世界资源研究所
WORLD RESOURCES INSTITUTE

清華大學
Tsinghua University

**Working Paper**

# CLIMATE POLICY GREENHOUSE GAS IMPACT ASSESSMENT: A CASE STUDY OF BEIJING EMISSION TRADING SCHEME

JINGJING ZHU, YU WANG, AND RANPING SONG

## EXECUTIVE SUMMARY

China included controlling greenhouse gas (GHG) emissions in its *12th Five Year Plan for National Economic and Social Development (2011-2015)*, reaffirming the international consensus on the need to take action on climate change. To achieve this goal, the Chinese government issued policies to set energy intensity and carbon emission intensity targets, place limits on energy consumption for producing certain products, set up low-carbon city pilot programs, and initiate seven pilot programs for carbon emission trading schemes (ETS).

As more policies are adopted, the question of how to effectively, comprehensively, and objectively assess each policy's impact on greenhouse gas (GHG) emissions becomes of great importance, especially when climate and energy policies interact. Understanding exactly how a policy affects GHG emissions can help decisionmakers select, design, implement, and improve new polices.

Assessment of a policy's impact on GHG emission reductions can be conducted before, during, and after the implementation of a policy. By assessing likely impacts of planned policies, the government can select the most effective policies, set an overall emission reduction goal by integrating the impacts of individual policies, report on expected GHG effects of policies and actions being considered or implemented, and, eventually, attract and facilitate financial support. Impact assessments during or after implementation can help the government determine whether a policy has achieved its expected results, inform further implementation, and ensure cost effectiveness and efficient use of resources.

## CONTENTS





**Suggested Citation:** Jingjing Zhu, Yu Wang, and Ranping Song. 2014. "Climate Policy Greenhouse Gas Impact Assessment: A Case Study of Beijing Emission Trading Scheme" . Working Paper. World Resources Institute, Beijing. Available online at http://www.wri.org.cn/etsassessment.

With this in mind, the World Resources Institute (WRI) and its partners worked with nearly 200 experts from governments, academic institutions, corporations and nongovernmental organizations (NGOs) to develop the *Greenhouse Gas Protocol: Policy and Action Standard* (World Resources Institute 2014), called the Policy Standard, which provides guidance on assessing the impact of climate change and energy policies on greenhouse gas emissions. The Policy Standard has been used to assess the GHG impact of 27 policies and actions from 20 countries and cities.

This study applied the Policy Standard to assessment of one of China's seven pilot projects on emission trading schemes – Beijing Emission Trading Scheme (Beijing ETS). Assessing this pilot should not only provide information to help improve continued emission trading in Beijing, but it should also give insights that could be applied to a larger national emission trading scheme, which is under consideration.

In additional to quantitative assessment of GHG impact, policy implementation tracking can provide "ground-truth" on a policy's current status of implementation, shed light on challenges, and help audience appreciate the context of quantified assessment results. This study applied the *Climate Policy Implementation Tracking Framework* (Barua, Fransen, and Wood 2014), called the Tracking Framework, also developed by the World Resources Institute, which provides detailed guidance on tracking indicators in the policy implementation process. Using the Tracking Framework, we developed indicators on finance, licensing, permitting, and procurement; information collection and tracking; compliance and enforcement; and other administrative activities to track the implementation of Beijing ETS. Additionally, we developed a monitoring plan to collect information for ex-post impact assessment.

In conducting this assessment, the study team examined the feasibility and applicability of the Policy Standard and the Tracking Framework in the Chinese context. Based on the assessment results, we discuss several issues regarding plans for China's national ETS, and make recommendations to assess and track Chinese policies.

This research began in 2013 and was completed in 2014, whereas the Beijing ETS pilot runs until 2015. Therefore, although some assumptions have been adjusted based on the most recently available data, this is an ex-ante assessment of policy.

## Assessment Results and Discussion

Since the launch of Beijing ETS in November 2011, Beijing has carried out activities including basic research and development, emission allowance allocation, and trading, and compliance—smoothly in most cases. To assess the impact of Beijing ETS, this study set up two scenarios: the baseline scenario and the policy scenario. The baseline scenario represents $CO_2$ emissions without the emission trading scheme, while the policy scenario represents $CO_2$ emissions with the emission trading scheme. The difference between the two scenarios represents the $CO_2$ emissions reduced by Beijing ETS.

The assessment results show that Beijing ETS reduced $CO_2$ emissions by 0.41 megatonnes of $CO_2$ ($MtCO_2$) in 2013, 1.56 $MtCO_2$ in 2014, and 2.90 $MtCO_2$ in 2015. These reductions are 0.60, 2.25, and 4.19 percent of the baseline scenario $CO_2$ emissions for the three years, respectively. The cumulative emission reductions for all three years total 4.87 $MtCO_2$. The reductions were modest but the ETS policy changed the emissions trend for regulated companies. Because of the ETS policy, emissions of key emission institutions started to decrease, reversing a trend of increasing emissions under the baseline scenario. Therefore, the ETS contributed to an earlier emissions peak for Beijing. The pilot's mission was to test the procedures, rather than to achieve spectacular reductions in the first phase.

### Emission Trading Scheme and Power Sector Mitigation

Unlike many other emission trading schemes, Beijing ETS requires both power producers and power consumers to surrender emission allowances for power-related $CO_2$ emissions. To avoid double counting emissions, the scheme counts emissions from power generated at plants outside of Beijing and consumed inside Beijing as consumption-, or demand-end, emissions. Total power-related $CO_2$ emission reductions accounted for 45 percent (2.18 $MtCO_2$ over the three-year period) of the total emission reductions by Beijing ETS. Of these power-related emission reductions, 98 percent (2.13 $MtCO_2$ over three years) were by companies who reduced emissions to meet their caps partly by using less electricity. On the production end, emission reductions from power plants inside Beijing were negligible at only 50,000 $tCO_2$.

The reduction in production-side emissions was so small mainly because Beijing's thermal power plants are already tightly regulated and many have already installed or are about to install new technologies, and because Beijing ETS set lenient $CO_2$ caps for thermal power plants based on their historical emission intensities. To further reduce direct emissions from thermal power plants, Beijing ETS might consider changing the emission allowance allocation method. Rather than benchmarking an individual plant's historical performance, Beijing ETS could instead benchmark the emission intensity of all electricity produced by power groups. This design would allow power companies to further mitigate emissions by switching fuels or increasing their renewable portfolio, instead of relying only on reducing the emissions of coal-fired generating units.

Alternatively, Beijing might consider excluding the power sector from ETS coverage altogether. Since other administrative measures have been implemented to reduce emissions from power plants, and the current design of ETS does not drive further emission reductions, the power sector could be spared the effort of participating in ETS. As noted, the biggest reductions in emissions from power production came from the reduction in the demand for electricity by other companies as they made efforts to meet their own emissions caps.

Although a national ETS cannot simply extrapolate the Beijing ETS program, a relevant analysis of Beijing ETS can inform decisionmaking for a national ETS program.

First, a national ETS should seriously consider following Beijing's practice of including indirect emissions associated with electricity consumption in the emission allowance allocation for companies, given the fact that a large portion of the reductions in Beijing ETS was attributed to a reduction in electricity demand. This design option will be especially appealing in the case that the electricity pricing remains controlled. A regulated electricity price cannot send price signals to power consuming companies about the external costs of carbon emissions, while the inclusion of indirect emissions of electricity consumption can directly motivate the reduction efforts of those consuming companies.

Second, if the national ETS caps direct emissions from electricity production, the cap should be stringent in order to be effective and other issues must be considered. Determining the appropriate emission allowances for power plants is challenging. Around the country, power plants have different levels of technological and management sophistication, therefore varying mitigation potentials. The carbon emission intensity of electricity is also influenced by external factors such as how power is dispatched throughout the grid to meet fluctuations in demand. Therefore, the national ETS will need to invest sufficient time and effort to get the emission allowance allocation method right.

Third, if the national ETS covers both direct emissions from electricity production and indirect emissions from electricity consumption, double counting may become an issue. The solution employed by Beijing ETS will not work nationally. Beijing ETS covers both direct emissions from power production and indirect emissions from power consumption. To avoid double counting these emissions, the scheme defines direct emissions and indirect emissions based on different geographic boundaries: emissions associated with electricity production within the city are counted as power plants' direct emissions, while emissions associated with electricity imported from outside Beijing are counted as the indirect emissions of electricity users in the city.

Unlike Beijing, China as a whole does not import significant electricity, therefore cannot adopt Beijing ETS's GHG accounting arrangement to solve the issue. The national ETS design will need to address this issue, possibly by tracking and distinguishing allowances allocated to electricity producers and consumers.

### Use of Carbon Offsets in the Carbon Emission Trading Scheme

Beijing ETS allows companies to use China Certified Emission Reductions (CCERs), as well as emission reductions that are generated by energy conservation and forestry carbon sink projects and approved by relevant authorities to meet compliance obligations (all these emission reductions can be called "carbon offsets"). In Beijing ETS, the use of carbon offsets cannot exceed 5 percent of a company's total emission allowances, and at least 50 percent of the carbon offsets must be originated by projects within Beijing. In theory, allowed carbon offsets could amount to 3.41 $MtCO_2$, 3.38 $MtCO_2$, and 3.31 $MtCO_2$ from 2013 to 2015 respectively, which is more than the estimated reductions resulting from Beijing ETS during the same period. If most of the allowed carbon offsets had been used, there would have been more supply than demand, which would have had a significant impact on allowance price.

In reality, fewer carbon offsets entered the Beijing carbon market than were allowed. The availability of carbon offsets originated within Beijing was particularly limited. In the 2013 compliance cycle, no certified carbon offsets were issued or entered the ETS. During this period, the average price for emission allowances in Beijing ETS was Y 60.4 per metric ton of $CO_2$ and 931,000 metric tons of allowances were traded.

Given the continued limited supply of Beijing-originated offsets, carbon offsets have had no observable impact on the allowance price in the 2014 compliance cycle so far.

The limited supply of carbon offsets was the result of authorities' caution in approving certified credits and of the lengthy process of generating carbon offsets. Although controlling the approval of offsets allows the government flexibility in managing offsets supply and the emission allowance price, such an approach lacks the transparency and certainty that market participants seek. In the long term, it is important to make sure the allowed carbon offsets do not exceed estimated reductions in the same period. To do so, the government needs to conduct ex-ante GHG emission reduction assessments, and consider the results when setting the limits of using carbon offsets.

## Policy Recommendations

This study demonstrated that the Policy Standard can provide a feasible, practical, and meaningful framework to assess the greenhouse gas impact of climate and energy policies in China. The Tracking Framework can help track policy implementation in China. Based on the conclusions of this paper and the experience of applying the two tools, we offer four policy recommendations.

- **Conduct an ex-ante assessment for major energy and climate policies in a systematic manner**

We recommend that ex-ante assessments be conducted for major energy and climate policies during their planning, formulation, and revision phases. Besides quantifying GHG impacts, ex-ante assessment can help identify unexpected issues, thus helping improve the feasibility and effectiveness of policies. When combined with other types of impact assessment, an ex-ante GHG assessment offers policymakers a comprehensive understanding of trade-offs.

The Policy Standard can be used to assess all kinds of policies. Although this ex-ante impact assessment framework for ETS in China has a relatively large degree of uncertainty in its findings because of limitations in data availability and the type of model used, government bodies and other researchers can still adopt it as the foundation for further improvement and customization.

