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INTRODUCING AN ABSOLUTE CARBON CAP INTO CHINA'S FIVE-YEAR PLAN:

RATIONALE AND RECOMMENDATIONS

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This report was commissioned by United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), under its North-East Asia Low Carbon City Platform (NEA-LCCP). It provides an overview of Wuhan's low-carbon strategies and policies. NEA-LCCP chose Wuhan as a case study to better understand low-carbon development in China. This report reviews Wuhan's low-carbon performance and provides an overview of socio-economic data, urban development strategies, and the key drivers of the city's low-carbon growth. It also includes a comprehensive examination of the strategic measures and policy instruments that local governments have implemented.

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ABOUT IGDP

iGDP, innovative Green Development Program, is a non-governmental Chinese think tank that focuses policy research and implementation on green and low-carbon development. Our goal is to strengthen China's low-carbon environmental policy design and implementation through interdisciplinary, systematic and empirical policy research. We work with all stakeholders to promote a zero-emissions future. The innovative Green Development Program was initiated by Energy Foundation China. It is the secretariat of China's Green and Low-Carbon Development Think Tank Partnership (GDTP), sits on China's Green Finance Association Experts Committee, and is a member of the North-East Asian Subregional Programme for Environmental Cooperation's Low-Carbon City Platform.

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Abbreviations & Acronyms

CO_2	Carbon Dioxide
CPC	Communist Party of China
FYP	Five-Year Plan
GDP	Gross domestic product
GHGs	Greenhouse gases
IEA	International Energy Agency
iGDP	Innovative Green Development Program
IPCC	Intergovernmental Panel on Climate Change
MEE	Ministry of Ecological Environment
MRV	Monitoring, Reporting and Verification
NDCs	Nationally determined contributions
NDRC	National Development and Reform Commission
tce	Tonnes of coal equivalent
UNFCCC	United Nations Framework Convention on Climate Change

EXECUTIVE SUMMARY

"Green growth" has become a ubiquitous mantra in China's political pronouncements and building a "beautiful China" is now one of the country's five core development goals. Among leading emitters, China has made the greatest reduction of carbon emissions per unit of GDP in the past twenty years. China is also the world's leading investor in renewable energy and has the largest installed capacity of wind and solar power. This progress is attributable to a comprehensive policy system in China that promotes energy efficiency, renewable energy development, and limiting coal consumption, and aims to peak CO_2 emissions around 2030. However, there are countervailing trends. China's carbon emissions are still growing rapidly, contributing between 27% and 46% of global CO_2 emissions growth in 2016 and 2017, and China's CO_2 emissions per capita and per unit of GDP both remain higher than the global average. China is also still investing in coal power plants, despite the fact that the risk of stranded assets continues to grow and renewable energy has become more economically competitive than coal.

Absolute carbon cap targets are policies that set successive absolute caps on the quantity of domestic CO_2 emissions in some specified interval time, e.g. a five-year period. An absolute carbon cap can play the core role in an environmental policy system designed to lead the way towards a low-carbon and green economic system. As an environmental policy, it provides clear targets for what should be achieved when a national long-term strategy for low-carbon and green growth is set out, and provides a clear indication of what is needed to mobilize investment in low-carbon technology and infrastructure to meet these national low-carbon imperatives.

There is a need to set a strong economy-wide climate goal to decarbonize economic growth throughout China's provinces. Without such a goal, a change in investment behavior toward green growth projects is unlikely to happen. Even with existing robust environmental policies and clean energy development objectives, the climate impact of China's future economic growth remains unclear. With only a short time window left to meet global climate safety goals, introducing enhanced climate policies to limit China's carbon emissions growth is crucial to the world's sustainable development.

Implementing an absolute carbon cap is feasible. *China's Third National Communication Report* has already predicted greenhouse gas (GHG) emissions under different scenarios. This can provide the basis for setting a carbon cap. Also, the new Ministry of Ecology and Environment (MEE) has extensive experience implementing emission caps for various pollutants. Local governments, especially those participating in low-carbon pilot program, have already experimented with carbon caps in their jurisdictions.

To implement an absolute carbon cap in the 14th Five-Year Plan (FYP), this report suggests setting a mandatory goal based on other binding economic and energy goals. This cap should reflect China's long-term emissions mitigation vision. This goal should be allocated to regions in different forms including growing or declining caps. China has set a series of binding indicators for energy saving and carbon control since 2006. An absolute carbon cap is a useful and robust instrument to link and harmonize the targets for these indicators.

An absolute carbon cap is not a silver bullet to all problems. However, it provides more certainty about carbon emission trajectories and the strong, long-term market signals that are necessary to guide investment behavior and tackle climate change. A well-designed absolute carbon cap can be the first step to leverage a systematic policy system that effectively and efficiently reduces emissions. This system includes stringent sectoral GHG emission standards, a GHG information disclosure mechanism, as well as an instrument to mainstream climate polices into macro development and financial strategies

BACKGROUND

CHINA'S POLITICAL COMMITMENT TOWARDS GREEN GROWTH

China's national strategy for addressing climate change has been raised to new heights. Promoting "ecological civilization" is a core component of President Xi's political agenda and green growth is one of the five pillars in the current administration's platform. China aspires to step up as a world leader in low-carbon development as its works to mitigate its high levels of pollution and GHG emissions.

The report of the 19th National Congress of the Communist Party of China (CPC) describes China as exercising leadership in international cooperation on climate change and states that the country has become an important participant, contributor and leader in global efforts to protect the environment and develop sustainably. Speeding up reform of the system for developing an ecological civilization and building a "beautiful China" are now vital long-term guiding principles in China's long-term national development. A vision and targets for "quality growth" and green growth towards 2030 and 2035 were set out at the 19th National Congress of the Communist Party of China in 2017.

