includes the following: i) increased competition among participating bidders in order to bring the prices down; and ii) that the participation in the auction is limited to bidders that have the capacity to implement projects at the contracted price in the given timeframe while contributing to the broader development goals (IRENA & CEM, 2015). Apart from increasing competition, technology-neutral auctions reduce prices due to technological development and reduce the risk of under-contracting due to the high level of participation of potential project developers in the bid (IRENA & CEM, 2015).

On the other hand, auctioning comes with some concerns such as the lack of oversight and transparency in the procurement process. Transaction costs (often associated with administrative procedures) may be high in comparison to the total anticipated profits for bidders and can constitute a barrier to entry for smaller players. Also, an unfavorable auction design (e.g. strict compliance rules, requirements, and low ceiling prices) may not attract enough bidders or even lead to disorderly competition, high non-realization rate, and low bids due to the winner's curse and aggressive market entry (Matthäus et al., 2021; Wiser et al., 2003). Also, if profits are lower for project developers under auctions, pressure on the manufacturers upstream and downstream might exert negative influence on the quality control and innovation ability (del Río & Kiefer, 2022). Additionally, the near absence of power purchase agreements (PPA) for new projects could lead to uncertain outcomes (i.e a discontinuation of project funding for renewable projects) and project delays with no penalty or accountability for nonperformance (Wiser et al., 2003).

Especially for the development of the whole renewable industry and its supply chain, the auction mechanism brings about a competitive environment that pressures the companies and forces them to accept higher risks, increasing costs, and lower returns, leading to a risk-return misalignment (Đukan & Kitzing, 2021). The low margins and even revenue loss due to underbidding might affect technical quality and reliability of projects or even devastate the credibility and competitiveness of the whole industry (IRENA, 2013; Welisch & Poudineh, 2020). Therefore, a scientific evaluation system and appropriate design is integral to avoid the harm dysfunctional auctions might bring in the long run (Đukan & Kitzing, 2021).

Since 2004[3], the Chinese government has had long experience with RE tenders[4], as with FITs (BEETZ, 2018). For instance, the 2019 auction results showed that more than 30% price reduction was from utility-scale solar projects on average compared to May 2018 levels. In that same year, over 250 subsidy-free projects totaling more than 20 gigawatts (GW) were approved, with solar representing more than 70% of the projects (Zhu & Song, 2020). Additionally, the Chinese government took further steps to move from a FIT system to an auction-based system. In 2018, China's NEA published a notice regarding the 2018

3 The first renewable tender, a wind project, was launched in 2003 by the National Development and Reform Commission (NDRC), six years before creating the FIT policy. However, at that time, the renewable industry in China was still in its infancy.

4 Actually, these project-specific auctions are generally referred to as concession schemes, not the auction mechanism in the later stage (Azuela et al., 2014).

Administrative Requirements of Wind Power Development, where the Administrative Guidance for Competitive Allocation of Wind Power Projects was attached to the notice. This move signaled the launch of the auction mechanism for future wind power awards, in order to reach grid parity of wind power by 2020 (MAKE Consulting, 2018; WOOD MACKENZIE POWER & RENEWABLES, 2018). At the same time, a similar structure for the solar projects is also on the agenda (BEETZ, 2018). These actions show China's aggressive move by shifting from a FIT system to an auction-based mechanism.

2.1.4 Renewable Portfolio Standard (RPS)[5]

Renewables Portfolio Standards (RPS) is a quota-based mechanism, which requires power producers to produce a certain proportion of their electricity from renewable sources (Yang et al., 2021). In most of the cases, jurisdictions that adopt RPS or other quota obligations also allow the use of tradable renewable/green energy certificates (TGC) (REN21, 2020). TGC is seen as a superior regulatory framework for promoting the diffusion of renewable electricity technologies because it requires a minimum level of renewable-based generation. In the short term, it minimizes the social costs of reaching a certain goal with a high degree of predictability. This policy is widely applied in US states like Connecticut, Maine, Nevada, Massachusetts and in countries like Canada, Japan, and all over Europe (Palmer & Burtraw, 2005; S. Wang et al., 2022).

RPS has many strengths including its cost and administratively effectiveness, straight-forward and easy measuring way, and its ability to create market demand for renewable energy (Mah et al., 2021). Compared to the FITs, which are suitable for the early stage of the development of the renewable energy industry, RPS is suitable for the industry when it is mature. Because, under RPS, to maximize profits, power producers tend to choose renewable energy with relatively mature technology and lower cost.

Against the background of green and sustainable development becoming the mainstream of the current China, in May 2019, China formally released their long-awaited RPS plan, which sets the minimum renewables consumption at a provincial level and distributes the responsibilities for renewable energy consumption among obligated parties (Zhu & Song, 2020). This policy mandates renewables consumption in coastal provinces and stimulates

5 Renewable energy targets, tradable green certificates (TGC).

interprovincial power trade. However, plans for interprovincial renewable power transactions have been limited because of diverging interests and goals between provinces. On 10 February 2021, the drafted Renewable Power Consumption Targets During 2021-30 was released by the NEA. In this draft policy, grid companies will steadily increase the amount of power purchased from clean generation sources from 28.2% in 2020 to 40% by 2030. More importantly, the draft policy clearly indicated that the increase of PRS from 2021 level will vary across provinces, to a uniform 40% by 2030 at a constant rate for each province (NEA, 2021). This policy will mandate renewables consumption in coastal provinces (where many corporations have loads) and stimulate the interprovincial power trade. However, the challenge for implementation in China is the misaligned incentives between provinces, which will be a key factor hindering interprovincial renewable energy transactions (Zhu & Song, 2020).