- **Address other existing and planned policies, and nonpolicy drivers in impact assessment**

Besides the policy in question, other existing and/or planned policies may influence emission levels. By analyzing the interactions of different policies, impact assessment can provide an accurate picture of the net impact of the policy in question while helping to improve coordination among policies. Nonpolicy drivers, such as macroeconomic conditions, should also be considered in the assessment.

We recommend that researchers and government agencies consider other existing and planned policies and nonpolicy drivers when estimating impacts of specific policies. This can be done by incorporating those factors into the baseline scenario as demonstrated by this study. The Policy Standard provides more guidance on this issue.

- **Improve the tracking of major climate and energy policies' implementation to increase transparency**

Tracking the implementation of policies can provide updated information on indicators associated with inputs, activities, intermediate effects, and final effects that compose the causal chain of the policies. Increasing the transparency of implementation tracking can help companies and stakeholders better understand and respond to relevant policies.

Therefore, we recommend government bodies publicize policy implementation information in a transparent, timely, and systematic manner. Relevant information includes financial and nonfinancial input as well as information on activities related to licensing, permitting, and procurement; information monitoring; compliance and enforcement; and other policy administration activities. Based on such information, the government can work with research institutes, civil society organizations, companies and other stakeholders to identify implementation barriers and solutions, leading to better policy design and implementation.

- **Conduct ex-post impact assessment for major climate and energy policies**

Data availability, model limitations, and other unforeseeable factors create a relatively large degree of uncertainty in ex-ante assessment. Ex-post assessment, in contrast, can provide a more accurate conclusion, and can generate recommendations for continued improvement. To collect data for ex-post assessment, one needs to identify key performance indicators of policies and track them during the policy implementation period.

We recommend making ex-post impact assessment a significant and permanent part of policymaking. Doing so will allow future policymaking to benefit from the experience of current policy design and implementation. The Policy Standard provides a framework to conduct ex-post impact assessment. This paper identifies key performance indicators and the main parameters needed to conduct an ex-post assessment for Beijing ETS, and proposes an initial monitoring plan, which can assist the government or other researchers in collecting data and conducting ex-post impact assessment of ETS pilots.

### Limitations of the Study

Limited data availability and relevant assumptions may have introduced errors to this study. This study did not address several areas. First, it did not assess the social, economic, and other environmental effects of Beijing ETS. Second, it did not consider the economic feedback that could arise from Beijing ETS, such as the additional impact of the ETS on industrial structure. Third, when estimating power-related emission reductions, this assessment did not consider ETS's impact on electrification trends in different industries. Finally, because emission allowances can be banked during the three-year period of the pilot scheme, there may have been considerable uncertainty when calculating emission reductions for each year.

## INTRODUCTION

Scientific evidence shows that climate change is a direct result of human activity. The *Fifth Assessment Report of the Intergovernmental Panel on Climate Change* warns that if we are not able to implement more climate mitigation measures by 2030, the agreed goal of keeping the global temperature increase below 2°C will be increasingly difficult to achieve (IPCC 2014). Countries around the world have adopted and implemented policies, such as carbon trading scheme, to limit their contributions to climate change.

In addition to policies aimed at mitigating climate change, many policies on energy, environmental protection, and fiscal strategy have significant impacts on greenhouse gas (GHG) emissions and can play important roles in tackling climate change and realizing a transition to a low-carbon economy. Maximizing a policy's effectiveness in reducing GHG emissions throughout its design, adoption, and implementation stages requires the participation of many stakeholders, including government, research institutions, companies, and nongovernmental organizations (NGOs). To assess a policy's GHG impact, the World Resources Institute (WRI) and its partners developed the *Greenhouse Gas Protocol: Policy and Action Standard* (World Resources Institute 2014) (called the Policy Standard). WRI's *Climate Policy Implementation Tracking Framework* (Barua et al. 2014) (called the Tracking Framework) provides detailed guidance on tracking indicators of policy implementation.

### Paper Structure

This study applied WRI's Policy Standard and Tracking Framework to Beijing Emission Trading Scheme (Beijing ETS), a three-year pilot project, to examine whether these two tools are useful in assessing policies in China. This paper also provides suggestions for GHG impact assessment of other Chinese policies. Based on the results of the assessment, this paper discusses key issues and provides policy recommendations for Beijing ETS and the design of a nationwide ETS.

The first section discusses the significance and practice of policy impact assessment in general. The second section introduces the scope, structure, and key steps of the Policy Standard. The third section gives a quantitative assessment of the GHG impact of Beijing ETS following the procedures and methods provided in the Policy Standard. The fourth section shows how the Tracking Framework was used to identify key performance indicators in the implementation of Beijing ETS and describes the policy's current implementation status. Finally, conclusions and recommendations are offered based on these assessment results. Appendixes A through D provide more information on the methodologies, data, and other factors used to conduct a GHG impact assessment of Beijing ETS.

### Limitations of the Study

Because of limitations of the assessment framework, calculation models, and data availability, this assessment has room for improvement. First, some data were not available, thus this study extrapolated missing data from the other available data, which could lead to deviations in the results. Second, this assessment considered only the impact of Beijing ETS on greenhouse gases, but did not analyze the policy's social, economic, and other environmental effects, resulting in a relatively restricted conclusion that does not reflect the policy's comprehensive impacts. Third, the study did not account for possible economic feedback from the ETS, such as the dynamic relationships between the emission allowance price, the energy price, and companies' production and operation, or the changes in industrial structures resulting from the ETS. Fourth, the calculation of emission reductions from electricity production and consumption overlooked the impact of Beijing ETS on the electrification levels of each sector. Additionally, this calculation assumed that the direct emissions from fossil fuel combustion and indirect emissions from power consumption will be reduced according to the historical emissions ratios of each sector. This approach can underestimate or overestimate the emission reductions caused by power consumption. Finally, because emission allowances can be banked during the three-year pilot scheme, considerable uncertainty existed for each year's emission reductions, whereas the overall reduction for all three years is more precise.

## POLICY GHG IMPACT ASSESSMENT: SIGNIFICANCE AND PRACTICES

The term "policy" refers to plans, actions, programs, or measures adopted and implemented by governments. This definition includes broad policies and plans to achieve mid- or long-term goals (e.g., China's National Climate Change Program), specific policy instruments (e.g., carbon emission trading scheme), and mechanisms to promote certain technologies, processes, or practices (e.g., replacing inefficient electric motors with energy-saving ones). This paper focuses mainly on policy instruments, but in some cases also addresses the other two types of policies.

### Significance of Policy Impact Assessment

Assessing the GHG impact of one or several policy instruments is called "policy GHG impact assessment." This assessment can inform the design, implementation, and improvement of policies.

By assessing the GHG impact of a policy before implementation (ex-ante), a government can select a policy instrument based on the assessment results; it can better understand the impact of various policy designs and thereby improve the final policy; it can comprehensively consider the emission reduction results of different policies before setting overall emission reduction goals; and it can use assessment results to report on the policy's future impact. In these ways, policy GHG impact assessment can help attract and facilitate financial support for implementing mitigation policies.

Assessing the GHG impact of a policy during or after implementation (ex-post) can determine whether expectations for the policy's impact will be or have been fulfilled. It can provide information for further implementation and help decisionmakers determine whether to continue the current policy or make a change. Assessment helps practitioners gain experience and find good practices. Estimates of how each policy contributes to the overall mitigation goal can help ensure their cost effectiveness and the efficiency of resource use. Reporting on the policy's GHG impact may be necessary to meet the reporting requirements of funders.

To obtain comprehensive and objective results, assessing a policy's impact on GHGs often involves tracking its implementation. Governments and other stakeholders can obtain important basic data for GHG impact assessment from the tracking. Implementation tracking is an important way to understand policy effectiveness. For example, the government can better understand the availability of different enabling mechanisms, as well as barriers that may result in inefficiency or failures of the policies. The government can quickly react to problems that arise in the tracking process and enact solutions.

In sum, conducting GHG impact assessments of policies that either directly address or indirectly impact climate change helps stakeholders better understand the expected and actual effects of policy instruments. It also improves the efficiency and effectiveness of a government's application of climate policy instruments.

### International and Domestic Practices with Policy GHG Impact Assessment

- **International Practices**

The experiences of developed nations show that a good foundation for successful policy assessment and effective policy improvement consists of a strong supporting legal framework, working departments with clearly defined roles, a mature tracking system, suitable assessment methods, and sufficient availability of data.

Assessing policy instruments and programs for their effectiveness during and after their implementation has become common in developed countries over the past few decades. Tracking policy implementation provides basic information for such an assessment (see Box 1). Assessing the projected impacts of a policy— specifically the projected change in GHG emissions—as a means of selecting a policy or program (ex-ante) is a relatively newer practice.

The European Commission's "Impact Assessment Guidelines" and its "Roadmap" require assessment of the potential impacts of regulations and policies (European Commission 2005). The European Environment Agency (EEA), which focuses on "environmental policy results, cost effectiveness and improving means," assesses the implementation effects of the European Union's (EU's) environmental administrative methods and measures [1]. As early as 2001, EEA released a methodology framework for ex-post assessment of policy effectiveness [2]. In collaboration with the Organisation for Economic Co-operation and Development (OECD), EEA manages the OECD/EEA database of economic instruments for environmental policy and oversees Europe's climate data center. These data resources provide a supportive base for policy assessment.

Germany's Umweltbundesamt (UBA) develops and assesses different scenarios of energy supply, researches the impacts of technological implementations and policy measures in the energy industry, provides advice to policymakers, and makes information on the environmental sustainability of the energy system available to the public. [3]

The UK Department of Energy and Climate Change (DECC) established the "appraisal of policy options" system, which assesses policy options to identify those most likely to produce the largest returns with the smallest costs. [4] DECC's climate impact assessment is concerned with change in GHG emissions and the cost efficiency of the UK's climate-change policy system. DECC has released an evaluation guide and an evaluation planning template addressing assessment methodologies. [5] In cooperation with the Department for Environment, Food and Rural Affairs (Defra), DECC developed The Magenta Book—Guidance for Revaluation, [6] which addresses the main methodologies of policy impact assessment. Additionally, several laws, such as the UK Statistics of Trade Act (1947), the Electricity Act (1989), the Gas Act (1995), the EU Renewable Energy Directive (2009), the EU Energy Statistics Regulation (2010), and the Climate Change Act (2008), require that related departments provide data to DECC.

The U.S. Government Performance and Results Act (1993) authorizes the U.S. Government Accountability Office (GAO) to report to Congress its audit results on the effects of implementing public policies. The U.S. Environmental Protection Agency (EPA) also conducts assessments of the economic impact of GHG-emission-reduction policies and related standards. Assessment topics include comprehensive market-based legislation and regulations aimed at specific industries. [7] EPA has completed environmental and economic impact assessments of the American Power Act (2010), the American Clean Energy and Security Act (2009), and the Low Carbon Economy Act (2007), among others. [8] Assessment results, assessment models, and other information are published on the EPA website. These economic, social, and environmental impact assessments are essential tools for drafting new policies.

Australia's Climate Change Authority, established in 2012, provides the Australian government with independent and expert advice on the implementation of climate-change-mitigation policies. The Authority provides the Australian Parliament or the Minister responsible for climate change

### Box 1 | TRACKING POLICY IMPLEMENTATION: INTERNATIONAL PRACTICES

Tracking a policy's implementation process is an important step for comprehensive assessment of policy effectiveness.

The U.S. Government Performance and Results Modernization Act[a] requires the Office of Management and Budget (OMB) to monitor and assess every policy, organization, project, and other contributor on the achievement of outcome goals, determining the challenges faced at every stage and identifying the countermeasures that should be taken.

