Governance first, markets second
Policy recommendations for a carbon-neutral China

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Introduction

Two years ago, President Xi Jinping announced to the 75th session of the United Nations General Assembly that the country would adopt more vigorous policies and measures to combat climate change. He said that China aimed to peak its carbon dioxide (CO_2) emissions before 2030 and achieve carbon neutrality before 2060. A guidance document and action plan to achieve these goals followed a year later, in October 2021. The government incorporated the 2030 and 2060 climate goals into its updated Nationally Determined Contribution (the country's climate action plan), required as part of the Paris Agreement on Climate Change.[1]

This is a considerable step for China. The country is—by a long way—the world's largest emitter of CO_2,[2] and emissions continue to rise. China's pledge to achieve carbon neutrality, in which human activity no longer results in net emissions of CO_2 into the atmosphere, potentially heralds a breakthrough in the global fight against climate change.

China has made significant progress in reducing the carbon intensity of its economy and made great gains in energy efficiency across its industrial sector. It has seen tremendous growth in the use of wind and solar renewable power. The country's total production of renewable electricity is only slightly less than that of Europe.[3]

China has had considerable success in developing the technologies required for a carbon-neutral economy. It is a global leader in the production of photovoltaic solar panels. And it has the leading position in the electric vehicle battery supply chain. Around half of all electric vehicles in the world are in China, thanks to strong policy support.

China is a leader in the so-called "clean coal technologies" that burn coal more efficiently and emit less CO_2 per unit of electricity generated. Its stock of coal-fired power stations is globally much more efficient than those in Europe and the United States. The country is investing in its electrical grid infrastructure and experimenting with power trading—moves that will support greater use of renewable energy.

Despite this progress, the scale of change required to achieve carbon neutrality should not be underestimated. It will require a radical restructuring of the country's entire energy system and economy, and it will have major implications for China's institutions and governance system.

This discussion paper is based on workshops and interviews conducted (in July–September 2021) with Chinese and European experts on the environment, climate change, energy and governance. It discusses the driving forces behind China's quest for carbon neutrality and the primary sources of CO_2 emissions. It examines the institutions, policies and instruments that are shaping the energy system and analyses reduction efforts across four major areas of CO_2 emissions. It also highlights obstacles to implementing the carbon-peaking and carbon-neutral commitments and makes policy recommendations to help keep China on the path to achieving carbon neutrality by 2060.

The government has indeed made considerable progress in announcing polices, guidance and initiatives to move towards its climate commitments. Many of the recommendations are aligned with and build upon these government initiatives.

1 Chinese Government Report to the United Nations Framework Convention on Climate Change (UNFCCC): "China's Achievements, New Goals and Measures for Nationally Determined Contribution" available at https://www.fes.de/lnk/4j4, last accessed on 14th February 2022.

2 China accounts for about 28% of total greenhouse gas emissions from fossil fuels according to the International Energy Agency (2021), GHG Emissions from Energy, available at https://www.fes.de/lnk/4j5, last accessed on 14th February 2022.

3 "International Energy Agency press release: "China has a clear pathway to build a more sustainable, secure and inclusive energy future", available at https://www.fes.de/lnk/4j6, last accessed on 29th September 2021.

Carbon neutrality: Minimizing risk and becoming a global leader in key industries

China's attitudes towards the environment have changed as the country has developed and its priorities have shifted. In the 1980s, the focus was on tackling localized industrial pollution. In 1994, the State Council, which is the executive body of the government, approved the Agenda 21 blueprint for sustainable development. Agenda 21 combined a focus on economic growth with poverty elimination, population control, protection of the environment and the more sustainable use of natural resources. Agenda 21 undoubtably delivered on economic growth and poverty; in the mid-1990s, China had around 500 million people living on less than $1.90 a day (the World Bank's benchmark for measuring global poverty). By 2016, this had fallen to 7.2 million.[4] However, the environment was neglected in the rush for development.

The burning of coal and the rise of heavy industry and construction all contributed to a significant deterioration of the air quality in vast parts of China. By 2013, the situation had become so bad that the government felt compelled to release a policy specifically to control air pollution in major urban centres.[5]

Since 2007, a new concept called "ecological civilization" appeared in the discourse around the environment.[6] It came to prominence in a speech by then-President and Communist Party General Secretary Hu Jintao at the 17th National Congress of the Communist Party of China in 2007. Ecological civilization differs from sustainable development and Agenda 21 in the emphasis it places on the political and cultural dimensions of sustainability. It requires changes in the thinking and actions of institutions, officials and citizens. Ecological civilization has grown in importance under President Xi. The principles of ecological civilization were incorporated into the Communist Party of China Constitution in 2012 and the People's Republic of China Constitution in 2018. The concept has become closely associated with President Xi's ideas and theories around development and the challenges that the country faces in the twenty-first century. These include modernizing the system of governance and maintaining economic growth and development so that China becomes a stronger country with greater international influence and its people enjoy happier, safer and healthier lives.[7]

A comprehensive guidance document outlining the core principles and main objectives of ecological civilization was published in 2015.[8] In addition to protecting the environment, ecological civilization calls for improving spatial planning and urbanization to better consider the impacts on resources and the environment. It calls for innovation and structural adjustment to improve the quality and efficiency of industry. It also recognizes the need to strengthen environmental governance by better monitoring and implementing environmental laws and regulations. Ecological civilization also highlights the need to respond to climate change and to control greenhouse gas emissions.

A shift in climate thinking

In discussions around climate change, China has historically advocated the principle of "common but differentiated responsibilities and respective capabilities". This principle, incorporated into the 1992 United Nations Framework Convention on Climate Change, maintains that because developed countries are responsible for the largest share of

4 BBC: "Has China lifted 100 million people out of poverty?", available at www.bbc.com/news/56213271, last accessed on 28th February 2021.

5 The Central People's Government of the People's Republic of China: "Action plan for the prevention and control of air pollution of September 10th, 2013", available at https://www.fes.de/lnk/4j7, last accessed on 14th February 2022.

6 C. Goron: "Ecological civilization and the political limits of a Chinese concept of sustainability" in China Perspective, vol. 4 (2018), pp. 39–52.