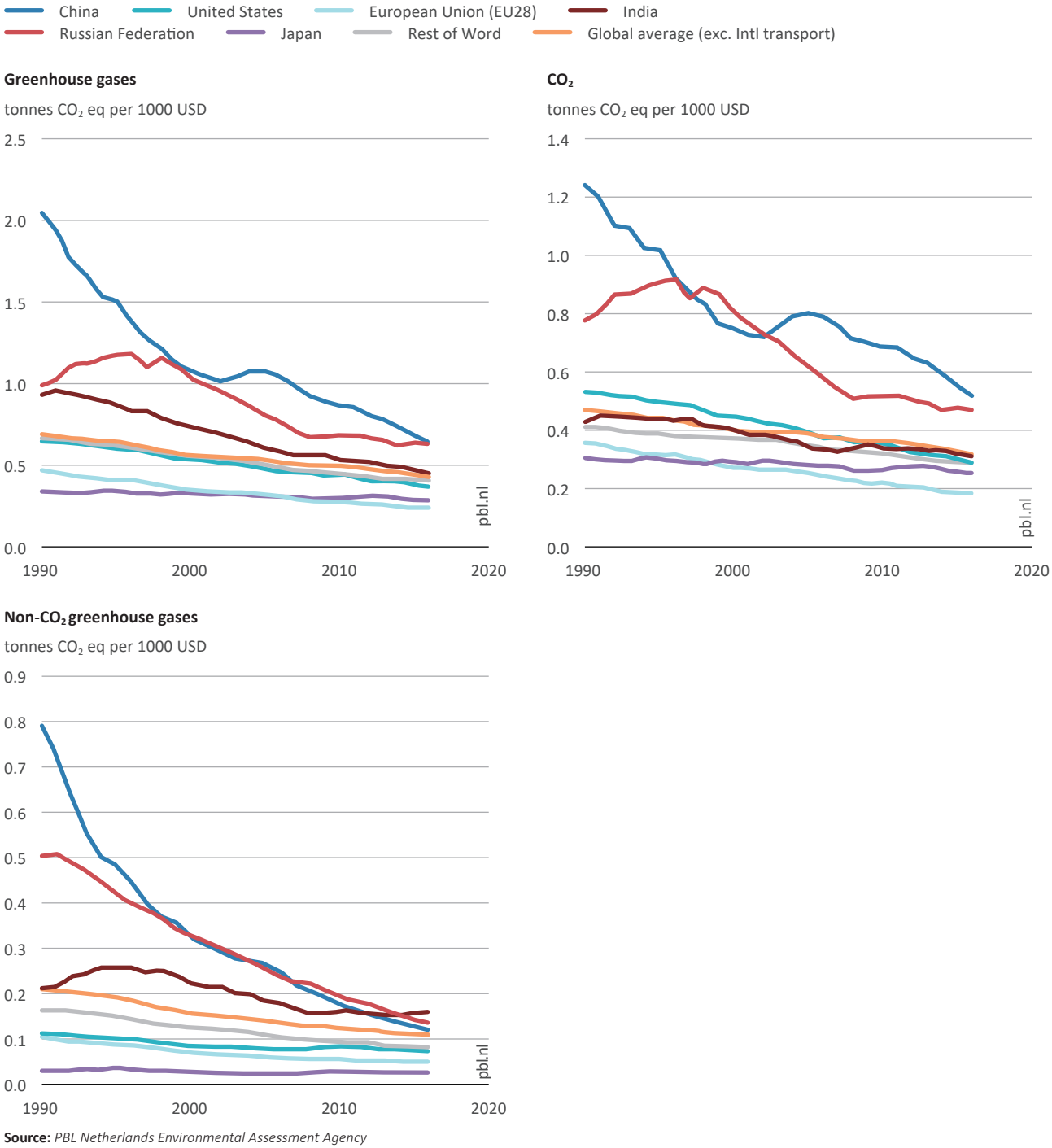
Table 1 | Highlights of indicators for China's 2030/2035 development goals

2030 GOALS	DESCRIPTION	NATIONAL STRATEGIES
GDP	2035 Modernization Goal	19th CPC National Congress Report
Income	2035 Middle Developed Countries	Same as the above
Innovation	2035 Innovation-driven Country, Expenditure on R&D per GDP: 2.8%	Same as the above National Strategic Plan for Innovation Driven Development toward 2035
Clean Air	All cities annual average PM2.5 concentration meeting WHO guidelines	National Plan for Air Pollution control
Clean Water	The water quality in seven key basins reaching above average	National Plan for Water Pollution Control
Carbon Emissions	Peaking energy related CO_2 emissions before 2030	National Determined Action of China, 2016

China's Nationally Determined Contribution (NDC) to the Paris Agreement committed that the total amount of CO_2 emissions should peak around 2030 and that the country will strive to reach the peak as early as possible. It also commits to CO_2 emissions per unit of GDP to be 60%-65% lower than in 2005, and for non-fossil fuels to account for about 20% of primary energy consumption by 2030 (NDRC, 2015).

China has made notable progress toward its climate change commitments, shown in Table 4. China is now the world leading renewable energy investor with the largest solar and wind installed capacity. China has also achieved the greatest improvement in carbon intensity. As indicated in Figure 1, China's CO_2 emissions per unit of GDP declined around four times faster than the global average between 2000 and 2017 (Olivier & Peters, 2018)

Figure 1 | Emissions per US Dollar of GDP, at PPP 2011 prices



Source: *PBL Netherlands Environmental Assessment Agency*

This political momentum and policy progress can be attributed to China's domestic need to increase economic efficiency, fight air pollution and improve its overall environmental quality. At present, with the reform of China's environmental protection management system, it has become particularly important to integrate and find synergies between policies that address climate change, pollution, and environmental management.

Table 2 | China's Climate and Energy Goals

POLICY AREAS	OBJECTIVES	MANDATORY TARGETS[1]	LOCAL-LEVEL IMPLEMENTATION	NATIONAL STRATEGIES
Total CO_2 Emissions	N/A	N/A	A few pilots	*N/A*
Total CO_2 Emissions Peak Year	Peak around 2030	Yes	Over 20 cities aiming at early peak	*NDC*
Carbon Intensity	In 2030, 60-65% lower than 2005 level	Yes	All local governments	*NDC and The 13th FYP Guidelines*
Energy Intensity	In 2020, 15% lower than 2015 level	Yes	All local governments	*The 13th FYP for Energy Development*
Total Energy Consumption	5 Billion tce by 2020	No	All local governments	*The 13th FYP for Energy Development*
Non-fossil fuel Energy Share	15% in 2020 20% in 2030	Yes	All local governments	*The 13th FYP for Energy Development*
Coal Use	4.1 Billion tons by 2020	Yes	Key Air Quality Regions	*The 13th FYP for Energy Development, The Work plan for Strengthening Coal Consumption Cap in Key Cities for Air Pollution Control*

Source: *iGDP Policy Mapping*

[1] There are two types of targets in China's Five-Year Plan, one is A mandatory target, and the other is A predictive target. The former will receive more institutional and policy support than the latter.