Germany established the "Energy of the Future" monitoring process, requiring its Federal Energy Minister and Federal Environment Minister to produce an annual monitoring report integrating inputs from other departments to identify how specific measures were executed to achieve the targets. Beginning in 2014, the government was directed to issue a progress report every three years that emphasizes broad strategies and identifies barriers to implementation.[b]

Sources:
a. GPRA Modernization Act of 2010, P. L. 111–352. January 4, 2011, United States, http://www.gpo.gov/fdsys/pkg/PLAW-111publ352/pdf/PLAW-111publ352.pdf.
b. "Energy of the Future" monitoring process in Germany, http://www.bundesnetzagentur.de/cln_1412/EN/Areas/Energy/Companies/MonitoringEnergyofTheFuture/MonitoringEnergyoftheFuture-node.html.

with its reviews of the following climate policies and actions: Australia's emissions reduction targets, carbon budget and cap for the carbon pricing mechanism, progress toward realizing Australia's mid- and long-term emission reduction targets, the carbon pricing mechanism, the national greenhouse and energy reporting system, and the renewable energy target. [9]

International research organizations, consulting firms, and other nongovernmental organizations (NGOs) also conduct policy impact assessments. For example, Denmark's green think tank, CONCITO, periodically publishes the *Annual Climate Outlook Report,* which covers Denmark's current emissions situation, and assesses adopted policies; ECOfys and the Netherlands' Environmental Assessment Agency analyzed the potential for the Netherlands' new policies to reduce emissions; the World Resources Institute (WRI) analyzed the emission reductions that can be realized by U.S. federal regulations and actions (Fransen 2013).

### Domestic Policy Impact Assessments

China has taken steps to explore policy impact assessment in recent years; however, it has just begun GHG impact assessments of climate policies.

A primary legal framework for assessing the environmental impact of plans was established through measures such as the Law on Appraising of Environment Impacts (2003), [10] the Regulation of Environmental Impact Assessment of Planning, [11] and the Interim Measures for the Administration of National Special Planning. [12] These documents set requirements for environmental impact assessments of government plans and define specific assessment responsibilities. Additionally, the Law of the People's Republic of China on the Supervision of Standing Committees of People's Congresses at Various Levels (2006) clearly prescribes mid-stage assessments of the Five-Year Plans for National Economic and Social Development. Chinese governments and departments at all levels have established policy research centers that assess policy impacts. However, these laws and regulations have no requirements for GHG impact assessment of policies and most policy research centers have not yet incorporated GHG impact assessment into their work.

Interim Measures for the Administration of Performance Evaluation of Fiscal Expenditure, [13] based on the Budget Law of the People's Republic of China, provides a framework of indicators for evaluating fiscal expenditure performance. This framework includes indicators of economic, social, environmental, and sustainable impacts. One environmental impact indicator could be a project's GHG impact. Organizations and departments that receive funds from the Department of Finance to implement policies or projects are required to submit performance reports within a specified time period. These reports can embody the results of an ex-post impact assessment of a policy or project.

The Chinese government's main practice on climate policy impact assessment is the assessment of environmental and GHG emission-reduction targets in its five-year plans. For example, the "Mid-term Impact Assessment Report on China's 12th Five-Year Plan" [14] outlines the implementation status of the following targets: $CO_2$ emission intensity control target, the energy consumption mix optimization target, and the energy consumption intensity control target. From 2009 to 2013, the annually published reports of China's Policies and Actions on Climate Change [15] also addressed the GHG impact of China's climate policies. These reports introduced key policies, mitigation effects, and fiscal investment in different areas of climate change mitigation and adaptation, [16] and demonstrated the general trend in climate policies; however, the reports rarely assessed single policies or specific plans. China also has some experience in policy implementation tracking (see Box 2).

No quantitative assessment of the GHG emission reductions achieved by China's seven pilot carbon trading schemes had been published as of this writing. Some researchers and institutes have conducted in-depth studies of the energy-saving and emission-reduction effects of other policies. For example, the Climate Policy Institute at Tsinghua University published the "Annual Review of Low-Carbon Development in China (2011-2012)," which calculated the amount of carbon dioxide emissions reduced by the main policies and actions during China's 11th Five-Year Plan period (Qi et al. 2012). The emission reductions from policies and actions such as the Top-1,000 Energy-Consuming Enterprises program, an energy conservation program focusing on 10 key sectors, a program that phased out obsolete production capacity, an governmental action that encouraged energy performance contracting, and the energy-saving vehicles policy, were calculated by multiplying the energy-saving data from the National Bureau of Statistics by corresponding carbon emission factors. The report also clarified the formula and

## Box 2 | TRACKING THE IMPLEMENTATION OF CHINA'S CLIMATE POLICIES

China's government is paying increasing attention to monitoring the implementation of its policies. In May 2014, the Standing Committee of the State Council decided to inspect and supervise the implementation progress of current policy instruments, and introduce third-party assessment and social evaluation.[a] This decision is an important symbol that the government is strengthening policy tracking.

The National Center for Climate Change Strategy and International Cooperation (NCSC) has built an administration platform to assess and score provincial governments' performance toward their GHG emissions targets. This platform can examine the effects of energy-saving measures in each provincial (including regional and civic) government, as well as selected key energy consumption companies. The results are made public by the National Development and Reform Commission (NDRC).[b]

The Chinese government is promoting audits of climate policy implementation. The National Audit Office (NAO)'s Audit Work Development Plan (2008–2012) proposed audits for environmental protection projects and for significant national policies and measures. Currently, the auditing work in the climate change field focuses mainly on the audit of energy-savings and emission-reductions policies and projects in the Five-Year Plan for National Economic and Social Development. It is carried out by the Audit Department in Agriculture, Resource and Environmental Protection under NAO. The audit includes: the allocation, management, and use of energy-savings and emission-reduction funds; the implementation of related policies and regulations; and the performance of energy-saving and emission- reduction projects.[c]

So far NAO has implemented three energy-saving and emission-reduction audits to the five- year plan, and released the results in May 2011 and May 2013. In the 2013 audit report,[d] it announced the progress of energy-saving and emission-reduction policies in 10 provinces from 2010 to 2011, including the number of rules that related to energy-saving target allocation (more than 40 rules), the aggregated number of funds invested in energy-saving and emission-reduction projects (Y 84.8 billion) , and the number and performance of energy-saving and emission- reduction projects supported by fiscal funds (energy-saving capacity of 50,996 kilotons of standard coal equivalent).

At the same time, the announcement of NAO pointed out that some companies used energy-saving and emission-reduction funds improperly, some projects had not reached expected results, and some energy-saving and emission-reduction funds had not been appropriated according to the budget requirements. The announcement urged relevant departments to appropriate funds as scheduled.

Additionally, the Ministry of Finance notice, Interim Measures for the Administration of Performance Evaluation of Fiscal Expenditure,e requires national agencies, political organizations, public institutions, and other independent legal entities that receive funds from the department of finance to evaluate the performance of projects that have significant social or economic impacts. This includes evaluation of indicators related to project decisions, project management, and project performance. The former two categories of indicators involve the tracking of project implementation, such as the appropriation, and implementation of management schemes.

Sources:
a. China News, May 31, 2014, "Supervision Teams of the State Council Will Examine the Policy Implementation Status, http://finance.chinanews.com/cj/2014/05-31/6233814.shtml.
b. The administration platform for assessing and scoring provincial governments' performance on GHG emissions control target, http://203.207.195.149:8080/AssessmentSupportingPlatform/JSP/login.jsp.
c. National Audit Office, July 1, 2011, "National Audit Office Published Audit Work Development Plan during the 12th Five Year Plan Period," http://www.audit.gov.cn/n1992130/n1992150/n1992379/2758107.html.
d. National Audit Office, May 17, 2013, The audit results of 1139 energy saving and emission reduction projects in 10 provinces, http://www.audit.gov.cn/n1992130/n1992150/n1992500/3280941.html.
e. China Ministry of Finance, April 2, 2011, "Notice of Issuing Interim Measures for the Administration of Performance Evaluation of Fiscal Expenditure," http://yss.mof.gov.cn/zhengwuxinxi/zhengceguizhang/201104/t20110418_538358.html

underlying assumptions for calculating the emission reductions from policies on energy conservation in buildings and energy-saving electric appliances.

The State Grid Energy Research Institute's research on the Energy Consumption Control Policy quantified the effects of energy-consumption-control policies, and calculated energy savings from policies on industrial structure adjustment, energy-demand management, energy production, and fiscal subsidies (State Grid Energy Research Institute 2013). The Energy Research Institute of the National Development and Reform Commission (NDRC) conducted a number of energy system analyses. For example, "Analysis of China's Energy and Greenhouse Gas Emissions Scenarios and Emission Reduction Costs" used the integrated policy assessment model for China (IPAC) to calculate the impacts of energy taxation, renewable energy, industrial efficiency, and other policies on China's energy-related $CO_2$ emissions (Jiang et al. 2008).

These studies used different assessment methodologies and calculation models or formulas, and explained the assessment processes and key assumptions with varying degrees of details. However, they did not provide a widely applicable framework for assessing a policy's energy savings or GHG-emission-reduction impact. In comparison, the Policy Standard provides a complete, clear, and consistent systematic framework to assess the GHG impact of different types of policies or actions. The Policy Standard also provides a unified framework for quantifying GHG impacts, and it allows researchers the flexibility of using different calculation models while disclosing the assessment results through standardized and transparent means.

The effectiveness and implementation status of climate change mitigation policies in China have attracted the attention of many international institutions. Climate Action Tracker, the International Energy Agency (IEA), the U.N. Environmental Program (UNEP), and the Climate Policy Initiative have all developed methods to track and assess China's climate mitigation progress. They have presented specific methodologies within many different scopes that can be referenced for future research.

### Section Summary

Conducting an impact assessment of a policy is helpful in determining the policy's effectiveness; it can inform policy design, implementation, and adjustment; it can help governments screen optimal policy instruments, set up general emission-reduction goals, and reasonably allocate resources.

A review of policy impact assessment practices in selected developed nations shows that some countries have built a legislative basis for policy impact assessment; assigned government departments to conduct the impact assessments; developed policy assessment methodologies, tools, and models; established ex-ante and ex-post assessment systems; and built abundant database resources. Assessment results are used in policy design, screening for optimum policies, and policy implementation.

In China, a legal framework for environmental impact assessment of government plans exists; however, there is no specific legal base for GHG impact assessment of policies. China has set up a mechanism that requires the environmental performance evaluation of policies and projects based on fiscal management. Current GHG impact assessment is focused mainly on broad national goals such as the Five-Year Plans for National Economic and Social Development, and GHG impact assessment of specific policy instruments is rarely conducted. Quantitative and scientific impact assessment has not yet became a necessary part of the policymaking process. Government research institutes and NGOs have conducted research on the economic, social, and environmental impacts of existing policies. However, research that addresses a widely applicable and flexible policy impact assessment framework still lags behind. China has adopted a series of policies to mitigate climate change. Building an open, scientific, and timely system for GHG emissions impact assessment, and a standardized, comprehensive, and scientific policy impact assessment framework and methodologies, is crucial to ensure and promote the emission reduction effects of these policies.