7 China Daily: "Xi Jinping's report at 19th CPC National Congress", 18th October 2017, available at https://www.fes.de/lnk/4j8, last accessed on 14th February 2022.

8 The Central People's Government of the People's Republic of China: "Opinions of the Central Committee of the Communist Party of China and the State Council on Accelerating the Construction of Ecological Civilization" (Beijing, 2015), available at www.gov.cn/xinwen/2015-05/05/content_2857363.htm, last accessed 20th January 2022.

historical emissions, they should take the lead in emissions reduction. As a developing country, China argued it should be allowed to grow its emissions in line with its continuing economic development.[9]

The shift to committing to achieve carbon neutrality by 2060 (albeit ten years later than most developed economies and even as its emissions are still growing) shows how China's attitude towards climate change has changed in recent years. The carbon neutrality commitment only considers CO_2 emissions. These are by far the single-largest contributor to climate change, accounting for three quarters of global greenhouse gas emissions from human activity.[10] However, other greenhouse gases from industrial processes also possess significant global warming effect, including methane, nitrous oxide and fluorinated gases. China declared in 2021 that it will take action to control non-CO_2 greenhouse gas emissions,[11] particularly methane.[12] This will help in efforts to reach climate neutrality where human activity results in no net effect on the climate system.

Climate change is a long-term threat …

What is behind China's change in thinking around climate change? Chinese decision makers and climate experts are increasingly aware of the threat that climate change represents to the country, its economy and its citizens. As shown in multiple scientific studies, climate change is expected to increase the frequency of extreme weather events, further exacerbating existing environmental problems. China's per capita water resources are only a quarter of the global average.[13] Further warming will put more stress on these resources, especially in the arid north of the country, which is already subject to frequent drought. The eastern and southern regions of the country, on the other hand, are expected to see more frequent occurrences of flooding, especially in the areas around the heavily populated Yangtze River and Pearl River deltas.

Rising temperatures and an increased likelihood of flooding will impact the agriculture sector and the county's food security. More extreme temperatures will lead to increased demand on China's scarce energy resources for cooling and heating of buildings. Rising sea levels and coastal flooding have the potential to cause huge economic damage in and around some of China's most densely populated coastal regions and cities. Higher temperatures and floods will also impact labour productivity, especially if temperatures become too hot to work outside.

… but also an opportunity

For years, much of the global community has criticized China for dragging its feet in addressing climate change. Proactively taking the lead in reducing emissions will support its ambitions to have greater global influence. And it will enhance the country's soft power.

Creating a carbon-neutral economy will greatly improve the environment and quality of life for China's population. In doing so, it will help President Xi achieve his goal of creating a greener China with a much-improved environment for its citizens.

China's transport sector is hugely dependent on imported oil. It is the world's largest importer, most of which travels via sea, where it is vulnerable to potential disruptions at choke points, such as the Malacca Straits. The use of low-carbon electricity in place of oil in the transport sector would help reduce emissions and help alleviate the growing concerns around energy security.

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9 Iselin Stensdal: "China's Climate-Change Policy 1988-2011: From Zero to Hero?", FNI Report.

10 Total emissions of greenhouse gas due to human activity were 48.9 Gt in 2018 with CO_2 accounting for 35.2 Gt of this total, see World Resources Institute: "4 Charts Explain Greenhouse Gas Emissions by Countries andSectors", available at https://www.fes.de/lnk/4j9, last accessed on 14th February 2022.

11 Chinese Government Report to the United Nations Framework Convention on Climate Change (UNFCCC): "China's Achievements, New Goals and Measures for Nationally Determined Contribution", available at https://www.fes.de/lnk/4j4, last accessed on 14th February 2022.

12 U.S. Deparment of State: "U.S.–China Joint Glasgow Declaration on Enhancing Climate Action in the 2020s", available at www.state.gov/u-s-china-joint-glasgow-declaration-on-enhancing-climate-action-in-the-2020s, last accessed on 20th January 2022.

13 The Central People's Government of the People's Republic of China: "The People's Republic of China Second Biennial Update Report on Climate Change" (2018), available at https://www.fes.de/lnk/4ja, last accessed on 14th February 2022.

But perhaps more importantly, reducing emissions to tackle climate change will mean a staggering transformation of the global economic system. Achieving carbon neutrality will require China to adjust its economic model, from a reliance on investment and carbon-intensive heavy industry towards a more efficient and innovative, low-carbon green economy. Done successfully, it could potentially put China in a position of global economic leadership.

Seen in this light, China's commitment to peak emissions by 2030 and creating a carbon-neutral economy by 2060 are strategic targets that go beyond climate and environmental protection. Making good on the climate goals might compel officials and institutions to drive wide-ranging change across the economic, social and political systems in support of the next stage of development.

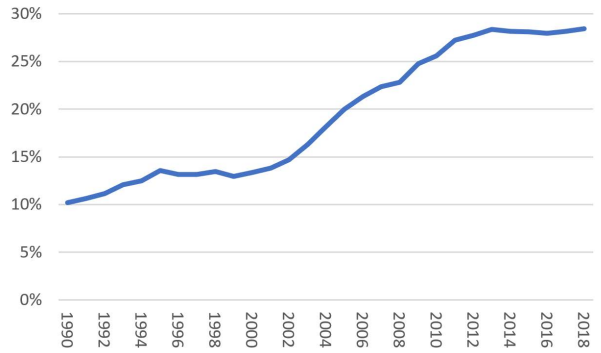
China's social and economic future is dependent on it becoming a low-carbon, technologically advanced green society. Its transformation from one of the world's poorest countries in 1980 to the world's second-largest economy today illustrates what the country can achieve. The Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality in Full and Faithful Implementation of the New Development Philosophy, issued by the State Council in October 2021, gives some indications. What is now needed is a deeper debate around the obstacles to this goal and details on how to make the carbon-neutral commitment a reality.

China's emissions: Slowing but heavy on industry, low on transport

A country's CO_2 emissions from fossil fuels are largely dependent on its level of economic development, the size of its population, its economic structure and sources of energy. With slightly more than 1.4 billion people, China is the world's most populous country. In just four decades it has moved from being one of the world's poorest countries to an upper-middle-income country and the world's second-largest economy.