RATIONALE FOR SETTING AN ABSOLUTE CARBON CAP[2]

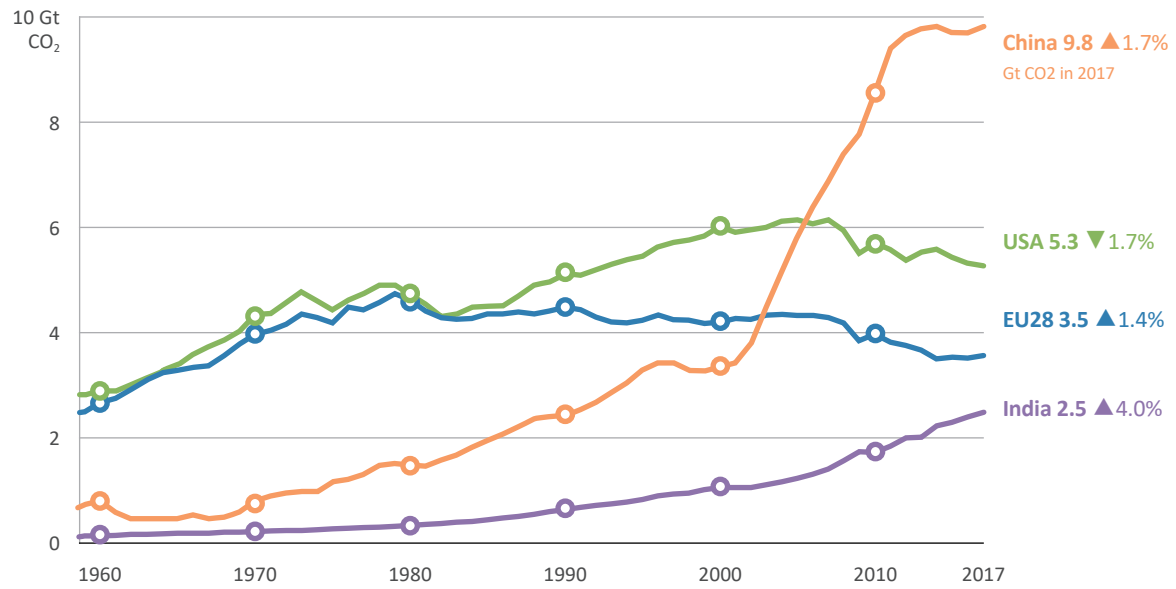
Setting an absolute carbon cap for China's 14th Five-Year-Plan will enhance China's climate action at both the international and domestic levels. It can make a contribution to global GHG emission reduction efforts and strengthen China's commitment to combatting climate change. At the domestic level, an absolute carbon cap can facilitate China achieving its carbon peaking target, as well as allow China to develop a long-term policy signal for green and low-carbon development, and to align carbon emissions control policy with the existing emissions control governance under the Ministry of Ecology and Environment.

I. URGENCY

1. Global Carbon Neutral Goal Requires Enhanced Climate Policies

The recently issued IPCC 1.5 Degree Report indicates that the world needs to achieve carbon neutral by mid-century to avoid catastrophic climate impacts (IPCC, 2018). While China is on track to achieve all the energy and environment targets in its strategic plans, there appears to be a lack of urgency with regard to total CO_2 emissions. China's CO_2 emissions continue grow, contributing 46% of global total growth in 2017, a significant leap up from 27% in 2016. China's per capita CO_2 emissions level is already higher than the EU average, and CO_2 emissions per unit of GDP remain higher than the global average. As indicated in Figure 2, while China is on track with current policies to achieve its 2030 targets, its total emissions are still increasing.

Figure 2 | Annual emissions: top four emitters



Source: *Global Carbon Project, 2018*

[2] Please see the Appendix for detailed discussion on carbon cap vs. carbon intensity targets and energy cap.

To keep global temperature rise within two degrees this century, total global CO_2 emissions should start declining now. What matters most to climate safety is the level at which emissions will peak, not the peaking year. In other words, a peaking year goal alone is not enough for long-term sustainable and climate-safe development. China needs an absolute carbon cap.

2. An Absolute Carbon Cap Can Send a Clear Policy Signal to Reduce Carbon Emissions

An absolute carbon cap can also send a policy signal to show China's commitment to green transformation. Unlike energy and air quality goals that indirectly affect carbon emissions, a carbon cap can provide a clear and direct policy signal to control carbon emissions. China's economic development model still relies heavily on fossil fuel consumption. The core measures for tackling air pollution have to do with adjustment of the country's energy and economic structures. The Revolutionary Strategy for Energy Production and Consumption (2016-2030) released in 2016 has proposed that "from 2021 to 2030, renewable energy, natural gas and nuclear energy utilization will continue to grow, and the use of high-carbon fossil fuel will be greatly reduced. Total energy consumption will be controlled within 6 billion tons of standard coal, non-fossil fuel will account for about 20% of total energy consumption, and natural gas will account for about 15%". This is a powerful target for transforming the national energy structure, but the one-size-fits-all approach may lead to social problems during implementation.

China's environmental goals have been the main driver of improving energy efficiency, limiting coal use and reducing carbon emissions. But environmental policies can deliver a state in which energy efficiency and overall environmental quality are high while total carbon emissions still grow, as observed in developed countries. In addition, environmental and energy efficiency goals can have unintended consequences regarding carbon reduction efforts. For example, electric vehicle (EV) programs can help cities meet the clean air goals, but increase demand for electricity from dirty sources. Though the long-term impact on climate might be positive, in the short term EV policies could create a surge in demand for electricity generated by a power system heavily dependent on coal as a primary fuel.