2.1.5 Cap-and-trade policy/emissions trading scheme (ETS)

The cap-and-trade policy, also known as the emissions trading scheme (ETS) is a market-based approach that puts a limit on the amount of greenhouse gas emissions that countries or firms can emit. It provides economic incentives in a form of allowance or price for entities that reduce their emissions. Entities can trade allowances in the market, which offer entities a strong incentive to save money by cutting emissions in the most cost-effective ways. By the end of January 2021, there are 24 ETS in force worldwide, covering 16% of global GHG emissions (ICAP, 2021a). The application of ETS penetrates to different levels of government, covering major sectors such as power, industry, building, transport, etc (C2ES, 2020; ICAP, 2021a; Talberg & Swoboda, 2013).

The cap-and-trade system is superior to all other emissions policies because it is market based and provides faster cuts in emissions. It essentially rewards innovation by offering a tangible cash infusion when fewer greenhouse gas emissions are produced. It eliminates the need for a carbon tax because the allowances offer a financial incentive for entities, and it will cost organizations more money to continue producing at the same levels. In the US, the average cost per ton reduced is $82 under the carbon cap versus $126 under the 15% RPS policy that attains comparable reductions (Palmer & Burtraw, 2005). ETS is a better mechanism to adopt because there will be automatic compliance from entities (Gaille, 2019). The policy will receive strong political support because it generates lots of revenue for the government. For instance, the government can decide to auction emissions credits to the highest bidder to generate revenue to support infrastructure needs, social programs, or national defense. ETS is ranked higher than renewable alternatives because it gives consumers more choices. A consumer can choose to do business with their competitors who are committed to reducing their pollution levels. Conversely, critics argue that ETS does not lead to behavior change to renewable energy because firms can purchase carbon credits to cheat the system. In other words, there is no structural way to monitor an organization's compliance but to take polluters at their word (Gaille, 2019). For this system to work, it requires strict enforcement of the maximum level of emissions with zero exemptions for polluters.

China has one of the world's largest CO2 emissions trading systems which allow them to create a carbon market for electric power generation, steel, petroleum refining, cement and other industries producing most of the country's greenhouse gas emissions (RAIMI, 2020). This system is viewed as the "green dispatch" strategy for its electric power supply and a mechanism to meet the country's goal of producing 20 percent of its electricity from renewables by 2030 (Magill, 2015). In 2013, China launched pilot cap-and-trade projects in seven different cities[6], covering more than 2,600 companies in the power section in regions with a population of more than 258 million, GDP of 13.0 trillion yuan, and emissions of 1501 million ton CO2 in 2011, covering 18.6%, 24.9% and 16.2% of China's total population, GDP and emission (Gao et al., 2020). In 2017, China politically launched its national ETS, starting operation in 2021 and its goal is to contribute to the gradual reduction of carbon emissions in China and to the success of green and low-carbon development (ICAP, 2021b). This goal is reaffirmed by the country's Nationally Determined Contribution (NDC) under the Paris Agreement, the 13th Five-Year Work Plan (FYP) for Greenhouse Gas Emission Control, and the President Xi Jinping's announcement in September 2020 that China' key mitigation targets is to include peaking carbon emissions before 2030 and achieving carbon neutrality by 2060 (ICAP, 2021b). The Chinese national ETS is estimated to cover more than four billion tCO2, accounting for 40% of national carbon emissions. The system's scope is to be further expanded in the future (ICAP, 2021b).

Currently, the national ETS cap is adjusted ex-post based on actual production levels. The compliance obligations are limited to the level of free allocation as per benchmarks, plus

6 Five cities started the pilot system in 2013 and 2014: Beijing, Shanghai, Tianjin, Chongqing and Shenzhen. With two more provinces joined right after the initial launch: Guangdong and Hubei. In 2016, an eighth pilot ETS was launched in the province of Fujian (ETS in China, 2021).

20% of their verified emissions (ICAP, 2021b). This means that no allowances must be surrendered for verified emissions above this threshold. China also faces the technical challenge of developing the registry and trading platform. No carbon price is available at this moment as the national ETS began actually operating in 2021. The existing Chinese regional ETS pilots are gradually transitioning into the national ETS (C. Wang et al., 2021). In the short term, the pilots continue to operate in parallel to the national market, covering the sectors and entities not included in the national market. In the long term, more sectors will be included in the national ETS, overlapping entities are expected to be integrated into the national market. More importantly, through the regional ETS pilots, this green approach strategy became a market based solution that reduced greenhouse gas emissions, reduced the need for high-carbon power such as coal, and encouraged the use of more solar and wind power (CCAP, 2014). This system is viewed as an efficient way to generate billions in government revenue and provide an incentive for industry and businesses to reduce their emissions more efficiently while keeping production costs down.

2.1.6 Government procurement & purchasing (GPP) / Green Procurement

Government procurement & purchasing (GPP) or the green procurement process is when the government acts as a “greening” agent and influencer in the market economy by participating in the market as purchaser while at the same time regulating it through the use of its purchasing power to advance social and environmental objectives (Ho et al., 2010). Moreover, public authorities act as ‘leaders’ in the process of changes in consumption towards greener products. It involves the integration of environmental issues into purchasing decisions based on price, performance, and quality (Lacroix et al., 2010). GPP is a popular method adopted by the Organisation for Economic Co-operation and Development (OECD) countries such as Singapore, Korea, Denmark, and the United Kingdom that provide up-front capital grants or rebates for renewable energy installations or renewable projects funded by tax revenue (Geng & Doberstein, 2008). In OECD countries, green procurement ranges from 5% to 19 % of national GDP which shows that governments favor GPP policy as part of the environmental development goals (Geng & Doberstein, 2008).