Figure 1: China's share of global CO_2 emissions, 1990–2018

Source: International Energy Agency (2020), available at https://www.fes.de/lnk/4j5 , accessed on 14th February 2022.

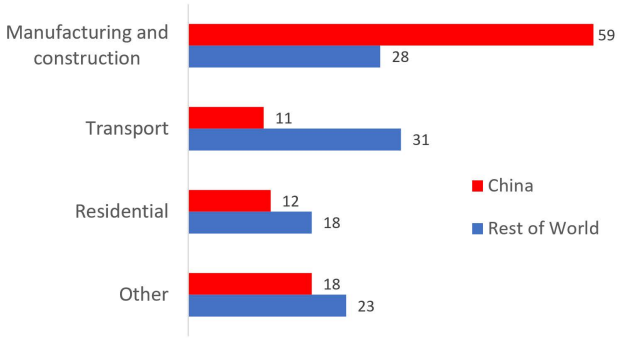


Energy-intensive manufacturing, exports and urbanization have been responsible for much of China's economic success. Over the past two decades, the urban population has grown by more than 400 million persons.[14] Basic materials such as cement and steel have been used to build the houses and infrastructure for the newly urbanized populations, but they have been a significant contributor to the CO_2 emissions. China's per capita consumption of steel and cement is among the highest in the world (figure 2).

This economic dependence on industry and manufacturing means that per person industrial emissions are higher than those of more advanced economies that are less dependent on the industrial sector to drive growth. The country's per capita emissions from buildings and transport,

Figure 2: CO_2 emissions, by end-use sector (percentage)

Source: International Energy Agency (2020), available at https://www.fes.de/lnk/4j5, accessed on 14th February 2022



however, are lower than those of advanced economies. The extent to which China's economic structure is oriented towards carbon-intensive industry can be seen in figure 2. Manufacturing and construction's share of China's total emissions is more than double that of the rest of the world.

Despite being the world's largest user of renewable energy, China is still heavily reliant on coal, which provides 56.8 per cent of its total energy and 78 per cent of its electricity consumption, according to China's National Bureau of Statistics (2020). Coal emits around 1.7 times more CO_2 than natural gas for the same amount of energy. The dominance of coal means that China's per capita CO_2 emissions are higher than those of similar economies that use a greater share of lower-carbon fuels, such as natural gas, nuclear power and renewables.

China's energy-intensive industrial structure and dependence on coal means that despite being an upper-middle-income country, its per capita CO_2 emissions are actually higher than those of some advanced economies like Japan and the European Union (though not the United States).

14 The World Bank: "Urban Population – China", available at https://data.worldbank.org/indicator/SP.URB.TOTL?locations=CN, last accessed 15th December 2021.

Central areas of action for a climate-neutral China

Achieving climate neutrality will be a challenge across several sectors, ranging from more efficient administration to reforms in the major emitting industries. The following table and ensuing explanations break down much of what needs to be done by sector.

Governance first, markets second

- Improve coordination between central ministries and agencies to avoid potential conflicts.
- Encourage and institutionalize provinces to cooperate and clarify how risks and benefits are shared among provinces.
- Improve monitoring and supervision of local governments.
- Use lessons learned to adjust and fine-tune central government policies.
- Establish a financial assistance fund to support areas facing serious socioeconomic difficulties in phasing out fossil fuels and moving to a low-carbon economy.
- Allow household energy prices to rise to reflect the true cost of production, including carbon.

Electricity: Change rewards and invest in flexible grids

- Reward coal-fired power stations for providing flexibility and peak shaving rather than for guaranteed operating hours.
- Prioritize investment in a flexible grid with better interregional connectivity.
- Actively develop power markets to allow more cost competitive renewables to have a greater role in generation.
- Remove residential subsidies so that electricity prices reflect the true cost of production.
- Encourage greater grid connectivity across provinces to support greater use of renewable energy sources and reduce need for excess coal-fired capacity.
- Wealthier regions should take the lead ahead of poorer regions in this process towards moving away from coal-fired generation.
- Implement just transition funds to provide economic support to regions dependent on coal.

Buildings: Implement 15-minute cities, improve and enforce standards

- Upgrade and better enforce energy efficiency and building construction standards.
- Reform local government finances to reduce reliance on land sales.
- Introduce taxes to reduce speculative property purchases.
- Develop policy instruments that would support the renovation and retrofitting of buildings over demolition and new construction.
- Plan and build integrated cities where basic services are all nearby (so-called "15-minutes cities").
- Extend the emissions trading scheme to building materials.
- Lead by example: Build government projects and social housing with the highest efficiency standards.

Industry: Push for greater energy efficiency and electrification

- Extend energy efficiency programmes to cover all manufacturing and new economy infrastructure.
- Accelerate government support and funding for the research, development and deployment of low- and zero-carbon technologies.
- Include industry in the emissions trading scheme and therefore push for higher energy efficiency. electrification and use of low- and zero-carbon technologies.

Transport: Support electrified vehicles and reconfigure cities

- Encourage the development of battery-powered cars.
- Support the development of charging infrastructure.
- Extend restrictions on internal-combustion engine vehicles to more cities.
- Set deadlines to phase out the sale of internal-combustion engine vehicles.
- Reconfigure cities to create communities that support living and working locally and encourage walking and cycling over the use of private vehicles.

Governance first, markets second

Meeting the carbon peaking and carbon neutrality commitments will require an overhaul of governance and institutions. Government departments and regulatory agencies, laws and standards all will need to be strengthened and reformed.

The need to improve environmental institutions is reflected in the principles of ecological civilization, which is the government's high-level policy framework for green, low-carbon development. They include improving laws and regulations governing the environment and pollution as well as enhancing the use of property rights and tools, such as prices, taxes, financing and other market-based mechanisms, to help reduce emissions and improve the environment. Ecological civilization also calls for the country to improve supervision, monitoring and enforcement of environmental laws and regulations.