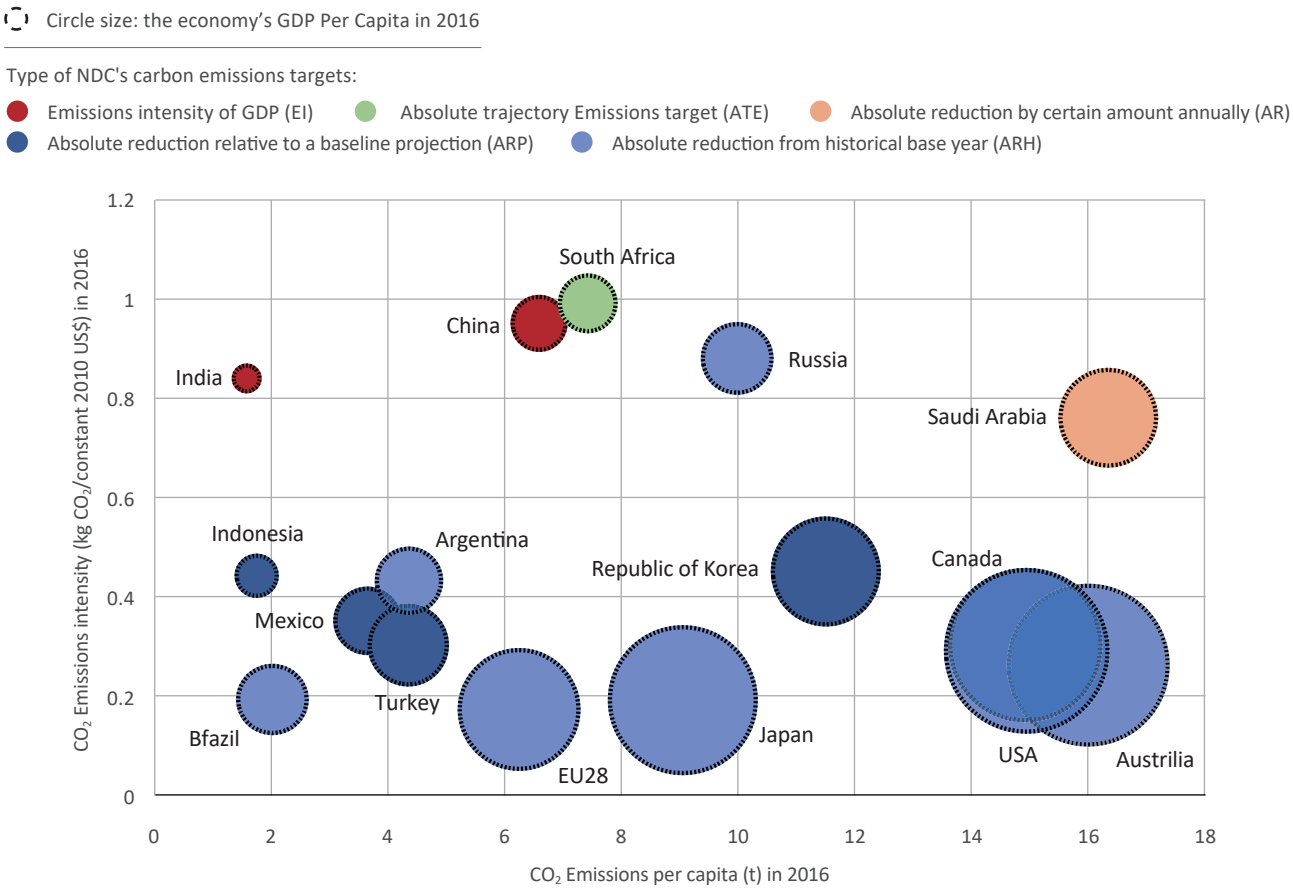
A carbon cap gives local governments more flexibility, balances between coal control and renewable energy development, and encourages local governments to try to increase the proportion of renewable energy consumption and expand the space for economic development. It does this not only by adjusting the energy structure but also by greening industrial structures.

3. Absolute Carbon Cap Setting in Other Countries

Most leading GHG emitters have set their absolute carbon emission goals, some of which are developing countries such as Mexico, Brazil, Indonesia and Argentina. As one of the largest GHG emitters with per capita carbon emissions that have exceeded the EU average (see Figure 3), by setting a carbon cap China can strengthen its commitment to climate change and demonstrate its climate leadership.

There are four different ways for countries to set absolute carbon emission targets. First, a goal based on the emissions projection. South Africa's NDC consists of a 'peak, plateau and decline' GHG emissions trajectory, which gives a range of 398–614 $MtCO_2e$/year between 2025 and 2030, reaching a peak between 2020 and 2025 and a plateau for the following decade, before starting to fall. Second, setting an absolute GHG emissions reduction goal without a baseline. Saudi Arabia, for example, has committed to reducing carbon emissions by 130 Million tons of CO_2 equivalent, although a baseline was not defined. Third, setting an absolute emission goal based on a projected future emission baseline, such as Indonesia, Mexico, Turkey and South Korea. For example, Mexico's NDC proposes to unconditionally reduce combined GHG and black carbon emissions by 25% compared to "business-as-usual" projections in 2030. Fourth, developing absolute reduction goals based on historical emissions baselines. All developed countries are obligated to set these goals while different countries pick different base years. The European Union, for example, committed in its NDC to reducing emissions by at least 40% compared to 1990 levels by 2030.

Figure 3 | Carbon emissions goals of the top 16 GHG emitters



Source: *The circle sizes represent per capita GDP.*

II. FEASBILITY

1. China's Emission Trend is Clear

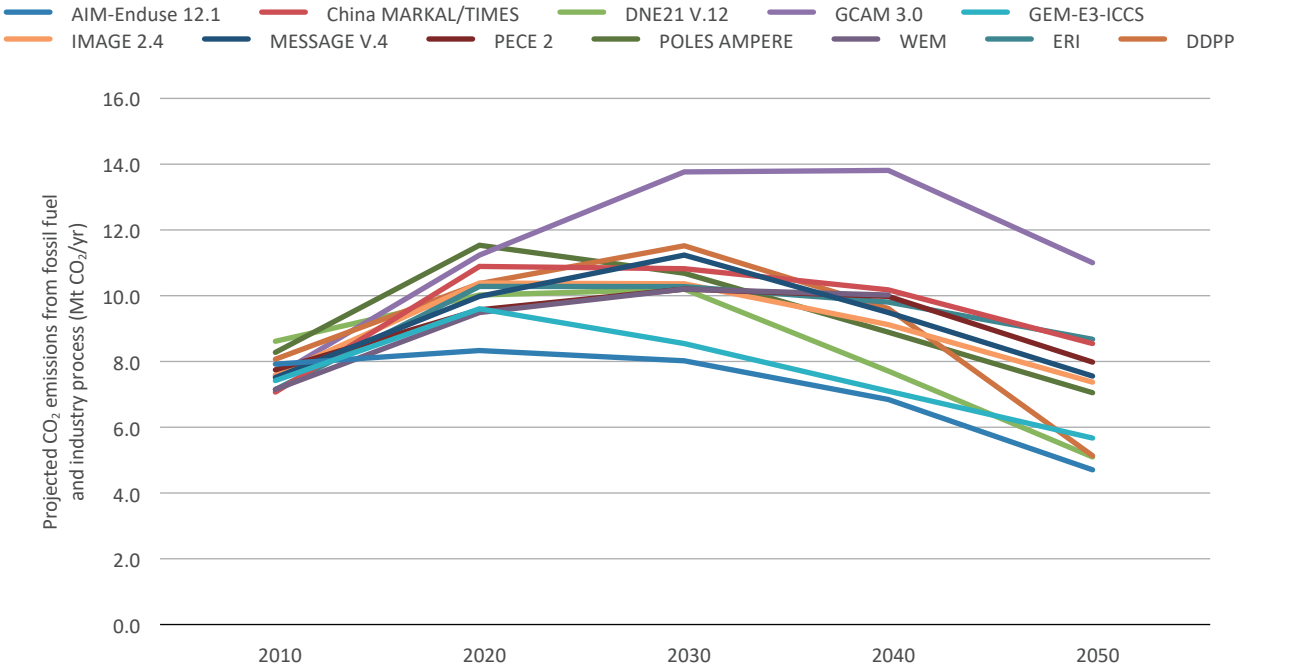
Setting an absolute carbon reduction target is an achievable next step given the progress China has made on carbon intensity (carbon emissions per unit of GDP) reduction as well as the scenario analysis of China's carbon emissions projections.