The pros and cons of the GPP or Green Procurement process varies. Government can enjoy the cost savings from reduced energy consumption, resource use, and material management. They also reap qualitative benefits such as improved image and achieving policy/program objectives (Lacroix et al., 2010). Other cost reduction may be due to lower waste management fees, lower hazardous material management fees, less time, and costs for reporting and easier compliance with environmental regulations. The cons of the GPP approach are that it offers fewer incentives for project performance and buy-in from suppliers will take persistent effort (Lacroix et al., 2010). Some environmentally preferable products aren't as readily available, or meet performance specifications, or may be too costly (OECD, 2014). There could be hidden costs as a result of miscalculations about the products being procured and how they are used and disposed of. Lastly, other cons include lack of trained professionals who can discern and label green environmentally friendly products. GPP is a good mechanism, but it does not accelerate the reduction of gas emissions nor technological innovations as much as the Cap and Trade and Auctioning process.

China enacted GPP with the Government Procurement Law of 2003 (Order No. 68), which obligates the government to prioritize environmentally friendly and resource-efficient products. GPP has become an accepted method for environmental advancement. In 2003, the government procurement in China reached 20 billion USD or 6.7 % of their national GDP; a drastic increase when compared to the 12 billion USD in procurement in 2002 (Geng & Doberstein, 2008). In OECD countries, public procurement ranges from 15~20% of the national GDP on public procurement, and in order to mitigate climate change, the share of green public procurement is increasing among developed countries, with the number being more than 20% in major EU countries, and 75% in the UK (Yeo et al., 2016). This law requires all government agencies to prioritize energy saving products in their procurement list. Globally, China holds the largest total number of products certified for GPP – more than 93,000 products in 44 categories. Key products and categories include office supplies, transport, and construction materials (Hasanbeigi et al., 2019). As of today, there are no quantitative GPP targets that have been established at the national level and no standardized protocol for evaluating and reporting on the success of the GPP program. The policy is looked favorably in China for several reasons: it helps to mitigate climate change, conserving energy, reducing hazardous substances, and protecting local environmental conditions. On the other hand, implementing GPP is not free of obstacles. There are many barriers that prevent GPP from fully functioning including lack of knowledge and awareness among government officials, limited budget, high cost of green products, and ambiguity in legal requirements (Vejaratnam et al., 2020; World Bank, 2021). The impact of GPP cannot be recognized because a significant number of loopholes exist in the environmental legal system (Geng & Doberstein, 2008). For instance, there is no incentive for firms to comply with the GPP because the fines for operating illegally are smaller than operating legally. Moreover, a wide application of GPP can be costly for the Chinese government and they are more concerned with cost cutting approaches. Other barriers to GPP in China include low environmental awareness of government procurement personnel and suppliers, the depreciation for GPP, and resistance from public officials in enforcing GPP performance indicators and guidelines.

2.2 A Green Financial System

Achieving deep decarbonization, engaging in large-scale investment in renewable investment from the private sector, and realizing sustainable development depends on a greening financial system. In China, around $20 trillion of green investment will be needed in the coming 30 years to achieve the dual carbon goal, including $3 trillion over 2021-2030 and $17 trillion over 2031-2060 (CICC, 2022). The high investment needs accordingly require a robust green financial system to encourage, guide and support fundings into relevant green areas. China's financial system is dominated by the banking system, which indicates the indispensable role played by finance sector reform in building a more comprehensive green financial system and achieving the climate goal (IISD, 2015a). Green investments are characterized with larger early investment (with associated lower operating costs) and slower returns than conventional investments. Thus, it was perceived as an investment with high risk, which prevented it from attracting the private sector. Although green investments bring the benefits into society, these benefits are not adequately internalized through pricing. Using public sector and fiscal support is a primary mechanism to support green investments. However, due to the large scale of investment needs, public funds are not sufficiently enough to fulfill the green investment needs. In China, public sources account for at least 51% of total green finance, with nearly 95% coming from Central SOEs, policy banks and other major state-owned banks. Also, green public-private partnerships (PPP) provides one-fifth of climate finance (CPI, 2021). Thus, a green finance system, which relies on the market-based green finance channels from the private sector with structured government support can improve decision making and capital allocation.

China has been laying great emphasis on the advancement of green finance and has issued a series of strategic guiding policies over years. In 2016, the People's Bank of China (PBC) in conjunction with other seven ministries and commissions issued the "Guidelines for Establishing the Green Financial System", which established the top-level structure of

China’s green financial system and stated Public-Private Partnership (PPP) model social capital as an important tool. In 2017, regions in five provinces were selected as pilot zones to explore institutions and mechanisms that can provide experience to promote the development of green finance. In the leading policy document of the “1+N” framework released after the pledge on the 30.60 carbon target in 2021, actively developing green finance and establishing green finance standards are repeatedly underlined. Based on this, PBC later framed the development direction of green finance development called “three functions” and “five pillars”, promoting the financial system to a greener way. In 2022, CBIRC issued the “Green Finance Guidelines for Banking and Insurance Sectors”', establishing a green finance organization, management, and coordination mechanism. More specific details on the policy framework of green finance are as follows.

2.2.1. Green Credit

In China, efforts on green credit can be dated back to 15 years ago when the State Environmental Protection Administration (SEPA), the China Banking Regulatory Commission (CBRC), and the People's Bank of China (PBOC) jointly issued the “Green Credit Policy” in 2007. This Policy aimed to support green development through offering green credits for environmentally friendly industries. Then in 2012, CBRC issued the “Green Credit Guidelines”, helping to define green credit more consistently, encouraging banking institutions to develop green credit and adopt stronger environmental and social risk management (Wen et al., 2021). Later, CBRC continuously promulgated the “Energy Efficiency Credit Guidelines” in 2015, further structuring a more comprehensive package of guidelines, regulations, and policies to deliver green credit service in the realm of green, recycling, and low-carbon (Hu et al., 2022). As of the end of 2021, the balance of green loans in China was $2.5 trillion, a year-on-year increase of 33%, ranking first in the world in terms of stock size (PBC, 2022).