Central versus local

Policy planning is highly centralized in China. Virtually all major laws and policies are drafted by the central government in Beijing. Responsibility for implementing them is delegated to provincial and city governments. These local governments are given considerable discretion in how they implement central government directives, allowing them to be selective and innovative in how they apply them to local conditions.

This system of governance, however, encourages provinces to compete rather than cooperate with each other in attracting investment and driving growth. It has been less effective in solving problems of climate change and environmental governance, which extend beyond provincial boundaries. Moreover, local governments are often asked by the central government to achieve multiple and sometimes conflicting goals. In the socioeconomic realm, they must maintain growth, improve living conditions, provide employment and balance government finances as well as protect the environment. Success and promotion for local officials depends on juggling these priorities.

Given the overwhelming importance placed on economic growth by the central government until very recently, it is hardly surprising that local governments have tended to neglect environmental regulations in favour of boosting gross domestic product.

The widespread failure of local governments to control pollution and protect the environment has led to serious systemic environmental problems. The central government has in recent years addressed these failures using coordinated campaigns. In 2013, the government launched an action plan to control air pollution in response to the worsening air quality across many localities. But the best policy is ineffective if it is not combined with monitoring and supervision measures. One effort in this regard is a rolling campaign of environmental inspections that started in 2016. Led by officials appointed by the central government, it has resulted in more than 29,000 companies being fined more than 1.43 billion yuan ($216 million) and with 18,199 officials being disciplined for not correctly enforcing environmental regulations.[15] Still, supervision mechanisms need to go beyond periodic campaigns and instead become a permanent, predictable element in environmental policy implementation.

Some regions will be impacted more than others by the economy's transformation towards carbon neutrality. Regions such as Shanxi Province, the Inner Mongolia Autonomous Region and parts of Guizhou Province (among others) are vastly dependent on the coal industry. Others, like Hebei, Shandong and the provinces of China's northeast are the homebase of the country's heavy, carbon-intensive industries. To foster acceptance and justice in the quest for carbon neutrality, the central government will need to find ways to mitigate the consequences that transformation will have on employment and incomes within these regions.

Central government support is crucial for the advancement of climate policies. However, overzealous implementation by local officials keen to meet politically important central government priorities can lead to unforeseen and unintended consequences. In 2017, for instance, northern China's Hebei Province switched more than 2.5 million households from coal boilers to natural gas and electricity to meet year-end clean air targets. But ensuing gas supply shortages and the

15 China Perspectives (December 2018 edition): "Ecological civilization and the political limits of a Chinese concept of sustainability", available at http://journals.openedition.org/chinaperspectives/8463, last accessed on 20th January 2022.

lack of gas supply infrastructure left many homes without heat over the freezing winter.

The central government has learned from these experiences. It does not to want to make the same mistakes in pursuing its carbon-peaking and neutrality commitments. The Politburo, China's highest decision-making body, recently announced that it would meet its 2030 carbon-peaking commitments in an "orderly" manner and would correct any "campaign-style" carbon reduction by local governments.[16] This, however, has also been a common pattern in the past. At the same time, too much control from the centre brings the danger that it stifles grass-roots policy innovation and local experimentation.

Better coordination across central government

Part of the problem is lack of coordination across departments and ministries in the central government. Too often the priorities of agencies and ministries are not aligned, resulting in conflicts when policies are implemented at the local level. This can be seen in the failure to control the growth of CO_2 emissions, one of the goals in the previous Five-Year Plan.

Responsibility for climate change is shared across several ministries but primarily the Ministry of Ecology and Environment and the National Development and Reform Commission, a powerful ministry-level planning body. Much of the blame in not controlling CO_2 emissions has been attributed to the National Energy Administration, an energy planning body under the Commission. The National Energy Administration was publicly sanctioned in 2020 by a high-level central government inspection team for not placing environmental protection as a "high priority" and for promoting the development of coal power projects.[17]

More powerful and centralized than the state organs are the so-called Leading Small Groups of the Central Party Committee, which are characteristic of the leadership style of President Xi. They include the heads of most major ministries and agencies dedicated to meeting the 2030 peaking and 2060 neutrality goals. Indeed, they may bring the central coordination that is essential for a successful climate policy. One Leading Small Group is specifically dedicated to climate change, headed by Prime Minister Li Keqiang. Another one, headed by Politburo Standing Committee member Han Zheng, is leading the work on climate neutrality. The party leadership has used similar bodies in the past to lead and coordinate issues of national importance. The formation of this carbon-peaking and carbon-neutrality leading group reflects the political importance of meeting the 2030 and 2060 climate commitments.[18]

Markets need time to develop

The government has for many years been trying to reduce its intervention in markets and give greater freedom to market forces and pricing mechanisms to allocate resources across the economy. Progress has been slow, especially in the energy sector.

State-owned companies have a major role in China's economic system. They are often dominant players in their industrial sector or local area. Because they provide significant tax revenues and employment to local governments, they are often protected and given special treatment. This protectionism further inhibits the growth and development of competitive markets. Where competitive markets do exist, the government frequently intervenes to stabilize prices and protect state-owned players. As a result, there has been a cycle of shortage and overcapacity in the coal industry since at least the 1990s. In 2021, for example, the government ordered coal companies to increase production and, to control rising commodity prices, asked metal companies not to push up prices of raw materials.[19]

Electricity markets have been under development for decades, with renewed impetus since 2015, but despite

16 Carbon Brief (August 2021 edition): "China issues new 'single-game' instructions to guide its climate action", available at www.carbonbrief.org/china-issues-new-single-game-instructions-to-guide-its-climate-action, last accessed on 4th August 2021.

17 Carbon Brief (February 2021 edition): "Q&A: could an environmental inspector's criticisms accelerate China's climate policies?", available at https://www.fes.de/lnk/4jb, last accessed on 5th February 2021.

18 Carbon Brief (June 2021 edition): "Explainer: China creates new 'leaders group' to help deliver its climate goals", available at https://www.fes.de/lnk/4jc, accessed on 3rd June 2021.