## THE GREENHOUSE GAS PROTOCOL POLICY AND ACTION STANDARD

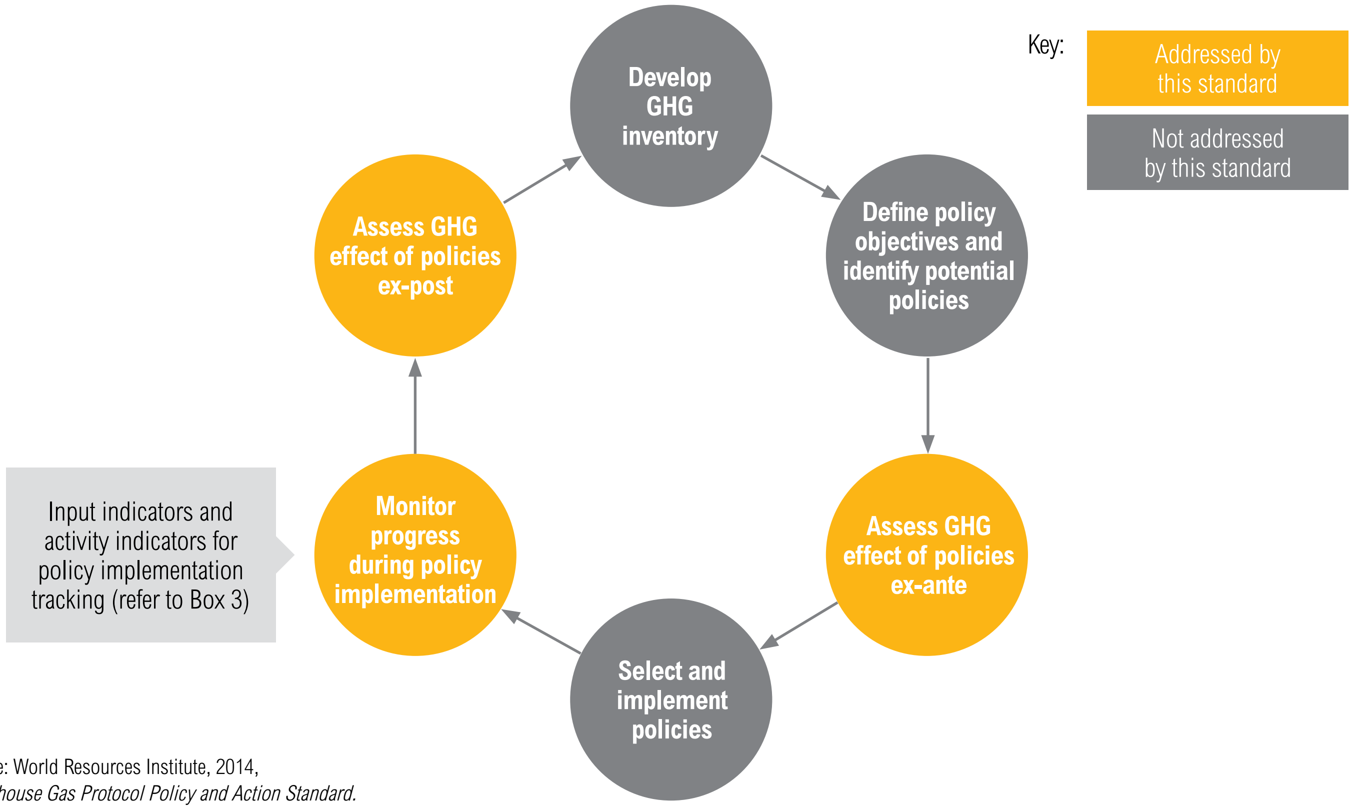
Although many countries had experiences in conducting impact assessments of their policy instruments, a widely accepted and standardized framework for greenhouse gas (GHG) impact was absent. Therefore, the World Resources Institute (WRI) and its partners convened about 200 experts from governments, research institutions, nongovernmental organizations (NGOs), and business in 20 countries and cities, including China, between 2012 and 2014 to develop the Greenhouse Gas Protocol: Policy and Action Standard (Policy Standard) to provide a methodology for GHG impact assessment of policies.

### Applicability of the Standard

The Policy Standard can be used to assess the GHG impact of policy instruments or the implementation of certain technologies, processes, or practices. Assessing broad strategies or plans requires identifying and assessing each of the policy instruments, technologies, processes, and practices that support the strategies. Because the information of these policies, technologies, and processes and practices can be very limited, assessing broad strategies may not always be feasible.

The Policy Standard is applicable to assessing various policy instruments (e.g., voluntary agreements and measures; regulations and standards; carbon emission trading; taxes and charges; and research, development, and deployment policies) at various geographic scopes (international, national, and regional) and in various industries. The standard can be used for ex-ante assessment of policies and to guide the monitoring of policy implementation, or for ex-post assessment to evaluate its effectiveness. By using this standard, policymakers and other stakeholders can achieve accuracy, consistency, transparency, completeness, and relevance in their assessments, and produce results to confidently select, design, and improve their emission-reduction policies. The three orange circles in Figure 1 show the areas where

Figure 1 | **Application of the Policy Standard**




Source: World Resources Institute, 2014, *Greenhouse Gas Protocol Policy and Action Standard.*

the Policy Standard can be applied in a policy design and implementation process.

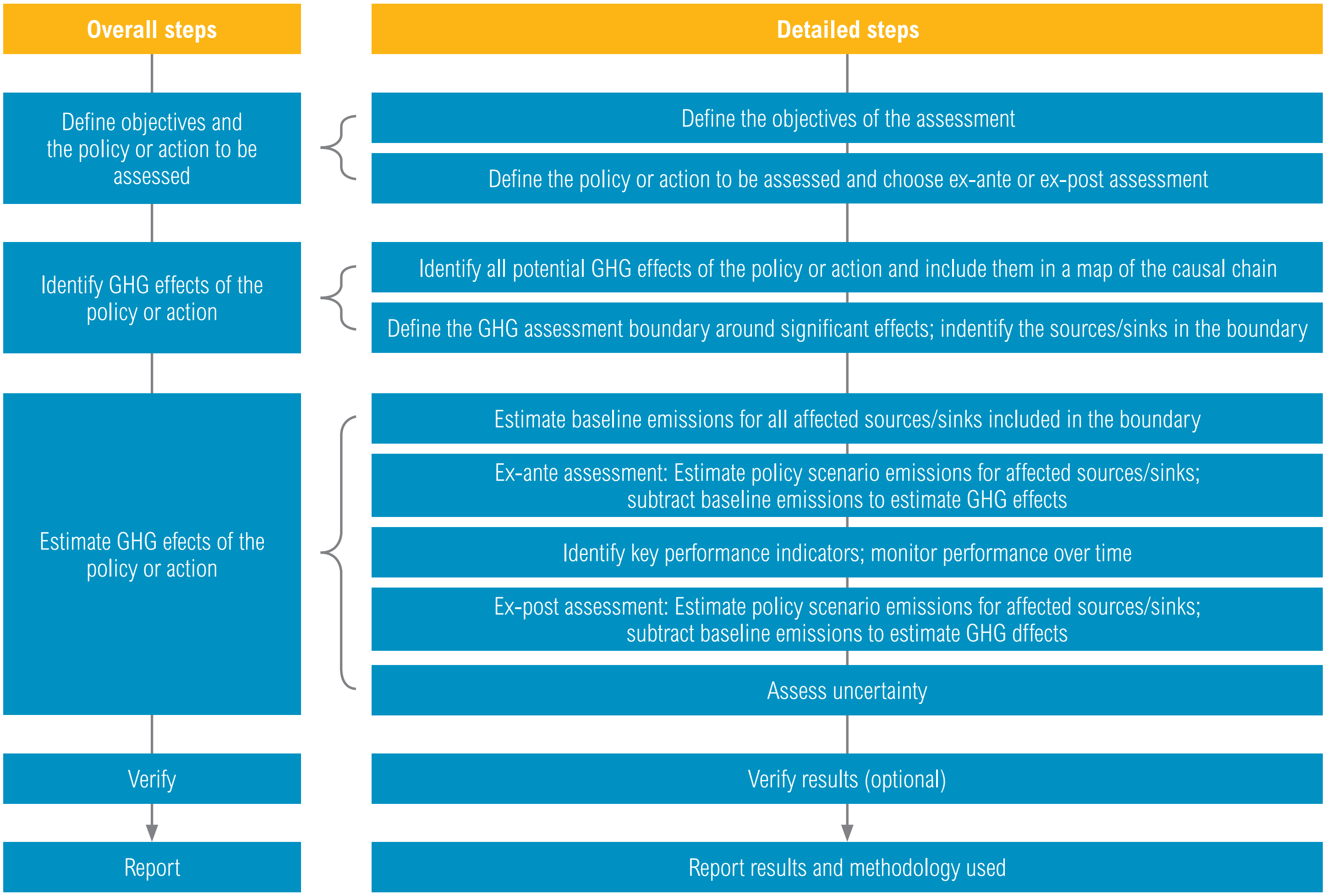
The Policy Standard is designed to measure the change in GHG emissions brought about by a policy instrument. By integrating the GHG impacts with policy costs and other data, the user can conduct a cost-effectiveness analysis, cost-benefit analysis, or multicriteria analysis of the policy. Although the standard itself does not address environmental, social, and economic impacts, its framework and basic process is equally useful for assessing these impacts; therefore, the standard can combine with other methods and data to assess the multifaceted impacts of a policy. This standard does not limit the types of calculation methods or models used in the quantification process. Thus, it can be applied to different existing models.

GHG policy impact assessments differ from GHG inventories of a region or an enterprise, but these two types of GHG analysis can complement each other. A GHG inventory is the first step of GHG management, helping researchers understand the background and identify the mitigation potential of a region or an enterprise. However, GHG inventories do not explain the reasons for emission growth or decline, or reveal the effects of individual policies or actions. GHG impact assessments of policy instruments can provide complementary information to GHG inventories to help governments better understand the reasons for changes in GHG inventories. Using the same calculation methods in the GHG inventory and the GHG policy assessment can enhance the comparability of the two results.

## Structure and Main Steps

The Policy Standard assessment process can be divided into five steps: (1) define the objectives of the policy or action to be assessed, (2) identify the GHG effects of the policy or action, (3) estimate the GHG effects of the policy

Figure 2 | **Policy Standard Assessment Steps**




Source: World Resources Institute. 2014, *Greenhouse Gas Protocol Policy and Action Standard.*

or action, (4) verify the results, and (5) report the results and the methodology. The steps are outlined in Figure 2 and discussed below.

### Step One: Define assessment objectives and policy or action to be assessed

Policy impact assessment can serve many purposes, such as choosing policies, assisting policy design, tracking policy effects, summarizing experiences, assessing emission reductions achieved by policies, or facilitating communication. Different starting points create different requirements for accuracy and comprehensiveness. Therefore, it is necessary to clarify the assessment objective at the beginning.

After determining the assessment objective, it is necessary to decide whether to assess an individual policy or a package of policies, describe the policy details, and choose the assessment type according to the policy's stage (ex-ante or ex-post).

The Policy Standard provides a checklist to which researchers can refer when describing policy details, including specific enforcement rules.

### Step Two: Identify GHG effects of the policy or action

To assess a policy's GHG impact, one must first clarify which process or activity is impacted by the policy and how. The Policy Standard requires mapping "causal chains" that show the effects a policy may trigger, including policy input, activities, intermediate effects, and the final GHG and non-GHG effects, as well as determining the GHG sources and sinks that are impacted.

After developing a causal chain map, one must determine the GHG assessment boundary, including the GHG effects, emission sources and sinks, GHG types, and the period of time covered by the assessment. Through a literature search, model predictions, expert scoring, and other means, a researcher can determine the likelihood that each GHG effect will occur and at what relative magnitude, and then determine the significance of each GHG effect. With this foundation, by integrating policy goals, research goals, availability of data, and other factors, the researcher can determine the GHG effects included in the assessment boundary.