The policy structure on green credit helps enterprises’ green transformation, provides more funds for R&D and innovation, improves energy efficiency and business performance, and facilitates carbon emission performance (X. Liu et al., 2022). Yet, there are also problems existing in the existing green credit system including the lack of information sharing platform available for all sectors and departments, relatively vague text in the policy which loosens the constraints on information disclosure, the absence of harmonious implementation standards of green credit standard (X. Liu et al., 2022). Also, the regional and socioeconomic disparity in the benefits of green credit and insufficient supervision over the capital flows, especially those of the heavily polluting companies are also challenges the green credit policy making needs to deal with (Hu et al., 2022; J. Zhang et al., 2022).

2.2.2 Green Bond

Officially, China joined the green bond market in late 2015. With its strong market potential, China has overtaken the rest of the world within a year, becoming the largest source of labeled green bonds (IISD, 2015b). During the period of 2016-2019, the green bond market in China gained tremendous growth. Up to 2020, the green bond market in China has achieved tremendous progress, where we see a steady annual growth rate, a more diversified issuer structure, and a decentralized trend (Climate Bonds Initiative, 2020). In 2021, the government announced a new "Catalogue of Green Bond Support Projects" as the updating of the old version in 2020, which substantially promotes the integration of the green bond market, standardizes the evaluation criterion, and aligns with the international market (J. Chen et al., 2022). By the end of June in 2022, China's green bonds stood at $167.4 billion, ranking the second in the world, demonstrating the rising attractiveness of China's green finance market (Zhou, 2022).

However, challenges to scaling China's green bond market still exist. One challenge is rooted in the discrepancies between China's local green bond guidelines and the international standard and guidelines. These discrepancies, particularly in the eligibility of the green bond projects and the use of proceeds, might prevent international investors from investing green bonds in China (Lin & Hong, 2022; M. Zhang et al., 2022); Another challenge comes from insufficient information disclosure. Information related to green bonds is not fully disclosed in China, laying barriers to detect and evaluate (Climate Bonds Initiative, 2020); the raised funds sometimes was not invested in the green industry totally because of due to the lack of monitoring and supervision (J. Chen et al., 2022). Therefore, providing detailed disclosure of the use of proceeds, the eligibility of green bond projects, and also the environmental impact of projects in a consistent and transparent fashion can ensure investors of the green credentials of the bonds.

2.2.3 Green Insurance

The advance of green insurance can be dated back to the "Guiding Opinions on Environmental Pollution Liability Insurance Work" issued in 2007, which indicated that green insurance plays an inevitable role in environmental and social management (Q. Chen et al., 2022). In the Guidelines for Establishing the Green Financial System issued in 2016, developing green insurance to support environment protection and cope with disaster related to climate change is covered. According to the "Insurance Industry Focuses on Dual-carbon Goal Boosts Green Development Blue Book" released by the insurance association of China in 2021, China has integrated low-carbon transition into the insurance industry with increasing green investment and multiple insurance products across all sectors. Between 2018 to 2020, the insurance industry has provided $7 trillion green insurance protection for the whole society, and paid $8.2 billion in indemnity, effectively serving the role of risk protection (GFC, 2021).

Green insurance has made great progress, gradually making the green insurance system more comprehensive to serve the needs of green investment. Yet, there is still a large gap between the current situation and the desired level of risk protections to facilitate green and low-carbon transition (HSBC, 2021). Recurrent issues over the course of constructing a green insurance system in China have been a lack of data, absence of standards specifically for green finance, and a talent shortage in this field (GFC, 2021).

2.2.4. 30.60 Carbon Target and Green Finance: Opportunities and Challenges

The 30.60 Carbon Target proposed in 2020 requires China to achieve carbon neutrality in 40 years, which is half the time that developed countries take. Therefore, the government should actively engage in the financial sector and create supporting green finance policies to achieve the target. (Tong et al., 2022). In the State Council's "Guiding Opinions on Accelerating the Establishment of a Sound Green, Low-Carbon Circular Economic System" released in 2021, promoting the financial system's green transition was reiterated, which signals a great chance for green finance to develop and thrive (Lin & Hong, 2022).

The 30.60 Carbon Target has brought substantial financial demands. The financial system is indispensable in resource allocation, stimulating investment in low-carbon projects, and directing more capital to green and low-carbon fields. Meanwhile, public funds need to perform in a market-oriented way with the support of green finance to guide more private capital to the low-carbon transition (Sun & Nian, 2022). For example, the adjustment of industrial structure required by the 30.60 Carbon Target will accelerate the development of the green financial system. Scale development of the renewable energy industry, transition of traditional energy structure, and the innovation and promotion of emission reduction technologies require the financial system to guide capital flow and investment to green industry (Gu et al., 2021; Hu et al., 2022). Meanwhile, the low-carbon transition of enterprises also generates huge financial demands. Under the 30.60 Carbon Target, companies are required to reduce carbon emissions and achieve low-carbon transformation and green development. The green financial market not only provides financial support for the development of emission reduction technologies for enterprises, but also can offer regulation and supervision to the green and low-carbon financing behavior of enterprises (Han et al., 2022).

However, China's green finance embraces multiple challenges. Shortfall in green investment and financing, overinvestment in certain sectors due to specific incentives, and limited financial tools together leads to the mismatch between supply and demand in green investment (CICC, 2022). The domestic standard in green finance is still not unified enough, leading to a huge gap between the current domestic and international standards (X. Wang & Wang, 2021). The absence of precise mandatory regulation on information disclosure and unclear relationships among enterprises, financial institutions and regulators make it challenging to maintain a stable and effective green finance information disclosure system (Gu et al., 2021).