19 Reuters: "China intervenes to manage commodity prices", 4th August 2021, available at https://www.fes.de/lnk/4jd, accessed on 4th August 2021.

recent progress, they are not yet fully established everywhere across the national territory. This means that, by and large, the government continues to control energy prices and coal production rather than let them be dictated by the market. Until recently, this inhibited the use of renewable energy, which is too often squeezed out by other power sources, notably coal.[20]

The price of electricity (and heating) for households is kept artificially low across China. This is understandable when it protects poorer citizens living on low incomes. It makes less sense to subsidize prices for the urban middle class in developed cities who consume the most electricity. Keeping prices low encourages waste and gives little incentive for consumers to change their behaviours and choose more energy-efficient products. Over time, household energy prices should rise to better reflect the cost of production. But the government is sensitive to the effect this could have on inflation and social stability should this take place too rapidly.

Emissions trading scheme is ambitious

The price of carbon-intensive materials such as steel, cement and electricity do not yet include the price of CO_2 emitted during their production. China's National Emissions Trading Scheme, which has been a long time in development, finally started trading in 2021. The emissions trading scheme initially covers only China's power generation sector. Steel, concrete and other energy-intensive industries are not yet included. And due to the absence of marketized electricity prices, the carbon price born by the power sector cannot be transferred to, nor generate a price signal for the development of these industrial consumers. Even so, the launch makes it the world's largest carbon-trading scheme by volume of emissions. Over the long term, the scheme could be a useful tool in reducing emissions. In the short term, it may be of more political significance than anything else. The scheme currently only puts a price on the intensity of emissions, that is: on the CO_2 emitted per unit of electricity produced rather than on the absolute amount of CO_2 emitted by regulated facilities.

It took the European emissions trading scheme more than 15 years and several revisions to its governance framework for it to be better aligned with the European Union's climate policy objectives. There is little reason to expect that China's emissions trading scheme will develop much faster. More importantly, until other markets, such as electricity, are liberalized so that the price of carbon can be reflected in the market price of electricity, the emissions trading scheme will have little effect on shifting the energy mix towards cleaner sources of energy.

Recommendations

- Government-led administrative measures, incentives and penalties are likely to be more effective than market solutions in reducing China's emissions in the immediate term.

- The government should improve coordination to avoid potential conflicts between ministries, agencies and supervisory bodies, which could reduce the effectiveness of measures designed to reduce emissions. The party leadership recently took important steps by forming the Leading Small Groups.

- There are significant benefits to encouraging provinces to cooperate rather than compete with one another. Encouraging wider provincial cooperation could help accelerate the development of power markets. It could also help ensure that the move towards a carbon-neutral economy is a just transition, where the costs and benefits of carbon neutrality are more widely shared across the economy and society.[21]

- The regional integration needs to be institutionalized and formalized with a framework that details how risks and benefits are shared between the various regional stakeholders. This process could start in wealthier, more-developed areas like the eastern Yangtze River delta.

- Despite the importance of the climate targets, local governments may remain reluctant to take the bold

20 EU-China Energy Cooperation Platform: "Electricity markets and systems in the EU and China, June 2020", available at https://ec.europa.eu/energy/sites/default/files/electricity_markets_report_en.pdf, last accessed on 14th February 2022.

21 European Bank for Reconstruction and Development: "What is a just transition?", available at www.ebrd.com/what-we-do/just-transition, accessed on 4th November 2021.

actions required to achieve them. Part of this may be due to a lack of understanding around climate change and how the economy and society need to change to achieve them. The increased emphasis on climate change and the shift towards focusing on the quality of economic growth over meeting numerical GDP targets will help shift the incentives for local government away from growth at all costs and towards environmental protection.[22]

- Better monitoring and supervision of local governments will further improve climate governance. Central government environmental inspection bodies have helped to overcome some local government protectionism of polluting industries. A similar type of mechanism may be useful in monitoring local governments' implementation of their climate targets.

- The risk of this more centralized, top-down approach is that it may inhibit local governments' willingness to experiment and develop innovative ways of moving towards net-zero emissions. Central government monitoring and supervision should ensure that it can capture lessons learned at the local level and feed them back up to the central government so that policies and instruments can be adjusted and fine-tuned.

- Local governments may remain hesitant to close carbon-intensive industries, such as steel mills, coals mines and fossil fuel power plants, if they are dependent on them for revenue and employment. To support local governments in taking such a bold step, the central government could establish a financial assistance mechanism to support areas facing serious socioeconomic challenges in moving towards a carbon-neutral economy. Although China's political and economic situation is different to that of the European Union, the European Union's Just Transition Fund might serve as a useful template for policymakers that could be adapted to China's circumstances.[23]

- Measures need to be introduced to tackle demand. Household energy prices should be allowed to rise to better reflect the true cost of production, including the use of carbon. This will help raise awareness across the wider society on the need to limit consumption and encourage consumers to make better informed decisions around household energy efficiency.

- Care needs to be taken to ensure that price rises are just and fair across society. Prices should rise first in wealthier regions where consumers are better able to afford it. Subsidies can be removed in poorer areas once their incomes have risen to a level where they are better able to absorb the market cost of energy.

Electricity: Change rewards and invest in flexible grids

The technologies for producing low-carbon electricity from renewable energy, hydropower and nuclear power plants are mature and well understood. The cost of wind and solar renewable power has fallen significantly over the past decade. Renewable energy is now cost-competitive with coal-fired capacity.[24] In his address to the 76th session of the United Nations General Assembly (in September 2021), President Xi announced that China will not build any new coal-fired power projects overseas.[25] The challenge for China domestically is how to best accelerate the removal of coal-burning practices and replace them with low-carbon alternatives.

The power sector is slowly being reformed. Many provinces have set up power markets, and a handful of provinces have developed electricity spot markets. These are all still in the early stages of development. A market mechanism such as economic dispatch, whereby demand is met by the lowest cost source of electricity, is currently little used in China.

22 Reuters: "China's shift away from 5-year targets increases policy flexibility: official" 8th March 2021, available at www.reuters.com/article/us-china-parliament-economy-ning-idUSKBN2B00DL, accessed on 8th March 2021.

23 European Parliament: "Fact Sheets on the European Union – Just Transition Fund", available at www.europarl.europa.eu/factsheets/en/sheet/214/just-transition-fund-jtf, accessed on 14th February 2022.