China's prospects for peaking emissions earlier than 2030 look good. In 2017, China's carbon intensity had decreased by about 46% compared with 2005, thereby achieving its target of a 40-45% reduction in carbon intensity by 2020 three years ahead of schedule. However, more must be done. China will have to reduce its carbon emissions after peaking, as the Paris Agreement requires carbon neutrality by the second half of this century.

Although China did not put an absolute emissions reduction target when it declared its carbon peak year commitment, it is still possible to estimate China's future energy-related carbon emissions in total and by sectors based on China's econmic growth and energy consumption. Despite uncertainties in the domestic and international political and economic outlook, China's economic growth is likely to shift from high-speed to medium-high-speed growth, and policymakers are determined to achieve what they are calling "high-quality development". Aside from this, China's FYPs also include a set of economic and energy policy indicators that can be used to predict China's carbon emissions. For instance, research of Liu et al. (2017) uses 12 scenarios to explore the implications of enhanced

policies compared to the current Chinese policy environment in 2030 and 2050. As Figure 4 shows, the majority of the alternative scenarios illustrate a carbon peak near 2030. Total carbon peaking emissions range from 8.4Gt CO_2 to 13.7Gt CO_2, with a median value of 10.3Gt CO_2. in 2050, projected absolute carbon emissions range from 4.7 to 11Gt CO_2 with a median of 7.4Gt CO_2.

Figure 4 | China's CO_2 emissions projection under the "alternative scenario" 2010-2050



Source: *Liu et al., 2017*

2. Emissions Cap Practices of China's Environmental Regulatory System

The task of addressing climate change has been transferred to the newly formed MEE from the National Development and Reform Commission (NDRC). This is a major institutional rearrangement for the CPC Central Committee and the State Council, and can enhance the synergy between climate change and environmental pollution prevention and control, and bolster overall environmental protection. In the future, the work of tackling climate change, from policy and target formulation, to monitoring and implementation, will have to be better coordinated with environmental pollution control and ecological protection. China's existing environmental monitoring mechanisms, especially for atmosphere and water, mainly use the approach of total pollution emissions control for planning, standards, licensing, monitoring, and law enforcement. For example, China's environmental regulatory system has set a total emissions control for major air pollutants. The formulation of a total carbon emission control would be an important step in the integration of the emission monitoring reporting system and the improvement of the multi-pollutant emission standard system.

3. Pilot Experiments in Provinces and Cities

During the 13th FYP period, carbon caps have been implemented in many areas, including Zhenjiang and Beijing. Working backward from the city's carbon emission peak target, Zhenjiang has established a reverse mechanism based

on carbon emission growth and economic development trends to determine the its carbon caps. In 2014, a pilot assessment of carbon emission increments and intensity was conducted. Beijing implements a dual-control and dual-drop mechanism[3] for total energy consumption and intensity, total carbon emissions and intensity, and implements a target responsibility system of three-level dual-control for municipal, district, and key energy-using units. The work of these pilots can provide valuable experience for developing an absolute carbon cap at the national level.

Table 3 | Carbon cap pilots

CITIES	CARBON CAP PILOTS
Beijing	• Local legislation on emissions cap • Setting annual absolute targets for carbon emissions *Decision on Beijing' Implementation of Carbon Emissions Under Strict Control of Carbon Emissions* issued by Municipal People's Congress
Shanghai	• Setting a five-year absolute target and annual incremental amount for carbon emissions during the 13th FYP • Setting an absolute emissions reduction target in 2035 compared to the level of carbon peaking *Working Plan on Energy Saving, GHGs Emissions Control for 13th Five-Year Plan* issued by Shanghai Municipal government *Shanghai Master Plan 2017-2035: Striving For the Excellent Global City* issued by Shanghai Municipal government
Wuhan	• Setting an absolute target for carbon emissions peaking year of 2022 • Furtherly allocate the city-wide target into sectors and municipal districts *Wuhan's Action Plan on Carbon Emissions Peaking (2017-2022)* issued by Wuhan municipal government

Shanghai's Carbon Cap Under Long-term Reduction Target

Through the Shanghai Master Plan 2017-2035, the Shanghai municipal government has publicly committed to:

- Peaking total City-wide carbon emissions and per capita carbon emissions before 2025
- Reducing carbon emission by approximately 5% of the peaking level by 2035

Shanghai is currently the leading city that has incorporated its carbon cap into its municipal FYPs and long-term city development plan, which are legally -binding and can provide top-level guidelines for medium- and long-term city development. Since 2015, Shanghai has set annual incremental targets and made an absolute cap for carbon emissions in 2020 at the level of 250 Mt.

[3] Dual control refers to total energy consumption control and energy intensity control. Dual drop refers to total carbon emissions reduction and carbon intensity reduction.

Table 4 | Annual targets for incremental amount of CO_2 emissions (2015-2019)

YEAR	TARGET
2015	Within 8.7 Mt CO_2, striving to reach 7.8Mt or so
2016	Within 6.45 Mt CO_2, striving to reach 6Mt or so
2017	Within 5.8 Mt CO_2
2018	Within 5.15 Mt CO_2
2019	Within 9 Mt CO_2

To ensure Shanghai is on track to meet its carbon targets, the local government has also developed an assessment mechanism to evaluate the city's carbon reduction based on its effective existing MRV system for energy-saving. Annual incremental carbon emissions were decomposed into industrial and transportation sectors, which account for almost 80% of city-wide total emissions, while targets for carbon intensity were allocated among 14 administrative districts of Shanghai. However, compared with mandatory indicators such as energy saving and carbon intensity, Shanghai's city-wide carbon cap target is not mandatory and therefore receives less legal and institutional support.