### Step Three: Estimate GHG effects of the policy or action

The Policy Standard requires comparing GHG emissions within the assessment boundary under a baseline scenario and a policy scenario to estimate the GHG impact of the policy. The emission situation in the baseline scenario is what would have happened in the absence of the policy or action being assessed. The standard has specific requirements for reporting the baseline scenario. For example, the researcher must report whether any planed policies are included in the baseline scenario. The researcher should consider the most likely emission volumes of the emission sources within the assessment boundary during the assessment period. Different types of greenhouse gases can be compared based on their 100-year global warming potential (GWP).

An ex-ante assessment requires identifying the policy scenario, and predicting the likely GHG emissions that would result. The calculation of policy scenario emissions should include all emission sources within the assessment boundary during the assessment period, and use the same GWP measure as the baseline scenario. By comparing baseline scenario emissions with the policy scenario emissions, a policy's likely GHG impact can be quantified.

Conducting an ex-post assessment requires identifying and monitoring four categories of key performance indicators: inputs, activities, intermediate effects, and final effects. WRI's Tracking Framework document, a companion to the Policy Standard, gives detailed guidance on how to identify and track several categories of key performance indicators (see Box 3). Ex-post assessment also requires monitoring other important parameters needed for calculation. Researchers should develop and carry out monitoring plans for the appropriate performance indicators and parameters.

### Box 3 | CLIMATE POLICY IMPLEMENTATION TRACKING FRAMEWORK HELPS TO IDENTIFY KEY PERFORMANCE INDICATORS OF POLICY INPUTS AND ACTIVITIES

The *Climate Policy Implementation Tracking Framework* (Tracking Framework), a companion to the *Greenhouse Gas Protocol: Policy and Action Standard* (Policy Standard), provides detailed guidance about how to determine the key performance indicators related to input and activity. The input indicators correspond to a policy's finance or other inputs, and activity indicators correspond to functions such as permitting, procurement, information monitoring, and enforcement.

Input and activity indicators include:

***Finance:*** Policy implementation requires capital investment. Having sufficient funding within a certain time period is necessary. The Tracking Framework suggests that users focus on funding sources, capital flow, and actual allocation of funds when examining the impact of finance on policy implementation.

***Licensing, permitting, and procurement:*** Administration functions of a policy include licensing, permitting, and procurement. In most cases, the responsible institution will carry out these functions regularly during the implementation of policies. When identifying a policy's administrative indicators, it is important to consider what administrative functions the policy requires, which institutions are responsible for carrying them out, and whether quantitative indicators can be used to determine whether the functions are carried out.

***Information collection and tracking:*** Assessing the intermediate effects of policy implementation often requires collecting and tracking information about the status of the implementation. Compliance practices of policies can involve collecting information from regulated companies and other sources. All of this information serves as a basis for assessing policy effectiveness.

***Compliance and enforcement:*** For a policy to achieve its expected results, it is necessary to ensure compliance with regulations, and to guarantee that responsible departments are able to enforce policy conditions. Broadly speaking, methods of ensuring enforcement include imposing fines, public criticism, and other penalties. It is also possible to use incentive mechanisms such as subsidies or preferential taxation; or to mix penalties and incentives. The Tracking Framework provides guidance on identifying and summarizing enforcement indicators.

***Other administration activities:*** Activities related to policy implementation other than the functions mentioned above are classified as "other."

Source: Barua , Fransen, and Wood 2014.

Ex-post assessment of a policy also requires determining the policy scenario and estimating GHG emissions under this scenario. Ex-post assessments can be calculated with data collected from the actual situation. Baseline scenario emissions can be adjusted according to the actual situation. By examining the difference between emissions under the baseline scenario and the policy scenario, the researcher can quantify the policy's GHG impact.

Uncertainty analysis can help users understand the level of accuracy and uncertainty of the assessment results, allowing users to better decide how to properly interpret and use the results. The sources of uncertainty identified in the analysis can inform the improvement of data quality. The Policy Standard requires researchers to describe quantitatively or qualitatively the uncertainty, and provide the sensitivity analysis results of key parameters and assumptions.

**Step Four: Verify the results (optional)**

Verification of the assessment means that an independent third party examines whether the assessment report complies with all the requirements of the Policy Standard, and whether appropriate methods and assumptions have been applied.

Verification can provide the implementing entity and relevant stakeholders with confidence in the results. Therefore, the Policy Standard provides guidance for verification of assessment results.

**Step Five: Report the results, methods, parameters, and assumptions**

To ensure the credibility and transparency of assessment results, the Policy Standard sets out detailed requirements for reporting, including the assessment results, methods used, key parameters, and assumptions.

The Policy Standard provides a general framework of assessment, but does not suggest who should conduct each step. The assessment can be done by one team or by multiple researchers.

### Section Summary

The World Resources Institute collaborated with its partners to develop the Policy Standard, an effort to provide policymakers and researchers with a standardized framework and process of policy impact assessment. It can be used to assess the GHG impact of policy instruments and the application of new technologies, processes, and practices. The Policy Standard can be applied to many different industries, geographical scopes, policy types, and assessment types (ex-ante or ex-post).

The Policy Standard focuses only on GHG impact; it does not directly assess economic, social, or other environmental impacts. The accuracy of assessment results depends on the specific models or data used. If researchers want to compare the effects of different policies, add up effects of several policies, or verify, issue, and trade GHG emission reduction credits, they should follow additional provisions for the calculation methods and data.

Finally, the Policy Standard can be used in connection with the Tracking Framework to track four types of key performance indicators: input, activity, intermediate effects, and final effects. From this, researchers can obtain a comprehensive understanding of the policy from its processes to its effects. Sections 3 and 4 will apply the Policy Standard and the Tracking Framework to assess the impact of Beijing ETS and track its implementation.

## GHG IMPACT ASSESSMENT OF BEIJING EMISSION TRADING SCHEME PILOT

This study assessed the GHG impact of Beijing Emission Trading Scheme (Beijing ETS) based on the Greenhouse Gas Protocol: Policy and Action Standard (Policy Standard) by the World Resources Institute. It estimated the emission reductions and the emission trends driven by Beijing ETS that were additional to the effects of other policies. Results of this assessment are presented here along with information on the scenario settings, assessment boundaries, and key assumptions.

Quantitative assessment of a climate or energy policy's greenhouse gas (GHG) impacts can provide an important basis for evaluating its overall effectiveness. Impact assessment of policy instruments usually involves multiclass data, assumptions, and calculation methods that bring varying degrees of uncertainty to the final result. Conducting an assessment by following a clear framework, and by disclosing every step, can help stakeholders interpret the results objectively.

### Defining the Objective of the Assessment and the Policy

Beijing ETS uses a market mechanism to encourage companies to conserve energy and reduce emissions. ETS is a policy instrument to help realize China's broad strategy to reduce GHG emissions. Beijing ETS is being implemented from 2011 to 2015 with emission trading between 2013 and 2015 as a pilot for a national ETS. Therefore, this assessment provides information not only to improve Beijing ETS, but also to contribute to the design of a national ETS. The background of implementing Beijing ETS is given in Box 4.

Reducing GHG emissions in the power sector is an important condition for realizing China's climate change mitigation goal. Power production accounts for more than one third of China's GHG emissions. Beijing ETS includes both direct emissions from power production and indirect emissions from power consumption by industries. This study analyzed the ETS policy's actual impact on reducing emissions in the power sector.

Comparing the emission reduction impacts of different policies requires using the same methodology, data sources, assumptions, reporting formats, and boundaries for each policy. This assessment does not aim to compare emission reduction impacts of Beijing ETS and other existing or planned policies.

This research began in 2013 and was completed in 2014; whereas the Beijing ETS pilot runs until 2015. Therefore, although some assumptions have been adjusted based on the most recently available data, this is an ex-ante assessment of policy.

## How Beijing ETS Works

Beijing ETS caps $CO_2$ emissions of the "key emission institutions" in Beijing. Companies included in the program are given carbon "emission allowances," which represent the right to emit a certain amount of $CO_2$. Companies get free emission allowances from the government at the start of each compliance cycle, and can also buy or sell allowances on the market.

Companies are also allowed to use "certified emission reductions" [17] or "carbon offsets" to offset part of their carbon emissions. Carbon offsets cannot exceed 5 percent of a company's total emission allowances for that year. Carbon offsets come from government-approved offset projects, which companies can buy from the market.

At the end of each compliance cycle (e.g., the compliance deadline for the year 2013 was June 30, 2014), key emission institutions must surrender emission allowances and carbon offsets equal to their actual $CO_2$ emissions of that year (e.g., the $CO_2$ emissions of 2013).

## Beijing's "Key Emission Institutions"

Beijing ETS covers three main emission sources within its jurisdiction: direct emissions from fossil fuel consumption by stationary facilities, direct emissions from industrial processes or waste treatment, and indirect emissions from electricity consumption by stationary facilities.

Companies that produce average annual carbon emissions—including direct and indirect emissions [18] —equal to or higher than 10,000 metric tons are recognized as "key emission institutions" and are covered by the ETS. Companies with lower emissions are not covered. In 2013, 415 Beijing companies and institutions,[19] including heat-

### Box 4 | BACKGROUND ON BEIJING EMISSION TRADING SCHEME

Actively tackling global climate change was listed as an important task in China's *12th Five-Year Plan for National Economic and Social Development,* which included "gradual development of a carbon trading market" as a method to mitigate greenhouse gas emissions. The Working Plan for Greenhouse Gas Emission Control during the 12th Five-Year Plan Period specifically outlined "the creation of pilot carbon trading schemes." In October 2011, "the Notice of General Office of the National Development and Reform Commission on Developing Carbon Trading Scheme Pilots" approved pilot emission trading schemes in five cities and two provinces including Beijing and Shanghai.

Beijing set a target to reduce its energy intensity by 17 percent and its carbon emission intensity by 18 percent during the 12th Five-Year Plan Period.[a] The Beijing emission trading scheme (ETS) pilot will facilitate the energy-saving and emission-reduction efforts of Beijing enterprises, help explore this means of lowering the costs of emission reductions, and, to some extent, drive the progress of achieving Beijing's overall emission-reduction target. Additionally, good practices and experiences derived from Beijing ETS can inform the development of a national ETS. Preparation work for Beijing ETS was officially initiated in March 2012. The emission trading was officially launched on November 28, 2013, with a 2013 compliance deadline of June 30, 2014. The rate of companies' compliance with their emission control requirements reached 97.1 percent in 2013 .

Sources:
a. Beijing Municipal Government, 2011, Beijing Municipal Plan of Energy Conservation, Consumption Reduction and Tackling Climate Change during the 12th Five-Year Plan Period, http://zhengwu.beijing.gov.cn/ghxx/sewgh/t1198926.htm.

ing suppliers, thermal power plants, cement companies, chemical companies, other industrial companies, and services providers, were covered by Beijing ETS.

As the basis for determining emission allowances, the Beijing Municipal Commission of Development and Reform (Beijing MCDR) uses historical emission intensity (e.g., kilograms of $CO_2$ per kilowatt hour [kg $CO_2$/kWh] of electricity supplied to the grid) for existing heating supply facilities and thermal power generation companies, total historical emissions for existing facilities of all other companies, and industrial advanced benchmarks for emission intensity for new companies and facilities.