2.2.5 Policy Implications

After analyzing the current status, policy frame, opportunities and challenges of China's green finance, here are some recommendations and suggestions for policy makers to promote the development of green finance.

(1) Establishing clear, unified, and consistent green standards:
A clearer and more consistent system of standards, aligning with international standards for green finance, should be built to establish the foundation for healthy and sustainable growth for green financial products and promote international cooperation (X. Wang & Wang, 2021). A third-party attestation institution should also be introduced to enhance reputation and acceptance by the market and attract corporate and investment attention (CICC, 2022).

(2) Enhancing information disclosure:

It is necessary to improve the mandatory green-information disclosure and ease information asymmetry continuously (Yang et al., 2022). The government should build a data sharing platform and set specific departments to organize unified statistics and data disclosure (X. Wang et al., 2021).

(3) Promoting innovation on green financial tools:

China should accelerate the innovative green financial products required by the ever-growing financial market (Cui et al., 2020). Apart from traditional financial products such as green credit, green loans and green bonds, financial institutions and relevant departments should strengthen international cooperation and develop manifold green financial tools like sustainability-linked bonds, transition bonds, blue bonds, social bonds, and green supply chain financial products (GFC, 2021).

(4) Transferring policy motivation to market motivation:

The scale development of the green finance market requires more active market behaviors. Existing green finance policies support the development of green finance by providing facilitation measures, financial incentives, and risk sharing (Climate Bonds Initiative, 2022). However, current policies are weak in providing long-term momentum for green finance and sustaining a stable market supply. Policy design should help investment institutions and financial market participants benefit from green finance and reduce costs to promote the healthy development of green finance and transfer policy motivation to market motivation (Cui et al., 2020).

(5) Laying special emphasis on regional level policies:

The local green finance policy frame, the effectiveness of policies, and benefits from the green finance vary substantially by region in China (Guo et al., 2022; X. Liu et al., 2022). To attract funds and stimulate environmental investment in local green development, the regional governments should implement green financial policies more actively, take differentiated monetary and financial policies, and scientifically set the intensity of green regulation as well as marketization level according to local conditions (Guo et al., 2022). Some regions with lower levels of green finance growth should improve the infrastructure construction, update the industrial structure, shorten the economic gap, and learn from the successful experience of other regions (Lv et al., 2021).

In China, efforts on green finance can be traded back a decade. However, the green finance definition was officially adopted in 2016 in the Guidelines for Establishing the Green Financial System (the "Guidelines") (IIGF and UN Environmental, 2017). The Guidelines set up the stage of implementation of rapid development in the green finance system. Green finance is manifested in forms such as green credit, green securities (innovations such as green bond) and green insurance, green investment bank, etc.

Green bonds are recognized as low-carbon, climate-resilient investment opportunities by the United Nations. Since first entering the market in 2007, green bonds have seen strong growth, with green bond issuances reaching US$ 257.7 billion in 2019, a new global record. It is viewed as an innovative vehicle of green securities to access private sector capital. Officially, China joined the green bond market in late 2015. With its strong market potential, China has overtaken the rest of the world within a year, becoming the largest source of labeled green bonds (IISD, 2015b). Up to 2020, the green bond market in China achieved tremendous progress, where we see a steady annual growth rate[7], a more diversified issuer structure[8], and a decentralized trend[9] .

7 In 2019, China issued $55.8 billion green bonds, representing a 33% increase from 2018 (Climate Bonds Initiative, 2020).

8 There is a huge difference in the issuer types between 2016 and 2019. In 2016, Financial Corporates represented roughly 80% of the total volume of issuance, while in 2019, they only represented a third of the total volumes of issuance (Climate Bonds Initiative, 2020).

9 2019 sees the first municipal green bond in China. It is a signal of local governments' ambitions to address climate change (Climate Bonds Initiative, 2020).

References

Auffhammer, M., Wang, M., Xie, L., & Xu, J. (2021). Renewable Electricity Development in China: Policies, Performance, and Challenges. Review of Environmental Economics and Policy, 15(2), 323–339. https://doi.org/10.1086/715624

Azuela, G. E., Barroso, L., Khanna, A., Wang, X., Wu, Y., & Cunha, G. (2014). Performance of Renewable Energy Auctions: Experience in Brazil, China and India. The World Bank. https://doi.org/10.1596/1813-9450-7062

BEETZ. (2018, December 13). New renewable funding mechanisms higlighted for China – report. Pv Magazine International. https://www.pv-magazine.com/2018/12/13/new-renewable-funding-mechanisms-higlighted-for-china-report/

C2ES. (2020, June 22). California Cap and Trade. Center for Climate and Energy Solutions. https://www.c2es.org/content/california-cap-and-trade/

CCAP. (2014). Cap-and-Trade and New Market Mechanism Policy Design in China | Center for Clean Air Policy. Center for Clean Air Policy. https://ccap.org/cap-and-trade-and-new-market-mechanism-policy-design-in-china/

CDFA. (2021). CDFA Spotlight: Green Building Finance. Council of Development Finance Agencies. https://www.cdfa.net/cdfa/cdfaweb.nsf/pages/greenbuildingfactsheet.html

Chen, J., Jia, L., & Shi, Y. (2022). The Outlook of the Green Bond Market in China. 926–930. https://doi.org/10.2991/aebmr.k.220603.153

Chen, Q., Ning, B., Pan, Y., & Xiao, J. (2022). Green Finance and Outward Foreign Direct Investment: Evidence from a Quasi-Natural Experiment of Green Insurance in China. Asia Pacific Journal of Management, 39(3), 899–924. https://doi.org/10.1007/s10490-020-09750-w