Source: *Shanghai Urban Master Plan (2017-2035) & Shanghai 13th FYP for Energy Saving and GHGs Emission Reduction and Control*

One Lake Bishui Reflecting Sunset, Anhui, Hefei. (Photo by Zhang Quanyue)

RECOMMENDATIONS TO DESIGN AND IMPLEMENT AN ABSOLUSTE CARBON CAP IN CHINA

I. DESIGN AN ABSOLUTE CARBON CAP

1. Strengthen the Legal Basis for a Carbon Cap

China considers climate change to be a part of its long-term domestic environmental strategy and an important component of the ecological civilization vision of President Xi. However, one of the shortcomings of Chinese climate policy has been that it lacks a firm legal basis. Correcting this would fall in line with MEE's mandate to develop macro-level climate strategy, plans and policy.

The goals set in China's 12th and 13th FYPs, reducing carbon emissions per unit of GDP by 16% and 18%, respectively, are legally binding and undoubtedly powerful in the context of China's political framework. However, a law on climate change or a legal definition of CO_2 as a pollutant would be a far stronger spur for policy action. The transfer of the climate portfolio from NDRC to MEE could change that. This handover could change carbon mitigation from a token of international negotiations into a domestic environmental priority. There are three ways this could happen.

The first approach would be to give climate policy a firmer institutional foundation--to classify GHGs as pollutants that are subject to environmental law. Climate policy could be integrated into China's Environmental Protection Law, which will likely see revisions when MEE announces its work plan. The second approach would be to redefine the term environment in the law to encompass climate, making dangerous climate change a direct target of China's increasingly assertive, legally mandated environmental protection efforts. The third approach would be for China's legislature to finally create a standalone Climate Change Law. This would provide a legal basis to drive China's climate policy forward in a focused manner. Because creating such a law would be a lengthy process, adopting a more ambitious carbon cap would be an intermediate measure that runs in parallel to legislation.

2. Set a Carbon Cap Reflecting China's Long-term Vision

China set forth its long-term vision to make China A "great modern socialist country" by mid-21st century in the 19th CPC National Congress. Setting a carbon cap can facilitate the transformation of economic structure and energy system for carbon emissions reduction, while ensuring China maintains its high-quality economic growth to become one of the world's advanced economies by 2050.

The absolute carbon cap does not need to be constructed from scratch, but can be based on the existing energy and environment binding indicator system. Unlike developed countries, which use absolute carbon reduction targets in the context of international compliance, China's China's goal would be a quantity range linked with the speed of economic development. China's total carbon control target would be a comprehensive indicator reflecting the overall development of the economy, energy and environment, determined based on potential economic development targets at the local level.

In the absence of significant changes in the use of carbon capture technology, the annual rate of change in energy intensity and the rate of change in the proportion of non-fossil fuel in energy consumption converge. The existing GDP development target, GDP energy intensity reduction target, and the non-fossil fuel proportion of total energy consumption target can collectively approximate a total carbon control target. For example, in China's Third National

Communication on Climate Change, it is estimated that China's energy-related carbon emissions can peak with the level of 10-11.5Gt CO_2 during the period of 2025-2030, when its annual GDP growth rate in 2020-2025 and 2025-2030 will be 6% and 5% respectively, with the mandatory indicator for annual reduction rate of carbon intensity at the lowest level of 4% (see Table 5).

Table 5 | Alternative Scenarios Envisaged in Carbon Emissions Forecast by 2030 Indicators

YEAR	POLICY SCENARIO I	POLICY SCENARIO II
Population	Projected to reach 1.45 billion by 2030 with slow annual growth rates	
Annual Growth rate	2020-2025: 6% 2025-2030: 5%	
Economic structure	Share of tertiary section in the whole GDP: above 60%	
Energy Sector	Facilitate deployment and scaling up of low-carbon technologies; Implement more stringent energy efficiency standards; Strengthen incentive policies for the promotion of renewable energy and natural gas; Introduce national emissions trading system	
Climate Policy	Impose a rigidly carbon emissions control target based on the economic policies that promote economic transformation and upgrading	
	Annual reduction rate of Carbon intensity : 4-5%	Annual reduction rate of Carbon intensity : 5-6%
Energy Consumption	by 2030: 5.6-6.2 Gtce	by 2030: 5.5-6.0 Gtce
Energy-related Carbon emission	By 2030: 10.5-115 $GtCO_2$	By 2030: 98-106 $GtCO_2$ Peaking around 2026

Source: *Ministry of Ecology and Environment, 2019*

3. Define an Absolute Carbon Cap based on Existing Binding Targets

Under the 13th FYP (2016-2020), five key indicators which are incorporated into the administrative assessment and evaluation system can be directly used to calculate the amount of total CO_2 emissions for a specific period. These indicators are 1) Energy consumption reduction per unit of GDP (%); 2) Non-fossil fuel share of primary energy consumption; 3) CO_2 emissions reduction per unit of GDP (%); 4) GDP growth rate; and 5) total energy consumption.

A simple equation between total energy-related carbon emissions and the five indicators above can be expressed as follows:

$$C_{co2,t}=C_{co2,0}*(1-ef)^t*(1+gd)^t*(1-rn)^t$$

- $C_{co2,t}$ refers to total carbon emissions in the target year of t
- $C_{co2,0}$ refers to total carbon emissions in the base year of 0
- *ef* refers to annual average energy consumption reduction per unit of GDP(%)
- *gd* refers to annual average GDP growth rate
- *rn* refers to annual average substitution rate of non-fossil fuels in primary energy consumption
- *t* refers to number of years between base year and target year

The value for the three variables with *ef, gd, rn* can be derived from the 13th FYP as shown in Table 6.