The Policy Standard provides a template checklist of policy information. For detailed information on Beijing ETS policy, see Appendix A

## Identifying the GHG Effects of Beijing ETS

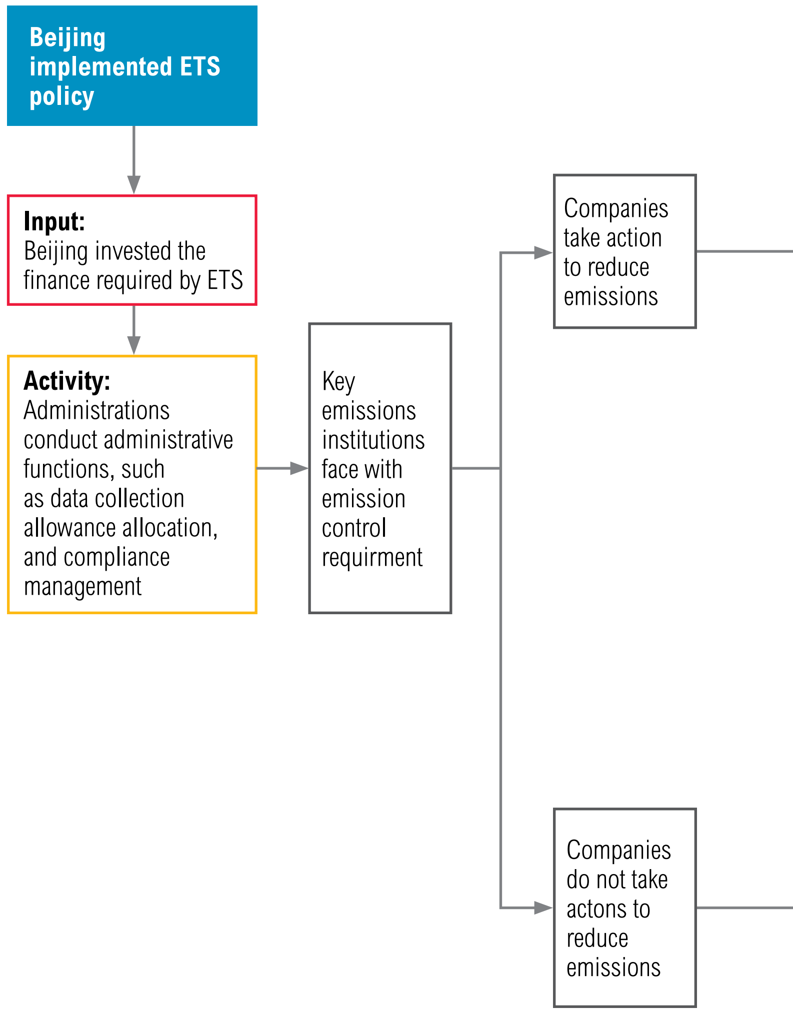
### Mapping the Causal Chain

The causal chain, introduced in Section 2, is a series of causally interrelated events or phenomena that shows how a policy instrument impacts GHG emissions. Mapping the causal chain helps researchers identify all the potential impacts of a policy. To determine the causal chain, the study team researched official Beijing ETS documents as well as the literature of other carbon-trading schemes, and consulted with experts. An abridged causal chain map is shown in Figure 3 as an illustration. The complete version of the map is in Figure B.1 of Appendix B.

Institutions covered by ETS are allotted certain amounts of emission allowances by the authorized department. In the complete version of the causal chain map, key emission institutions were divided into four categories according to the "Beijing Pilot Emission Trading Scheme Allowance Ratification Method (provisional)": manufacturers and other industrial companies, thermal power companies, heating suppliers, and service providers. Companies can take industry-specific measures to reduce direct $CO_2$ emissions based on the features of their emission sources. Companies can also reduce indirect emissions by reducing their electricity consumption.

A decline in electricity demand may result in a decrease in the electricity generated by thermal power plants, which in turn would lower the direct emissions from the power generation process. Furthermore, since Beijing relies heavily on electricity from external power grids, a decrease in

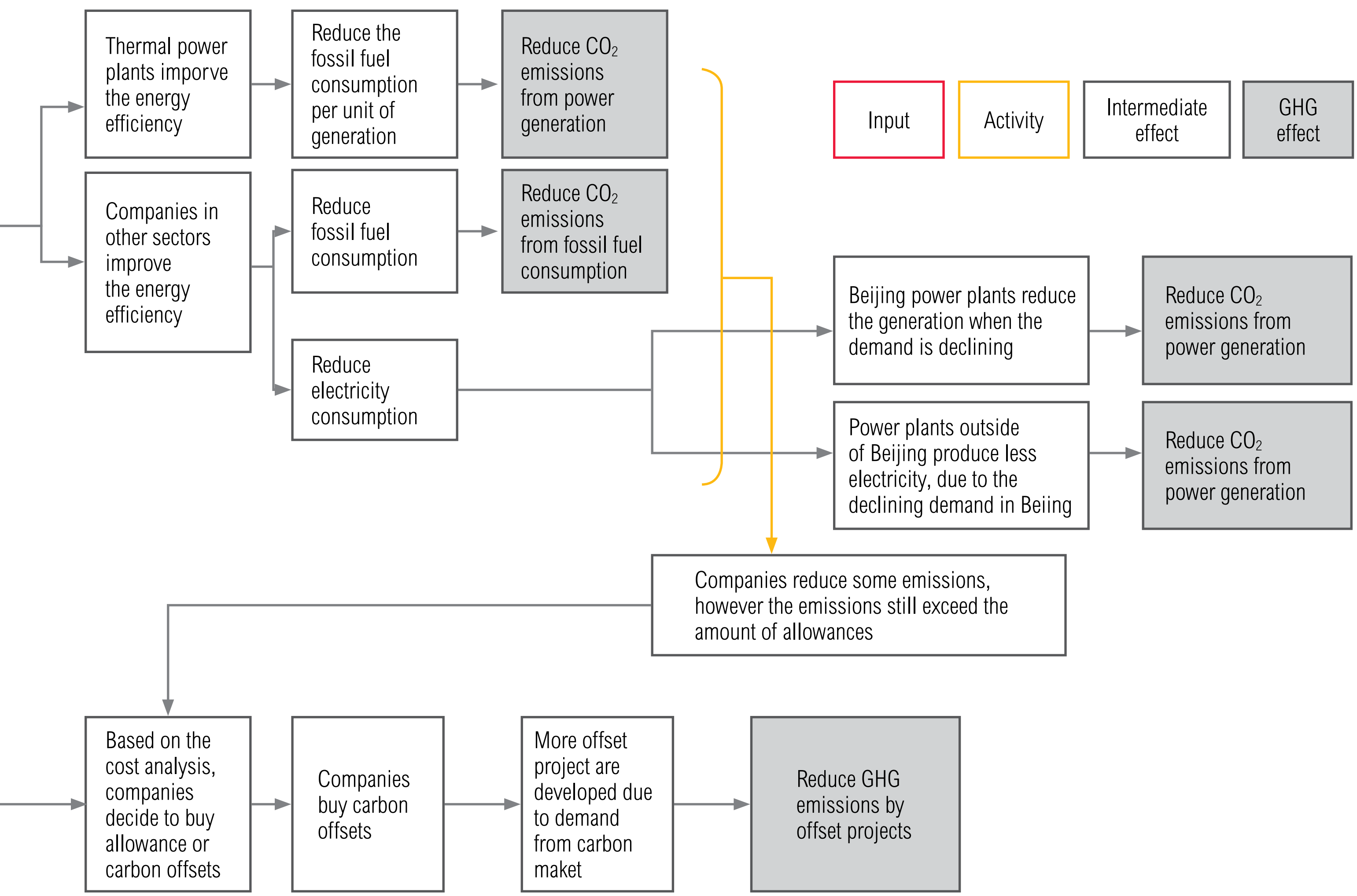
Figure 3 | **Causal Chain Map for Beijing ETS (abridged versi**




electricity demand by key emission institutions in Beijing may affect power producers outside Beijing. Because of China's electricity pricing regulations, the price of carbon has no impact on the electricity price for end users. Thus, we have not included the GHG effect caused by increased electricity prices in the causal chain map. [20]

By taking measures to reduce emissions, key emission institutions can meet their emissions-control requirement, which is equal to the initially allotted emission allowances. If they reduce emissions below their allowance limits, they can sell the extra emission allowances. If key emission institutions do not make sufficient reductions, they must buy emission allowances or carbon offsets on

**on)**




the market, or face fines. Key emission institutions will analyze the costs before deciding to purchase allowances or carbon offsets.

Purchasing emission allowances and carbon offsets or paying fines will increase companies' operational costs. If this cost is transferred to the price of their products or services, it may lower consumer demand and decrease production, ultimately causing a drop in emissions from the production processes. Demand from carbon markets is expected to send positive signals to offset project developers, resulting in the robust development of offset projects and further emission reductions from those projects.

### Defining the GHG Assessment Boundary

The GHG assessment boundary defines the scope of the assessment in terms of the range of GHG effects, the emissions sources and sinks, types of GHGs, and the assessment period. Beijing ETS focuses on $CO_2$ emissions between 2013 and 2015. It is uncertain how Beijing ETS will operate after 2015. Thus the assessment period is 2013 to 2015.

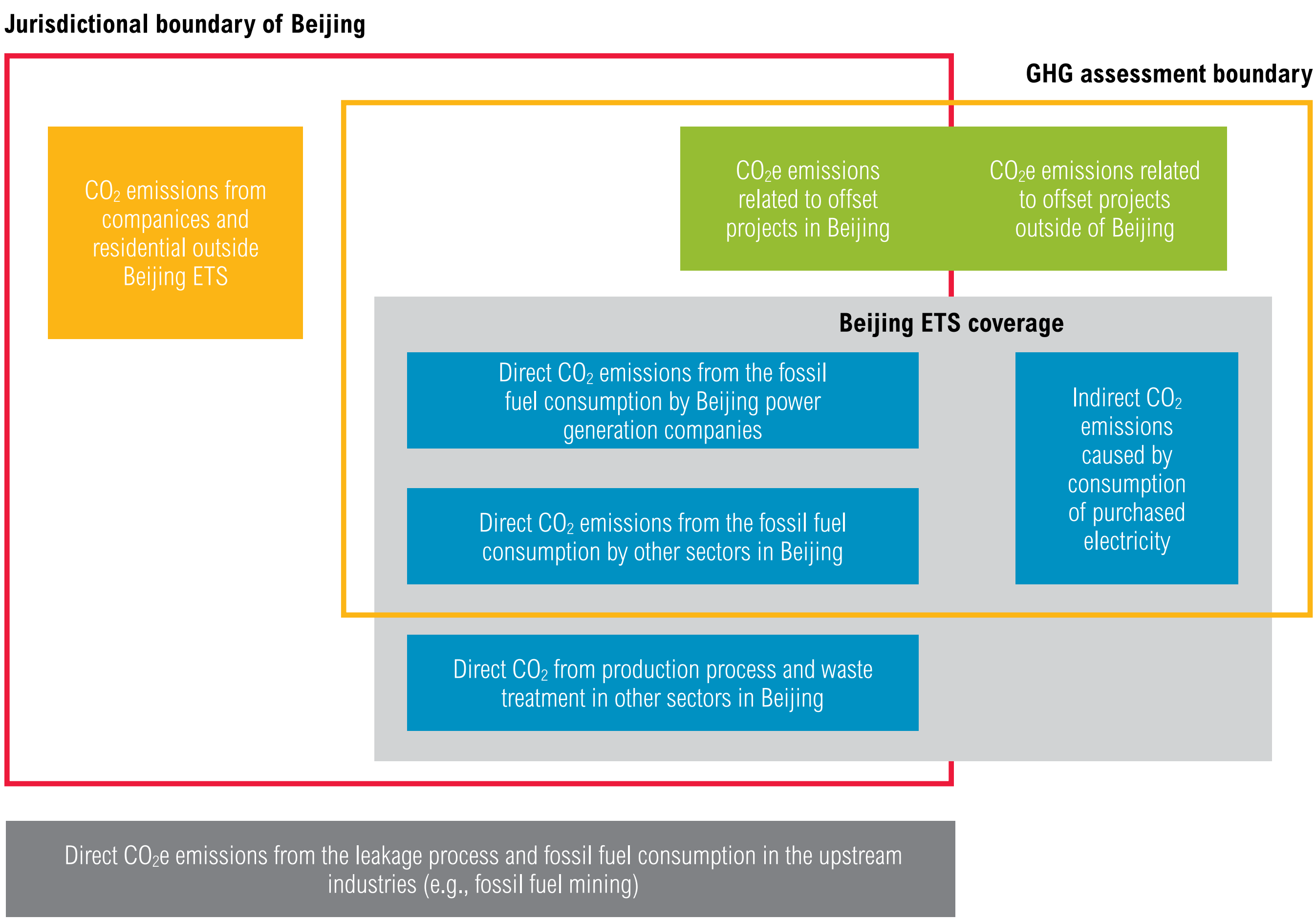
The assessment boundary was defined by incorporating expert consultation, literature study, research objectives, and the availability of data. Figure 4 shows the assessment boundary.