CICC. (2022). Guidebook to Carbon Neutrality in China: Macro and Industry Trends under New Constraints. Springer. https://doi.org/10.1007/978-981-16-9024-2

Climate Bonds Initiative. (2020, October 28). Report on Green Bond Issuance and Opportunities in China. Climate Bonds Initiative. https://www.climatebonds.net/resources/reports/china_gbio_cn

Climate Bonds Initiative. (2022, May 17). China Green Finance Policy 2021 Analysis Report. https://cn.climatebonds.net/cn.climatebonds.net/resources/China_Policy_Report

Climate Policy Initiative (CPI). (2021). China's Potential to Scale up Climate Finance. https://www.climatepolicyinitiative.org/wp-content/uploads/2021/02/%E4%B8%AD%E5%9B%BD%E6%89%A9%E5%A4%A7%E6%B0%94%E5%80%99%E9%87%91%E8%9E%8D%E8%A7%84%E6%A8%A1%E7%9A%84%E6%BD%9C%E5%8A%9B-2.pdf

Cui, H., Wang, R., & Wang, H. (2020). An Evolutionary Analysis of Green Finance Sustainability Based on Multi-agent Game. Journal of Cleaner Production, 269, 121799. https://doi.org/10.1016/j.jclepro.2020.121799

del Río, P., & Kiefer, C. P. (2022). Which Policy Instruments Promote Innovation in Renewable Electricity Technologies? A Critical Review of the Literature with a Focus on Auctions. Energy Research & Social Science, 89, 102501. https://doi.org/10.1016/j.erss.2022.102501

Du, Y., & Takeuchi, K. (2020). Does a Small Difference Make a Difference? Impact of Feed-In Tariff on Renewable Power Generation in China. Energy Economics, 87, 104710. https://doi.org/10.1016/j.eneco.2020.104710

Đukan, M., & Kitzing, L. (2021). The Impact of Auctions on Financing Conditions and Cost of Capital for Wind Energy Projects. Energy Policy, 152, 112197. https://doi.org/10.1016/j.enpol.2021.112197

ETS in China. (2021). Capacity Building for the Establishment of Emissions Trading Schemes in China. https://ets-china.org/ets-in-china/

Fan, J., Wang, J., Wei, S., & Zhang, X. (2018). The Development of China's Renewable Energy Policy and Implications to Africa. IOP Conference Series: Materials Science and Engineering, 394, 042034. https://doi.org/10.1088/1757-899X/394/4/042034

Gaille, L. (2019, April 16). 20 Cap and Trade System Pros and Cons. Vittana.Org. https://vittana.org/20-cap-and-trade-system-pros-and-cons

Gao, Y., Li, M., Xue, J., & Liu, Y. (2020). Evaluation of Effectiveness of China's Carbon Emissions Trading Scheme in Carbon Mitigation. Energy Economics, 90, 104872. https://doi.org/10.1016/j.eneco.2020.104872

Geng, Y., & Doberstein, B. (2008). Greening government procurement in developing countries: Building capacity in China. Journal of Environmental Management, 88(4), 932–938. https://doi.org/10.1016/j.jenvman.2007.04.016

GFC. (2021). Roadmap for Financing China's Carbon Neutrality. http://www.greenfinance.org.cn/upfile/file/20211204222634_82821_73556.pdf

Gu, B., Chen, F., & Zhang, K. (2021). The Policy Effect of Green Finance in Promoting Industrial Transformation and Upgrading Efficiency in China: Analysis from the Perspective of Government Regulation and Public Environmental Demands. Environmental Science and Pollution Research, 28(34), 47474–47491. https://doi.org/10.1007/s11356-021-13944-0

Guo, L., Tan, W., & Xu, Y. (2022). Impact of Green Credit on Green Economy Efficiency in China. Environmental Science and Pollution Research, 29(23), 35124–35137. https://doi.org/10.1007/s11356-021-18444-9

Han, S.-R., Li, P., Xiang, J.-J., Luo, X.-H., & Chen, C.-Y. (2022). Does the Institutional Environment Influence Corporate Social Responsibility? Consideration of Green Investment of Enterprises -Evidence from China. Environmental Science and Pollution Research, 29(9), 12722–12739. https://doi.org/10.1007/s11356-020-09559-6

Hasanbeigi, A., Becqué, R., & Springer, C. (2019). Curbing Carbon from Consumption: The role of Green Public Procurement (p. 105). Global E ciency Intelligence.

Ho, L. W. P., Dickinson, N. M., & Chan, G. Y. S. (2010). Green procurement in the Asian public sector and the Hong Kong private sector. Natural Resources Forum, 34(1), 24–38. https://doi.org/10.1111/j.1477-8947.2010.01274.x

HSBC. (2021). 2021 China Green Finance Development Report. https://www.business.hsbc.com.cn/zh-cn/campaigns/china-green-finance-report-2021

Hu, Y., Wang, H., Liang, J., & Li, J. (2022). Green Credit Service in China: Policy Review and Flawed Regulation. Industrial Engineering and Innovation Management, 5(2), 44–49. https://doi.org/10.23977/ieim.2022.050207

ICAP. (2021a). China National ETS. International Carbon Action Partnership. https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems%5B%5D=55

ICAP. (2021b). Emissions Trading Worldwide: Status Report 2021 (p. 173). International Carbon Action Partnership (ICAP). IRENA. (2013). Renewable Energy Auctions in Developing Countries (p. 52). International Renewable Energy Agency.

IIGF, & UN Environment. (2017). Establishing China's Green Financial System: Progress Report 2017.