24 International Renewable Energy Agency: "Renewable Power Generation Costs in 2020", available at www.irena.org/publications/2021/Jun/Renewable-Power-Costs-in-2020, last accessed on 14th February 2022.

25 BBC : "China pledges to stop building new coal energy plants abroad" 22nd September 2021, available at www.bbc.com/news/world-asia-china-58647481, last accessed on 14th February 2022.

Recent laws, administrative measures and clean energy targets prioritize the use of renewable energy over new coal capacity.[26] Yet, as of 2018, 78 per cent of China's electricity was still generated from coal-fired units. Most of them must provide a certain number of guaranteed hours of electricity. Guaranteeing "full load hours" for coal units makes it hard for renewable energy to take on a greater role even when it is cheaper.

The grid is designed around coal-fired generation. It lacks the flexibility to incorporate a greater share of renewable electricity. The problem is compounded by the lack of connectivity across provinces. This incentivizes each province to build enough generation capacity to ensure their own energy security. The result has been a significant excess of coal-generation capacity across the country.

China's coal sector is politically powerful. Interest groups include mine workers of state-owned enterprises, power companies and rail companies that transport coal and coal-fired power equipment for manufacturers. Some estimates suggest that the coal sector might be responsible for employing about 6.6 million people.[27]

The various players in the power sector, from miners to power utilities and the grid distribution companies, all have different economic and political interests. This makes the sector extremely hard to reform. Many coal plants are heavily indebted, often due to successively imposed technological upgrades. Any reduction in their operating hours could see them become unprofitable. The government is trying to remove the most indebted coal-fired-generation assets and reduce overcapacity from the system.[28]

The government sets power prices. Residential electricity, as well as industrial consumption, are both subsidized. Removing these subsidies would encourage consumers to make better decisions around consumption and help reduce demand. This is politically challenging, however. There is still considerable income inequality in China. Raising electricity prices across the country could disadvantage poorer sections of society and lead to social instability.

Recommendations

- The initial focus should be on reducing emissions from coal-fired power plants. Coal-fired power stations should be rewarded for providing flexibility and peak shaving during times of high demand rather than being paid for a guaranteed number of full load hours. This could be revenue-neutral. Their income could stay unchanged, but the change in function would result in burning less coal.

- Over the long term, the focus should be on structural reforms that allow markets to better reflect the true cost (including environmental cost) of coal-fired power generation, allowing lower carbon generation to assume a greater role.

- Grid companies should be incentivized to prioritize investment in creating a more flexible grid. This would include enlarging the grid beyond provincial boundaries and allowing it to balance over a larger area and reduce renewable curtailment. A more flexible grid, including storage, can utilize higher levels of renewable energy and support the retirement of excess coal capacity.

- Power markets should be encouraged to develop so that prices reflect the true cost of fossil fuels, including carbon. Residential subsidies should be gradually removed. And this process needs to recognize that it must be a just transition.

- The development of market price mechanisms and the retirement of uncompetitive coal assets should be managed regionally. The process should start in the more developed, wealthier regions, such as the Yangtze River and Pearl River deltas, which are better placed to allocate the costs and benefits associated with retiring coal-burning assets and developing more renewable

26 Columbia University Center on Global Energy Policy: "Trends and Contradictions in China's Renewable Energy Policy" 28th August 2020, available at https://www.fes.de/lnk/4je, last accessed on 14th February 2022.

27 Nautilus Institute for Security and Sustainability (Qingyi Wang): „Coal Industry in China: Evolvement and Prospects", available at www.nautilus.org/wp-content/uploads/2015/04/C5_final.pdf, accessed on 14th February 2022.

28 Reuters: "China to slash coal-fired power capacity at big utilities by merging assets" 2nd December 2019, available at www.reuters.com/article/china-coal-debt-idUSL4N28C1Y9, accessed on 14th February 2022.

sources. Lessons learned should be captured and used when less-developed areas are reformed.

- A transition fund can be used to provide economic support to regions that are particularly reliant on coal, such as the area around Shanxi and Shaanxi provinces and the Inner Mongolia Autonomous Region.

Buildings: Build 15-minute cities, improve and enforce standards

Per capita emissions from buildings are still low in China when compared with developed countries. But they are growing fast as rising incomes and living standards increase demand for cooling, heating and electricity.

Urbanization will continue. Government figures suggest that an additional 60 million people will become urbanized between 2020 and 2025.[29] The focus should be on reducing the emissions associated with the urbanization process as well as on improving the energy efficiency of existing buildings and supporting the creation of lower-carbon cities and communities.

China has energy efficiency standards and energy labelling for home appliances. But subsidized residential energy prices give little incentive for consumers to choose more energy-efficient appliances or improve the energy efficiency of their homes.

In the past four decades, China's urban population has grown by more than 660 million people. In the ten-year period ending in 2018, the urban population grew by 186 million people, with 69 million new residential buildings added to the housing stock.[30] The process of urbanization, moving people from the countryside into big and small cities, has been a huge driver of economic growth. It has helped reduce poverty and raise living standards. But it has also been a major contributor to CO_2 emissions. It has consumed vast quantities of carbon-intensive steel, concrete and energy.

The real estate and building sector is a significant part of the Chinese economy. Once linkages to upstream and downstream industries are considered, the sector accounts for around a quarter of China's GDP.[31] The importance of real estate as an asset, source of government revenue and employment means that there are significant vested interests across the building sector.

Housing is widely viewed as a store of wealth. A significant proportion of real estate demand comes from households buying properties as speculative investment. Local governments are also dependent on the property market for tax revenue. The sale of land to property developers has been a major source of revenue for local governments in recent years. The government is introducing reforms that will see land sale revenues collected by the tax bureau rather than by local government land bureaus. While this should give the central government more oversight over local government finances and property markets, it may do little to reduce speculative overbuilding. The government is also promoting new urbanization that focuses on the development and renovation of existing communities in villages, rural towns and smaller cities. Although this does not mean the construction of new cities and high-rise apartments will totally stop, the shift in focus towards the renewal of existing communities should be less energy- and resource-intensive than the previous model of urbanization which was largely reliant on moving the rural population into newly built cities.