Table 6 | Key indicators and targets for the 13th FYP

INDICATOR	2015	2020	5-YEAR AVERAGE	5-YEAR CHANGE IN TOTAL	TYPE OF INDICATOR
GDP growth rate	n/a	n/a	>6.5%	n/a	Predictive
GDP (trillion of yuan)	67.7	>92.7	n/a	n/a	Predictive
Energy consumption reduction per unit of GDP (%)	n/a	n/a	3.2	15	Mandatory
Non-fossil fuel share of primary energy consumption	12.1	15	0.57	n/a	Mandatory
CO_2 emissions reduction per unit of GDP (%)	n/a	n/a	3.89	18	Mandatory
Total energy consumption	n/a	50	n/a	n/a	Predictive

Source: *values in dark red are based on iGDP analysis*

The analysis above shows existing energy and economic indicators point towards an "invisible" carbon emissions cap by detailing many of the factors that would be required to set one. Transforming this invisible cap to a visible policy indicator, ideally a mandatory goal, is not only feasible but also critical to send strong policy signals and provide certainty.

II. IMPLEMENT AN ABSOLUTE CARBON CAP IN CHINA'S POLICY CONTEXT

1. Differentiated Regional Carbon Caps

The allocation and negotiation of the target can be based on both top-down and bottom-up considerations. Through central and local consultations, according to regional economic development, targets in different regions can either *involve an increase in total carbon emissions to a defined limit, or an absolute reduction in carbon emissions.* Which type is used in a specific region or industry would be determined and phased in in reference to local factors such as trends

in economic development, local structural adjustment and technology upgrades, energy substitution potential, and air quality and total air pollution control requirements.

The regions and industries that should give priority to the implementation of an absolute carbon cap requiring absolute carbon emission reductions should be those that are first to achieve carbon emission peaks before or around 2020, that are striving to achieve negative growth in total coal consumption, and that require special emission limits for atmospheric pollutants. These include the areas in the Beijing-Tianjin-Hebei, Yangtze River Delta, and Pearl River Delta regions, as well as the steel, cement, and other similar industries.

For the less developed central and western regions, and industries that cannot achieve carbon peaks during the 14th FYP period, the total carbon control target should allow emissions to grow while controlling the total amount within a defined, enforceable limit in the FYP and annual plan for socio-economic development.

2. An Absolute Carbon Cap and National Carbon Market Are Mutually Reinforcing

The national carbon market currently establishes a total amount of emission allowances within the market in a bottom-up manner and then distributes them to key emitting industries. The absolute carbon cap would be basically implemented in a top-down manner that can be based on the carbon market, which already developed a carbon intensity cap and methods for emissions measurements, reporting and verification. Industry and regional goals are also mutually compatible. This forms a dual constraint that reflects the "polluter pays" principle and the legal responsibility of the local government for local environmental benefits.

An absolute carbon cap can also provide an institutional basis for the carbon market to some extent, and since carbon market-related legislation has been delayed, there is still room to tweak its implementation. If a total carbon emission target were incorporated into national planning, it could serve as the basis for monitoring carbon emissions. In this way, it could act as a rapid, short-term means of supporting the development of the carbon market compared to legislation or other means.

3. Integrating Carbon Cap Implementation with the Existing Policy System

The absolute carbon cap will be implemented under the existing environmetnal and energy regulatory system, aligning with current environmental policy instruments. The main pillars of this system are environmental quality and pollutants emissions standards, MRV, and environmental impact assessment. Within this environmental management system, GHG emission standards for power plants, vehicles and energy-intensive industries will continue to be important supportive policies, like in Europe and California, where standards systems play an important role in bringing down emissions.

First of all, after allocating to the cap to emitters, the total carbon emission control goals should adhere to the environmental permitting system, relying on the existing pollution monitoring systems. The basic pollutants statistics, reporting and accounting mechanisms could be improved to include GHGs emissions. In addition, the legal penalties for violations of potential carbon emissions standards and failure to accurately report carbon data should be increased. As the fundamental environmental policy instrument, including GHGs emissions into the permitting system would enhance climate policy implementation significantly.

Secondly, the climate impact assessment should be included into the environmental impact assessment system. This can be a very strong and direct policy goal to influence economic and investment behaviors. For example, if a project or investment was calculated to have a high carbon emissions impact, the national or local government would need to review it and make careful investment decisions even if it was relatively energy efficient. Environmental permit is another important tool that can allow climate policy implementation to touch on the sources of emissions. Integration of carbon emission requirements into China's current pollution permits system would be an important move in this direction. One example would be setting a carbon emissions permit for key emissions units.

The policy alignment would also ensure daily monitoring and strengthen legal supervision, helping achieve success in long-term regulation and control. The regular environmental inspections can be carried out in accordance with the national five-year planning system, increasing the flexibility of achieving the indicator for the period, allowing annual deployment, and reducing the impact of the actual annual GDP growth above or below expectations.

4. Leverage Further Policy Actions To Enhance China's Climate Policy System

An absolute carbon cap is the first step to enhance China's climate policy system. Such an economy-wide macro-level goal could leverage at least three strong mitigation policies moving forward.

First, an absolute carbon cap can enable sectoral GHG emissions standards including CO_2 emissions per KWH standards for power plants, life-cycle GHG emissions standards for key industrial products, and GHGs emission standards for vehicles, similarly to what EU countries and California have done. The existing policies serving such goals are mainly energy related; there is lack of high-level policy to guide the development of carbon-oriented sectoral policies.

Secondly, an absolute carbon cap would improve information disclosure of GHG Emissions and an integrated MRV system. The creation of a source-based emissions inventory would likely be the first step in bringing carbon under an MRV regime. The Environmental Protection Law and other laws on air, water and solid waste require pollutants emission data to be publicly disclosed to the public, but GHG emissions currently have no such requirement. Bringing transparency to carbon emissions would be a huge step forward.

Thirdly, a carbon cap would help to mainstream climate policy into development and finance strategies. Reducing both carbon emissions and air pollution requires "optimizing four structures" - economic, energy, transportation and land-use structures. This makes environmental economic policies, including green finance, green insurance, green pricing, and carbon pricing, more important than ever. Putting a price on climate change risk and incorporating this into investment decisions and infrastructure development will prove to be a key approach to merge climate and economic policy.

The beauty under low-carbon energy, Yanqi Lake, Beijing. (Photo by Zhang Xu)

APPENDIX

CARBON CAP vs. CARBON INTENSITY TARGET AND ENERGY CAP

1. An Absolute Carbon Cap is an Enhanced Climate Policy and Complementary to the Carbon Intensity Target.

A carbon intensity target is a policy to set emission reductions relative to economic output. The difference between an absolute carbon cap and carbon intensity is mainly determined by forecasts about future national economic growth trends (Wing, Ellerman, & Song, 2006). Carbon intensity targets can be achieved through the reduction of carbon emission or the increase of GDP, meaning absolute carbon emissions can still increase as the economy is growing. In other words, even if the stringency of the carbon intensity target will be enhanced, it can be easily achieved by increasing production capacity.