IISD. (2015a, March 19). Green Finance is a Growing Focus for China. International Institute for Sustainable Development. https://www.iisd.org/articles/green-finance-growing-focus-china

IISD. (2015b). Greening China's Financial System. International Institute for Sustainable Development. http://public.ebookcentral.proquest.com/choice/publicfullrecord.aspx?p=4532673

IRENA. (2013). Renewable Energy Auctions in Developing Countries (p. 52). International Renewable Energy Agency.

IRENA, & CEM. (2015). Renewable Energy Auctions—A Guide to Design (p. 200). International Renewable Energy Agency.

Lacroix, R.-N., Laios, L., & Moschuris, S. (2010, October). Sustainable Logistics: Challenges and Opportunities of Greening the Procurement Process. 1ST OLYMPUS INTERNATIONAL CONFERENCE ON SUPPLY CHAINS, KATERINI, GREECE. https://cm.ihu.gr/LOGISTICS/images/logisticsdocs/icsc2010/fullabstracts/1_6_ICSC2010_006_Lacroix_et_al.pdf

Lin, L., & Hong, Y. (2022). Developing a Green Bonds Market: Lessons from China. European Business Organization Law Review, 23(1), 143–185. https://doi.org/10.1007/s40804-021-00231-1

Liu, J., Ou, M., Sun, X., Chen, J., Mi, C., & Bo, R. (2022). Implication of Production Tax Credit on Economic Dispatch for Electricity Merchants With Storage And Wind Farms. Applied Energy, 308, 118318. https://doi.org/10.1016/j.apenergy.2021.118318

Liu, X., Zhang, W., Cheng, J., Zhao, S., & Zhang, X. (2022). Green Credit, Environmentally Induced R&D and Low Carbon Transition: Evidence from China. Environmental Science and Pollution Research. https://doi.org/10.1007/s11356-022-21941-0

Lu, A. H. (2019, August 28). Renewable energy policy and regulation in China | Lexology. Grandall Law Firm. https://www.lexology.com/library/detail.aspx?g=efcbe490-76b7-481a-9021-72b1a1ae4696

Lv, C., Bian, B., Lee, C.-C., & He, Z. (2021). Regional Gap and the Trend of Green Finance Development in China. Energy Economics, 102, 105476. https://doi.org/10.1016/j.eneco.2021.105476

Ma, R., Cai, H., Ji, Q., & Zhai, P. (2021). The Impact of Feed-In Tariff Degression on R&D Investment in Renewable Energy: The Case of The Solar PV Industry. Energy Policy, 151, 112209. https://doi.org/10.1016/j.enpol.2021.112209

Magill, B. (2015, September 25). China Announces World's Largest Cap and Trade Program | Climate Central. Climate Central. https://www.climatecentral.org/news/china-announces-cap-and-trade-program-19496

Mah, D. N., Cheung, D. M., Leung, M. K. H., Wang, M. Y., Wong, M. W., Lo, K., & Cheung, A. T. F. (2021). Policy Mixes and the Policy Learning Process of Energy Transitions: Insights from the Feed-In Tariff Policy and Urban Community Solar in Hong Kong. Energy Policy, 157, 112214. https://doi.org/10.1016/j.enpol.2021.112214

MAKE Consulting. (2018). China Takes a Step Closer to Grid Parity with the Introduction of Wind Auctions. MAKE Consulting.

Matthäus, D., Schwenen, S., & Wozabal, D. (2021). Renewable auctions: Bidding for Real Options. European Journal of Operational Research, 291(3), 1091–1105. https://doi.org/10.1016/j.ejor.2020.09.047

NEA. (2021). The Energy Administration's Letter Soliciting Proposals for the 2021 Renewable Energy Power Consumption Responsibility Weight and 2022-2030 Expected Goals (能源局征求 2021 年可再生能源电力消纳责任权重和 2022—2030 年预期目标建议的函).National Energy Administration.

OECD. (2014). Going Green: Best Practices for Green Procurement—KOREA [Case study submitted by the Korean Environmental Industry and Technology Institute (KEITI)]. OECD. https://www.oecd.org/governance/procurement/toolbox/search/korea-best-practices-green-public-procurement-gpp-legal-policy-framework.pdf

Ogunlana, A., & Goryunova, N. N. (2017). Tax Incentives for Renewable Energy: The European experience. 507–513. https://doi.org/10.15405/epsbs.2017.01.69

Palmer, K., & Burtraw, D. (2005). Cost-effectiveness of renewable electricity policies. Energy Economics, 27(6), 873–894. https://doi.org/10.1016/j.eneco.2005.09.007

People's Bank of China (PBC). (2022). Green Finance Helps Carbon Peak Carbon Neutrality. http://www.pbc.gov.cn/redianzhuanti/118742/4489076/4500507/index.html

RAIMI, D. (2020, May 19). China's Emerging Policies for Emissions Reductions, with Dick Morgenstern. Resources for the Future. https://www.resources.org/resources-radio/chinas-emerging-policies-emissions-reductions-dick-morgenstern/

REN21. (2020). RENEWABLES 2020 GLOBAL STATUS REPORT. REN21 Secretariat. https://www.ren21.net/wp-content/uploads/2019/05/gsr_2020_full_report_en.pdf

Roberts, D. (2020). Feed-In Tariffs for Renewable Power and the Role of Auctions: The Chinese & Global Experience. China Economic Journal, 13(2), 152–168. https://doi.org/10.1080/17538963.2020.1752494

Rowlands, I. H. (2005). Envisaging feed-in tariffs for solar photovoltaic electricity: European lessons for Canada. Renewable and Sustainable Energy Reviews, 9(1), 51–68. https://doi.org/10.1016/j.rser.2004.01.010

Sherlock, M. F. (2020). The Renewable Electricity Production Tax Credit: In Brief (CRS Report Prepared for Members and Committees and Congress No. R43453; p. 16). Congressional Research Service.