Chinese building standards are fairly advanced, but enforcement of them by local governments is often weak and inconsistent. Carbon-intensive steel and concrete are the dominant construction materials in China. The construction industry is conservative and has seen little innovation in the use of lower-carbon construction materials and techniques. The desire to maximize profits coupled with weak implementation of building standards often results in poor building quality. The average building lifespan is only 25–35 years, much shorter than their designed lifespans. Extending building lifespans would considerably reduce

29 National Bureau of Statistics of China: "2019 China Statistical Yearbook", available at www.stats.gov.cn/tjsj/ndsj/2019/indexeh.htm, accessed on 14th February 2022.

30 ibid.

31 BBVA Research (Jinyue Dong and Le Xia): "How resilient is the economy to housing price fall?", available at www.bbvaresearch.com/wp-content/uploads/2018/03/20180326_China-Housing-market_edi.pdf, accessed on 14th February 2022.

the impact these buildings have on the environment and the whole lifecycle of carbon emissions.[32]

Recommendations

- China already has energy efficiency standards for home appliances and heating and cooling systems. The government should continue to upgrade and better enforce these standards. Energy-efficient products and appliances tend to cost more than those with lower energy efficiency standards. The government could put in place incentives or subsidies to encourage the purchase of the most energy-efficient products. It could tighten energy efficiency and other environmental performance standards so that manufacturers are forced to improve the energy efficiency of their products and appliances.

- The government should focus on ensuring that building lifespans and construction standards are enforced. These should be continually upgraded to improve the efficiency of new and refurbished buildings and encourage the use of recycled and low-carbon, more sustainable building materials and construction techniques. Extending the emissions trading scheme to include building materials, such as steel and concrete, will raise the cost of carbon-intensive building and help the transition towards more sustainable building materials.

- Real estate and related upstream and downstream sectors are a significant part of the economy. This makes curbing excess real estate development particularly challenging. The government has for several years attempted to temper speculative property investment. It has also been trying to rebalance the economy away from basic materials and construction towards higher-value manufacturing and services. Measures to reduce emissions by curbing excessive building should be aligned with these priorities.

- Local government finances should be reformed so that they are no longer reliant on revenue from land leases. Recent government reforms that channel land lease revenues to the tax bureau rather than local government are a good start. The government should go further and introduce property taxes to reduce speculative property purchases. These could be collected by local governments, thus giving them a more sustainable source of tax revenue than land leases. These taxes could take the form of progressive taxes on purchases as well as recurring annual taxes on ownership.

- The government's policy of focusing future urbanization around existing rural towns and smaller cities is sensible. Rather than knocking down existing buildings and engaging in large-scale rebuilding, it would be better for buildings to be integrated into the urban fabric. The priority should be to renovate and retrofit buildings where possible and to design cities where all basic services are within a short distance (such as 15 minutes when walking or cycling, hence the term, "15-minute cities").

- The government has a key role in raising awareness and reducing emissions across the building sector. The government can lead by example and require that all public projects, including social housing, are built to the highest energy efficiency standards. The government can also showcase innovative low-carbon building materials and design.

Industry: Push for higher energy efficiency and electrification

The focus should be on further improving energy efficiency, increasing electrification and accelerating the development of low-carbon technologies.

Manufacturing will remain critical for the Chinese economy. The government wants the country to move beyond basic industries and into more advanced, higher value-added and green technology sectors, where it hopes to become globally competitive. China's climate commitments are very much aligned with this industrial policy. The pathway to decarbonizing the industrial sector involves further improving energy efficiency, replacing fossil fuels with low-carbon electricity, increasing recycling and developing and deploying new low- and zero-carbon technologies in hard-to-decarbonize areas, such as steel and concrete. The government is making progress in many of these areas.

32 Science Direct: "Environmental impacts of short building lifespans in China considering time value", 1st December 2018, available at www.sciencedirect.com/science/article/abs/pii/S0959652618326751, accessed on 14th February 2022.

Government campaigns to improve efficiency in the most energy-intensive industries as well as remove outdated and inefficient industrial capacity over the past decade have led to significant gains in industrial energy efficiency. Further reductions in emissions can be achieved by replacing the direct burning of fossil fuels for process heat with low-carbon electricity. Increasing recycling, especially of metals and plastics, could reduce emissions from primary smelting and refining. Concrete-making has significant CO_2 process emissions. Primary steel-making using iron ore requires the use of coke made from coal. These are both areas that will require technological breakthroughs to decarbonize, or the use of carbon capture, utilization and storage that is currently uneconomical in the absence of a carbon price.

Recommendations

- Centrally mandated energy efficiency programmes should be extended beyond the most energy-intensive industries to the less-energy-intensive manufacturing sectors and areas of the "new economy", such as data centres.

- Technologies such as low-carbon hydrogen could have a role in reducing emissions from the hard-to-decarbonize sectors such as steel and cement, but this technology is currently immature and needs further research and development.

- The government should accelerate the research, development and deployment of technologies at a scale that will support the move to a low-carbon economy. Investment in power and distribution technologies will help support the electrification of industrial processes and the replacement of fossil fuels.

- The inclusion of industry into the emissions trading scheme will make fossil fuels more expensive. This will help accelerate improvements in energy efficiency, electrification and the use of lower-carbon technologies, including carbon capture, utilization and storage.

- The successful development and deployment of carbon capture, use and storage should not be used as an excuse to delay the widespread phasing out of coal in favour of renewable technologies and hydrogen produced from low-carbon electricity.

- Industrial emissions are linked to other parts of the economy, particularly construction. Reorienting the economy away from a reliance on construction, real estate and basic materials and towards higher-value-added manufacturing, technology and services will help reduce demand for carbon-intensive materials, such as steel and concrete.

Transport: Support electrification of vehicles and reconfigure cities

China's per capita emissions from the transport sector are relatively low but still growing. The focus should be to build on existing government policies and maintain the current trajectory around electrification of the transport system.