This study did not include the $CO_2$ emissions from industrial processes or waste treatment in Beijing ETS because of a lack of data for the baseline scenario. Cement and chemical industry facilities compose only a small group of Beijing ETS-covered companies, and emissions from industrial processes account for only about 3 percent of total emissions of these companies.[21] Thus, excluding the emissions from industrial processes had limited influence on the assessment results.

Emission reduction measures taken by companies covered by ETS could affect emissions of upstream and downstream industries. For example, the power sector's emission reduction actions could impact the production and sales activities of the coal industry, and emission reductions in the steel industry could affect its suppliers and customers. If the assessment boundary includes impacts on the upstream and downstream companies as completely as possible, the estimate of emission reductions will be probably larger than if it considers only the direct impacts. Including all kinds of indirect impacts in the assessment would require creating corresponding models, which could increase the uncertainty of the assessment results. To achieve reasonable certainty, the boundary used in this study does not include the impact of the ETS on upstream and downstream industries, and this fact should be considered in interpreting the assessment results.

The GHG effects and emissions sources included in the assessment boundary are detailed in Table B.5 in Appendix B, which also explains why certain GHG effects were excluded from the boundary.

Figure 4 | **Greenhouse Gas Emissions Assessment Boundary of Beijing ETS (based on emissions sources)**




Source: Authors.

Note: Beijing ETS= Beijing Emission Trading Scheme. $CO_2$e= $CO_2$ equivalent. "Beijing ETS coverage" includes the key emission institutions that are subject to ETS emissions limits. "Offset projects" are the three types of projects approved by the National Development and Reform Commission or Beijing Municipal Commission of Development and Reform: China Certified Emission Reduction (CCER) projects, energy conservation projects and forestry carbon-sink projects.

## Estimating GHG Effects of the Policy

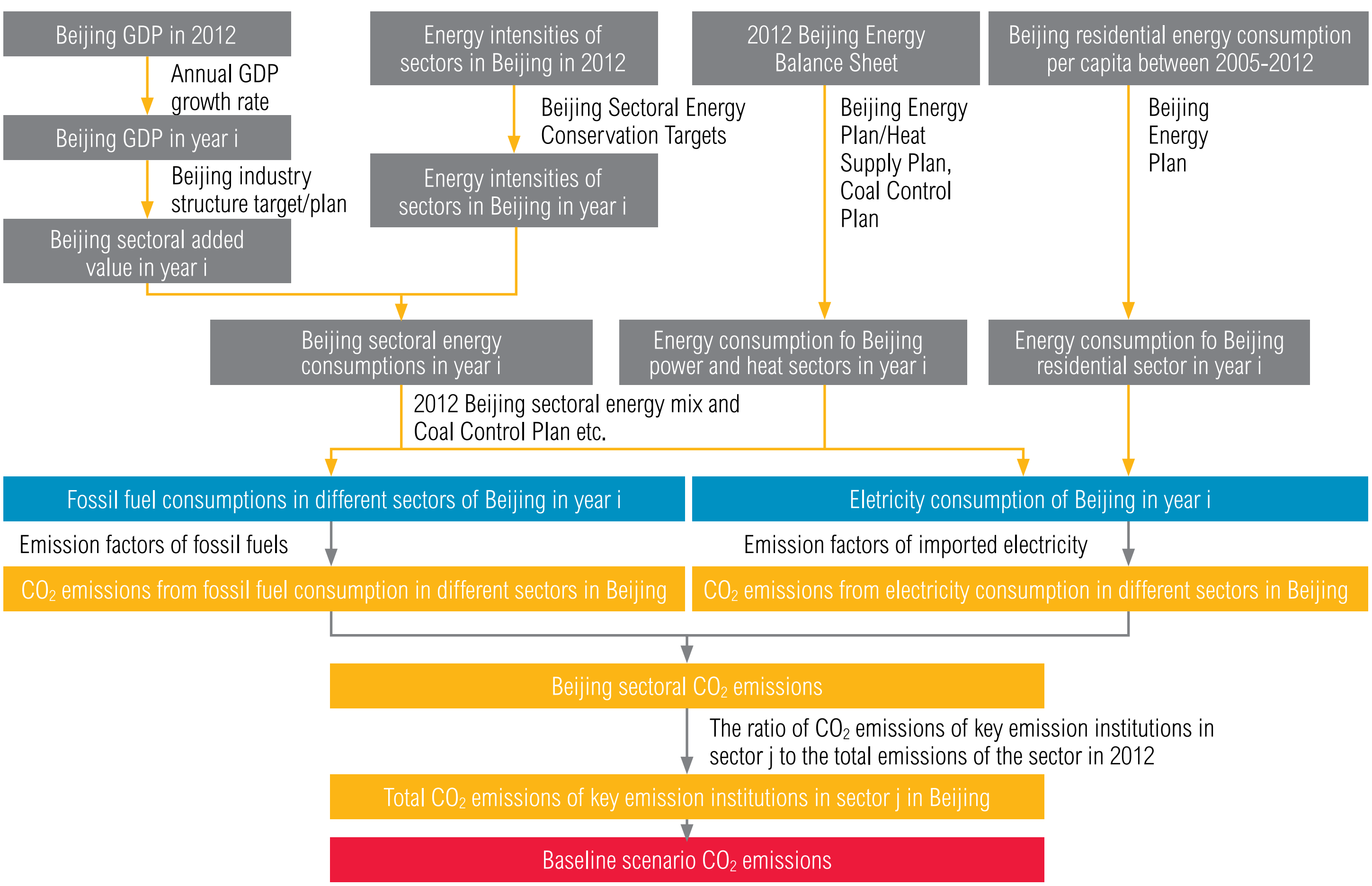
### Estimating Baseline Scenario Emissions

The baseline scenario $CO_2$ emissions are the emissions within the GHG assessment boundary under current energy-saving and emission-reduction policies, plans, and economic development trends, but in the absence of the Beijing ETS policy.

The framework used to calculate the baseline scenario $CO_2$ emissions is shown in Figure 5. This study used the Long Range Energy Alternatives Planning (LEAP) model to measure the demand for different types of energy in different sectors in Beijing. $CO_2$ emissions factors for each energy type were used to calculate the $CO_2$ emissions of each type of energy used in Beijing from 2013 to 2015. Finally, the ratio of energy-related $CO_2$ emissions from key emission institutions over that of the relevant sector in 2012 was used to estimate the baseline scenario $CO_2$ emissions.

Prior to implementing the ETS policy, Beijing had implemented or was in the process of implementing a series of policies to reduce energy consumption and lower GHG emissions. If these policies and ETS affect the same emission sources, it is necessary to consider how they interact. Based on document reviews and expert consultations, this study identified several policies that interact with the ETS policy, including the Energy Conservation Target Allocation Plan in Key Sectors during the 12th Five-Year Plan Period [22] (involving coal control), the 2013-2017 Working Plan for Accelerating Reduction in Coal Use and Develop-

Figure 5 | **Baseline Scenario Calculation Framework**




Source: Authors.
Note: In the figure, i=2013~2015. The baseline scenario emissions for 2011-2012 were calculated based on actual data for those years, which was mainly obtained from *Beijing Statistical Yearbook 2013, 2011 Status Report on Energy Usage for Key Energy Consumption Institutions in Beijing*, and *2012 Status Report on Energy Usage for Key Energy Consumption Institutions in Beijing*.

ment of Clean Energy in Beijing [23] (involving coal control), the Beijing Energy Development and Construction Working Plan during the 12th Five-Year Plan Period [24] (involving the optimization of the energy mix), Beijing Heat Supply Development and Construction Plan during the 12th Five Year Plan Period [25] (involving the optimization of the energy mix), and the 12th Five-Year Plan for National Economic and Social Development in Beijing [26] (involving industry restructuring). These polices are abbreviated as "interactive policies" in this paper.

The interactive policies, which are supported by specific policy instruments and measures, usually achieve their expected targets. Therefore, we assumed that these policies will realize their targets, and any additional effects could be attributed to ETS. The calculation framework in Figure 5 accounts for the impact of these interactive policies on baseline scenario $CO_2$ emissions. For example, the impact of the policy "Energy Conservation Target Allocation Plan in Key Sectors" has been considered in the calculation of sectoral energy intensity in Beijing in year i. For related formulas, detailed assumptions and data sources used in the calculation framework, see Formulas (B.1) to (B.10) in Appendix B.

The core formula for calculating the baseline scenario $CO_2$ emissions within the assessment boundary is:

$$EB_i=\sum_{j=1}^{n}[(E_{i,j,d}+E_{i,j,t})\times SHA_{2012,j,ETS}] \qquad (1)$$

In formula (1),

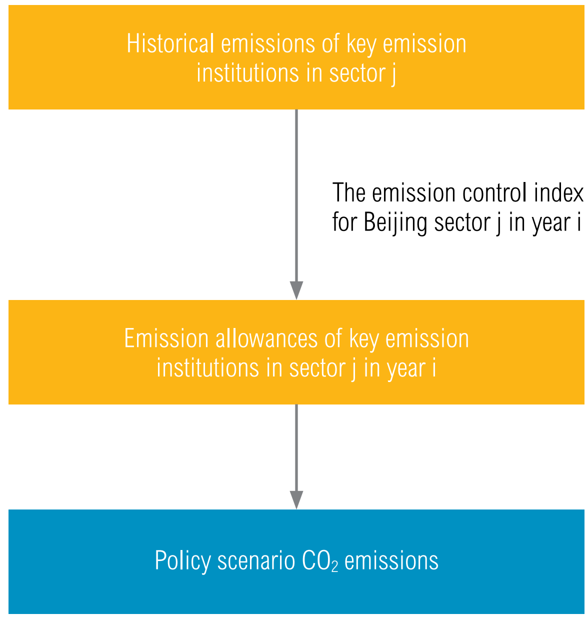
$EB_i$ Total $CO_2$ emissions from key emission institutions in Beijing ETS for year i within the assessment boundary under the baseline scenario, here i=2013~2015

$E_{i,j,d}$ Direct $CO_2$ emissions resulting from fossil fuel consumption in Beijing sector j for year i under the baseline scenario

$E_{i,j,t}$ Indirect $CO_2$ emissions resulting from electricity consumption in Beijing sector j for year i under the baseline scenario

$SHA_{2012,j,ETS}$ The ratio of total $CO_2$ emissions from energy usage by key emission institutions in sector j to the total $CO_2$ emissions related to energy consumption for that whole sector in 2012 Note: $CO_2$ emissions within the scope of the ETS between 2013 and 2015 are all calculated using the 2012 ratio.