China has been using carbon intensity targets in its international commitments and domestic actions. At the Copenhagen Climate Summit in 2009, China pledged to reduce its carbon emission intensity by 40% to 45% compared to 2005. Subsequently, China has begun to include the carbon intensity reduction target as a "legally binding" target in its 12th and 13th FYPs. In doing so, China's carbon emission per unit of GDP has decreased by 46% compared with 2005 by 2017.

However, according to the IEA's World Energy Statistics, China's total carbon emissions increased by 31.89% from 6.9 billion tons in 2009 to 9.1 billion tons in 2016. Meanwhile, the total GDP increased by 208.46% from USD 3.17 trillion dollars to 9.78 trillion dollars[4]. Therefore, while China's absolute carbon emissions are rising, it can always meet its carbon intensity reduction target as long as its economy keeps growing.

The two indicators in Table 10 show that a carbon intensity reduction indicator is designed to allow the absolute level of carbon emissions to be adjusted by the underlying economic fluctuations, and appears to be an appropriate instrument for a developing economy.

Table 7 | Comparison of the carbon intensity reduction goal and an absolute carbon cap

	CARBON INTENSITY REDUCTION	CARBON CAP
Key Features	A relative target	An absolute target
Stringency	A soft cap that allows carbon emissions to grow and can be easily affected by economic development.	A hard cap cannot be flexible adapting to economic uncertainty.
Applicable Period	Economic growth with high-speed rate. higher uncertainty about future trend.	A transition from energy-intensive economy to high-quality economic development. lower uncertainty about future.

[4] On a constant price basis of the year 2000.

When China's economy as a whole shifts from high-speed growth to medium- and high-speed growth, it will become difficult to use economic growth to promote carbon emissions reduction. In place of this, introducing an absolute carbon cap in the 14th FYP can send a clear policy signal to encourage the transformation of economic development from energy-intensive growth to low-carbon high quality economic growth. However, because China's regional economic development will be not be balanced during the 14th FYP or 15th FYP periods, policymakers should make combined use of carbon intensity and absolute carbon caps. For example, they could encourage the use of carbon cap in regions that are first to achieve carbon emission peaks before or around 2020, but still keep the use of carbon intentsity in the less developed central and western regions, and industries that cannot achieve carbon peaks during the 14th FYP.

2. An Absolute Carbon Cap Provides More Flexibility for Local Government to Pursue Green Growth than an Energy Consumption Cap

An energy consumption cap has been a useful policy instrument to control the final energy demand for a country's economic development. Since the 13th FYP, China has added absolute energy consumption as a voluntary indicator to work together with energy intensity reduction to facilitate China's sustainable energy future. However, the policy measures of energy consumption cap are centered on energy self-sufficiency, as the policy was designed to reduce dependence on energy (fossil fuel) imports. Therefore, while the energy consumption can contribute to environmental concerns including climate change and air pollution, it is less likely to bring an economy-wide decarbonization.

Compared with an energy consumption caps, carbon cap targets are more conducive for promoting green growth (Herzog, Baumert, & Pershing, 2006). As shown by the Kaya identity (Total CO_2 emissions = Population × GDP/ Population × Energy use/GDP × CO_2 Emissions/Energy use), absolute carbon emissions levels are affected by population growth, economic growth, energy consumption and the energy structure.

A carbon cap reduces absolute carbon emissions, which is a global public good. In China, this aligns with the central government's objective of developing ecological civilization. A carbon cap is also in line with China's international commitments for carbon peaking. Setting a carbon cap would thus address both domestic and international carbon and energy concerns.

While both energy consumption and carbon caps are command-and-control policies, they take different approaches to transform the energy system. Energy consumption caps focus on making changes to a fossil fuel-dominated energy system, which makes it hard to provide full support for renewable energy development. A study from International Institute for Sustainable Development (IISD) indicates that although China's renewable energy subsidies have increased in recent years, they are still relatively small compared with fossil fuel subsidies, with coal being one of the most highly subsidized fuels (Benjamin et al., 2016). However, carbon caps focus on policy interventions to address the negative externalities from energy consumption, emphasizing the scale-up of renewable energy and energy electrification. In addition, they aim to increase the share of renewable energy, decarbonize the transportation sector and develop high-tech and emerging industries

Table 8 | Comparison of energy consumption and absolute carbon caps

	CARBON INTENSITY REDUCTION	CARBON CAP
Strategic Positioning	Energy security	Global climate change and energy security
Goal	Energy saving	Carbon emissions reduction
Scale of Impact	• Demand side of the energy system	• The supply and demand side of energy system • Energy structure • The social-economic system
Target of Impact	The total energy consumption control	Energy consumption, energy structure and low-carbon technology
Key Policy Indicators	• Energy consumption intensity • Coal consumption cap • Oil consumption increase • The share of natural gas in the primary energy consumption	• Carbon emissions intensity • The share of renewable energy • The development of high-tech and newly emerging industries • Urban-rural low-carbon development • Low-carbon transportation, etc
Policy Implementation	• Lock into the fossil fuel-dominated energy system • Target the power sector and key energy-intensive enterprises	• Transition to the scale-up of renewable energy use and the electrification of energy consumption • Target the power sector, transportation and building sectors • Promote the electrification of energy system
Time of Policy Implementation	• Pilots in 12th FYP • National scale-up in 13th FYP	• Pilots in the 12th and 13th FYP, such as Beijing and Yunnan Province[5]
Disadvantages	• Fail to consider green electricity • Focus on energy saving with technology advancement but not energy structure adjustment	• Lack of legal support • Emission data availability and quality needs to be improved • Lack of complementary measures
Advantages	• Provide legal, policy and data support • Encourage the use of energy saving technology	• Focus on the whole economy • Allow energy consumption to increase and promote the development of renewable energy • Facilitate the development of low-carbon industries

[5] See "Decision on Beijing's Pilot Work on Carbon Emissions Trading under the Carbon Cap" (2013) and "Notice of the Yunnan Provincial People's Government on Distributing the Work Plan for Establishing the Total Carbon Cap and Control System and Target Decomposition in Yunnan Province and Implementing the National Carbon Emissions Trading Market Construction Plan in Yunnan Province" (2016).

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