Car use is rising, but penetration is much lower than in advanced economies. China has had considerable success in developing electric vehicles, and they receive strong policy support from the government. China is home to slightly less than half of the global stock of electric vehicles. Government policies favouring the procurement of electric battery and fuel cell buses to reduce localized air pollution have been particularly successful. Around 98 per cent of the global fleet of electric buses are in China.[33] Government support for electric vehicles has resulted in considerable economic benefits. Chinese electric vehicles dominate the domestic market, and China has a leading position in the global battery and raw materials supply chain. Exports are currently low, but it may not be too long before Chinese electric vehicles compete against incumbent automakers in the international markets.[34]

Policies restricting the registration of conventional internal-combustion engine in petrol and diesel vehicles in the

33 International Energy Agency: "Global EV Outlook 2020", June 2020, available at www.iea.org/reports/globalev-outlook-2020, accessed on 20th January 2022.

34 Mercator Institute for China Studies: "In the driver's seat: China's electric vehicle makers target Europe", available at https://merics.org/en/report/drivers-seat-chinas-electric-vehicle-makers-target-europe, accessed on 14th February 2022.

country's largest cities have supported the adoption of electric vehicles.

Initiatives such as the dual credit policy, which is a cap-and-trade system that forces auto manufacturers to produce rising volumes of electric vehicles, should help drive down prices for consumers. China has not yet announced a comprehensive ban on the sale of internal-combustion engine vehicles like some European countries have done. But Hainan Province, an island located off the coast of southern China, has said that it will end the sale of such vehicles starting in 2030.

Due to lower average incomes, per capita air travel is much less common in China than in more developed economies. Moreover, China's vast network of efficient electrified high-speed rail has also helped reduce road and air travel. Over short to medium distances it can be faster to take the high-speed rail than a flight to the same destination. Still, air travel is rapidly growing in China, with about 660 million flight trips in 2019 (up from 436 million in 2015 and just 266 million in 2010).[35]

Many of China's larger cities have well-integrated electrified public transport. This has limited the use of cars for commuting. Moreover, due to the high population density, resulting traffic congestions and lack of parking space, many Chinese use electric motorcycles rather than cars to commute on short distances. With the future urbanization plans moving away from developing new areas and focusing on developing existing towns and cities, electrified rail networks will link city clusters.

Recommendations

- The government should continue with its policy support for electrified vehicles. It should continue to encourage the development of battery cars and support the development of electric vehicle charging infrastructure and hydrogen fuel cells for commercial vehicles like heavy duty trucks and long-distance buses.

- License plate restrictions on internal-combustion engine vehicles in major cities have been effective in increasing the penetration of electric vehicles. These should be extended to other cities. As sales of electric vehicles rise and costs come down, the government should encourage more provinces to introduce deadlines to end the sale of internal-combustion engine vehicles.

- Measures to increase electrification will not reduce transport emissions if electricity is still generated from fossil fuels. Electrification of the transport system needs to be accompanied by reforms to raise the share of renewable energy and phase out the use of coal.

- The country could reduce demand for transport by reconfiguring cities and communities to support walking and cycling rather than the use of private vehicles. Planning and urban development should encourage cities to constantly adapt and favour the creation of communities that support living and working locally and thus reducing the need to commute.

35 The World Bank: "Air transport, passengers carried – China", available at https://www.fes.de/lnk/4jf, accessed on 10th December 2021.

Conclusion

The global transition to net-zero emissions will be challenging for economies everywhere. It will be even more challenging for China, which has yet to peak its emissions, to achieve this while it is still developing and urbanizing.

China's institutions and governance should be reformed so that they can better balance the need for carbon neutrality with other imperatives, such as growth and improving living conditions. The Chinese government takes a more active role in the economy than governments in many other countries. Administrative measures, incentives and penalties may be more effective and better suited to the political economy than waiting for markets and price mechanisms to induce changes in producers' and consumers' behaviours. Reforms need to be accompanied by improvements in monitoring and supervision, especially of and by local governments to ensure they are implementing the central government's carbon peaking and net zero agenda. With these reforms in place, climate policies and instruments can be adjusted in response to the changing priorities and local conditions.

Change needs to happen simultaneously. There is a strong leadership role for government in raising awareness and driving change across the state-owned sector in industry, buildings and transport. Where the State leads, the private sector will follow.

Innovation has a critical role, not only across China's institutions and governance structures but also in the technologies that support the move to net-zero emissions. Decarbonization is aligned with China's long-term strategy to become an innovative, technologically advanced economy. This transition will require economic restructuring. It will be expensive, and there will be winners and losers. But the current economic model is unsustainable and will not deliver the technological advancements and productivity gains that are required for China to become an advanced economy.

Markets are critical. They should be used where they are the right tool to effect timely and sustainable change. In particular, the development of a broad, robust carbon market is likely to be useful instrument in the medium and long term, though other measures may be needed to peak emissions and abate them in the short term. As the price of fossil fuels rises to reflect the cost of emissions, it will drive the use of lower-carbon alternatives across the whole economy.

This paper focuses on China's sources of CO_2 emissions and how they might be best reduced. The role that forests, grasslands and other ecosystems have in removing and sequestering carbon from the atmosphere is also important, and the recent government guidance document on carbon peaking and neutrality highlights this. It also emphasizes the need to protect and restore existing ecosystems and stresses the government targets to increase the area of natural carbon sinks, such as forests. But recent studies have also warned that considering the scale of emissions' reduction needed to reach carbon neutrality, these nature-based solutions would have only a limited, albeit valuable and necessary role.

The whole of society needs to be made more aware of climate change and how individuals can help reduce greenhouse gas emissions. The State can drive change in the electricity sector. State-owned enterprises can adopt low-carbon standards and technologies. But energy efficiency and technology can only go so far.

The government can be very effective in mobilizing the public with campaigns to change behaviour. The introduction of garbage sorting in some cities, for example, was accompanied by public information campaigns and activities to raise awareness and drive compliance with the policy. Campaigns like the Clean Plate campaign to reduce food waste have supported government efforts to improve food security.

Similar campaigns could help individuals be more aware of the impact that their behaviour, the choices they make and the products they consume have on greenhouse gas emissions and thus help them take up their part in reaching net-zero emissions.

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