Sun, Q., & Nian, Z. (2022). Green Finance Practice and System Construction under the Vision of "Double Carbon." Journal of Fujian Normal University (Philosophy and Social Sciences Edition), 01, 71–79.

Talberg, A., & Swoboda, K. (2013). Emissions trading schemes around the world (p. 32). Department of Parliamentary Services, Parliament of Australia.

Tong, J., Yue, T., & Xue, J. (2022). Carbon Taxes and a Guidance-Oriented Green Finance Approach in China: Path to Carbon Peak. Journal of Cleaner Production, 367, 133050. https://doi.org/10.1016/j.jclepro.2022.133050

Vejaratnam, N., Mohamad, Z. F., & Chenayah, S. (2020). A Systematic Review of Barriers Impeding the Implementation of Government Green Procurement. Journal of Public Procurement, 20(4), 451–471. https://doi.org/10.1108/JOPP-02-2020-0013

Wang, C., Shi, Y., Zhang, L., Zhao, X., & Chen, H. (2021). The Policy Effects and Influence Mechanism of China's Carbon Emissions Trading Scheme. Air Quality, Atmosphere & Health, 14(12), 2101–2114. https://doi.org/10.1007/s11869-021-01081-z

Wang, S., Zhao, W., Fan, S., Xue, L., Huang, Z., & Liu, Z. (2022). Is the Renewable Portfolio Standard in China Effective? Research on RPS Allocation Efficiency in Chinese Provinces Based on the Zero-Sum DEA Model. Energies, 15(11), Article 11. https://doi.org/10.3390/en15113949

Wang, X., & Wang, Q. (2021). Research on the Impact of Green Finance on the Upgrading of China's Regional Industrial Structure from the Perspective of Sustainable Development. Resources Policy, 74, 102436. https://doi.org/10.1016/j.resourpol.2021.102436

Wang, X., Zhao, H., & Bi, K. (2021). The Measurement of Green Finance Index and the Development Forecast of Green Finance in China. Environmental and Ecological Statistics, 28(2), 263–285. https://doi.org/10.1007/s10651-021-00483-7

Welisch, M., & Poudineh, R. (2020). Auctions for Allocation of Offshore Wind Contracts for Difference in the UK. Renewable Energy, 147, 1266–1274. https://doi.org/10.1016/j.renene.2019.09.085

Wen, H., Lee, C.-C., & Zhou, F. (2021). Green Credit Policy, Credit Allocation Efficiency and Upgrade of Energy-Intensive Enterprises. Energy Economics, 94, 105099. https://doi.org/10.1016/j.eneco.2021.105099

Wiser, R., Murray, C., Hamrin, J., & Weston, R. (2003). International Experience with Public Benefits Funds: A Focus on Renewable Energy and Energy Efficiency. Energy Foundation, China Sustainable Energy Program. https://resource-solutions.org/wp-content/uploads/2015/08/IntPolicy-China.PBF_.pdf

WOOD MACKENZIE POWER & RENEWABLES. (2018). China Takes a Step Closer to Grid Parity With the Introduction of Wind Auctions. https://www.greentechmedia.com/articles/read/china-takes-a-step-closer-to-grid-parity-with-the-introduction-of-wind-auct

World Bank. (2021). Green Public Procurement: An Overview of Green Reforms in Country Procurement Systems. World Bank. https://doi.org/10.1596/36508

Xu, T., & Ma, J. (2021). Feed-In Tariff or Tax-Rebate Regulation? Dynamic Decision Model for the Solar Photovoltaic Supply Chain. Applied Mathematical Modelling, 89, 1106–1123. https://doi.org/10.1016/j.apm.2020.08.007

Yang, D., Jing, Y., Wang, C., Nie, P., & Sun, P. (2021). Analysis of renewable energy subsidy in China under uncertainty: Feed-in tariff vs. renewable portfolio standard. Energy Strategy Reviews, 34, 100628. https://doi.org/10.1016/j.esr.2021.100628

Yeo, Y., Shin, K., & Lee, J. (2016). The Effects and Implications of Green Public Procurement with Economy-wide Perspective: A Computable General Equilibrium Approach. In EcoMod2016 (No. 9519; EcoMod2016). EcoMod. https://ideas.repec.org/p/ekd/009007/9519.html

Yu, C.-H., Wu, X., Lee, W.-C., & Zhao, J. (2021). Resource Misallocation in the Chinese Wind Power Industry: The Role of Feed-In Tariff Policy. Energy Economics, 98, 105236. https://doi.org/10.1016/j.eneco.2021.105236

Zhang, C., Chang, K., & Zeng, H. Y. (2021). The influences of fiscal and credit policies on renewable energy enterprises' investment in China. Journal of Renewable and Sustainable Energy, 13(2), 025901. https://doi.org/10.1063/5.0036258

Zhang, J., Luo, Y., & Ding, X. (2022). Can Green Credit Policy Improve the Overseas Investment Efficiency of Enterprises in China? Journal of Cleaner Production, 340, 130785. https://doi.org/10.1016/j.jclepro.2022.130785

Zhang, M., Zhang, C., Li, F., & Liu, Z. (2022). Green Finance as an Institutional Mechanism to Direct the Belt and Road Initiative towards Sustainability: The Case of China. Sustainability, 14(10), Article 10. https://doi.org/10.3390/su14106164

Zhou, L. (2022). China's Outstanding Green Bonds Reach 1.2 trillion Yuan. ChinaDaily. https://www.chinadaily.com.cn/a/202209/27/WS63330a3ba310fd2b29e7a11c.html

Zhu, C., & Song, J. (2020, February). Renewable energy procurement comes to China. PV Magazine International. https://www.pv-magazine.com/2020/02/27/renewable-energy-procurement-comes-to-china/