Figure 6 | **Policy Scenario Calculation Framework**




### Estimating Policy Scenario Emissions

The policy scenario $CO_2$ emissions are the $CO_2$ emissions within the assessment boundary after the Beijing ETS was implemented. This study assumed that the $CO_2$ emissions from key emission institutions in sector j for year i under the policy scenario are the same as their allocated emission allowances, which means that each sector covered by ETS will generally comply with its emission control requirements. Emission allowances for key emission institutions in sector j for year i under the policy scenario were calculated based on historical emissions and annual emission control indices. Figure 6 shows the calculation framework for the policy scenario. The historical $CO_2$ emissions of key emission institutions were calculated by multiplying activity data (fuel consumption or electricity use) by emission factors, which is consistent with the method of calculating Beijing sectoral $CO_2$ emissions under the baseline scenario.

$$EP_i=\sum_j T_{i,j} \qquad (2)$$

In formula (2),

$EP_i$ $CO_2$ emissions for year i within assessment boundary under the policy scenario

$T_{i,j}$ Total emission allowances for sector j in year i under the policy scenario

## Impact of Beijing ETS on Electricity-Related $CO_2$ Emissions

The impact of Beijing ETS on electricity-related $CO_2$ emissions is one focus of this study. The study team explored the impact of Beijing ETS on emission reductions in Beijing's local power industry as well as the power systems outside Beijing. It attributed the electricity-related emission reductions to either production-end management or demand-end management. Production-end management refers to the reduction of emissions intensity per unit of power generated by Beijing power companies through equipment retrofitting and efficiency improvement. Because grid companies' strategies of dispatch and power procurement, and power companies' strategies of increasing renewable power generation capacity and clean power capacity are not impacted by the amount of their emission allowances, these strategies were not included in production-end management. Demand-end management refers to efforts by end users to reduce electricity consumption, which reduces the amount of electricity generated, ultimately resulting in a decrease in emissions.

This study assumed that the electricity savings resulting from Beijing ETS will impact local electricity companies and external power systems based on the current power-supply ratios, thus electricity savings were allocated to Beijing electricity producers and external power systems based on the proportion of electricity they supply to Beijing. Formulas (3) and (4) respectively calculate the $CO_2$ emission reductions of the Beijing power industry caused by production-end management and demand-end management. Formula (5) calculates for $CO_2$ emission reductions in the power system outside of Beijing caused by demand-end management.

$$Dif_{i,S}=(EF_{i,P,es}-EF_{i,B,es})\times(ESB_{i,BJ}+ESP_{i,BJ})/2 \quad (3)$$

$$Dif_{i,D1}=(ESP_{i,BJ}-ESB_{i,BJ})\times(EF_{i,P,es}+EF_{i,B,es})/2 \quad (4)$$

$$Dif_{i,D2}=(ESP_{i,out}-ESB_{i,out})\times EF_{CDM} \quad (5)$$

In formula (3), (4), and (5),

$Dif_{i,s}$ Electricity-related emission reductions resulting from production-end management for year i

$EF_{i,P,es}$ Emissions factor of electricity supply of Beijing's power industry for year i under the policy scenario

$EF_{i,B,es}$ Emissions factor of electricity supply of Beijing's power industry under the baseline scenario

$ESB_{i,BJ}$ Amount of electricity supplied by Beijing's power industry in year i under the baseline scenario

$ESP_{i,BJ}$ Amount of electricity supplied by Beijing's power industry for year i under the policy scenario

$Dif_{i,D1}$ Electricity-related emission reductions in Beijing's power industry resulting from demand-end management for year i

$Dif_{i,D2}$ Electricity-related emission reductions in North China Grid resulting from the demand-end management for year i
Note: emission reduction of Beijing power industry is not included

$ESP_{i,out}$ Total power supply transferred to Beijing from external power grids for year i under the policy scenario

$ESB_{i,out}$ Total power supply transferred to Beijing from external power grids for year i under the baseline scenario

$EF_{CDM}$ Baseline emission factor for regional power grid in China
Note: the value of this parameter is 0.8040 $tCO_2/MWh$, which equals the average of the operating margin factor $EF_{OM}$ and the build margin factor $EF_{BM}$ of the North China grid in 2013.

The impact of production-end management is mainly observed in changes in the emission factors of electricity supply, while demand-end management mainly affects the demand for power, which in turn affects the amount of electricity supplied. However, it would be unreasonable to assume that the power supply would not change when estimating the impacts of production-end management, or to assume that the emission factor of the electricity supply will remain the same when calculating the reduction caused by demand-end management. For instance, if we changed formula (3) and used the power supply from the Beijing power industry under the baseline scenario or the policy scenario to calculate the emission reductions caused by production-end management, we may overestimate or underestimate the emission reductions. To avoid this misestimate, we used an average value of the power supplied by the Beijing power industry in both scenarios. Similarly, in formula (4), we used the average of emission factors for electricity supply in both scenarios in the calculation of emission reductions caused by reductions in demand. In addition, when considering the impact of Beijing's electricity demand on the power system outside of Beijing, we referenced the principles for calculating emission reductions in the Clean Development Mechanism (CDM) projects. We assumed that power plants with relatively high fuel costs (mainly thermal power plants) in the North China power grid would be the most vulnerable to the changes in power supplies (Liu 2005); therefore, in formula (5) we used the baseline emission factor for the North China power grid that was originally developed for CDM.

The other formulas related to the policy scenario and electricity-related emission-reduction calculations are listed in Appendix B as formulas (B.11) – (B.21).

## Assessment Results

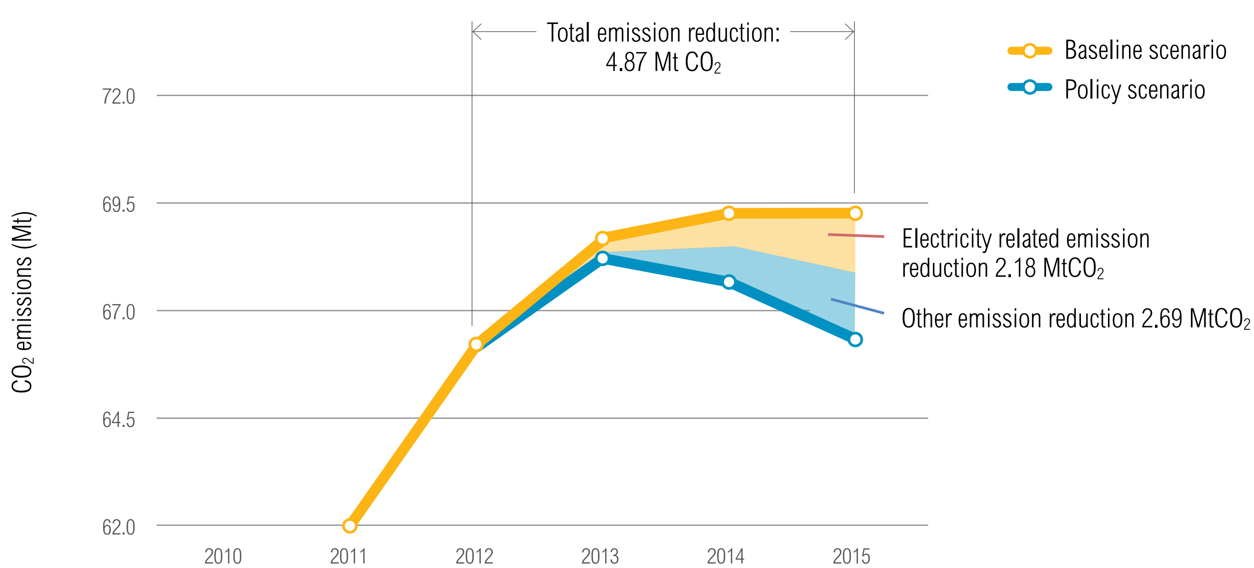
The impact of Beijing ETS on $CO_2$ emissions within the GHG assessment boundary is shown in Figure 7. The orange and blue lines show the $CO_2$ emissions in the baseline scenario and the policy scenario respectively while the gap between them shows the ETS-driven emission reductions for each year.

Beijing ETS resulted in emission reductions of 0.41 megatonnes of $CO_2$ ($MtCO_2$) (0.60 percent of the baseline scenario emissions) in 2013, 1.56 $MtCO_2$ (2.25 percent) in 2014, and 2.90 $MtCO_2$ (4.19 percent) in 2015, for a total of 4.87 $MtCO_2$ for the three-year period. This assessment estimated that the emission reductions in 2015 will equal 1.7 percent of Beijing's total emissions for the year.

Electricity-related emission reductions made up a considerable part of the overall emission reductions achieved under Beijing ETS. The electricity-related emission reductions shown in Figure 7 include the reductions in direct emissions produced by Beijing's electricity industries under the ETS and in indirect emissions from the electricity consumption of other companies.

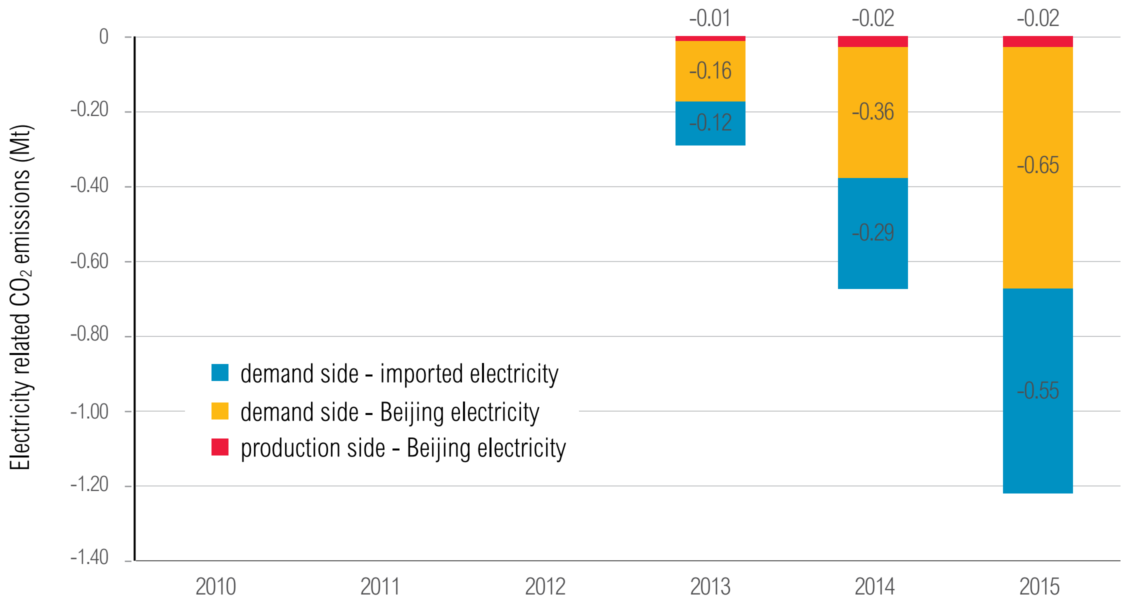
Because of the relatively large uncertainty regarding the number of carbon offsets used, emissions from offset projects were not included in the calculations of the baseline or policy scenarios. However, because factoring carbon offsets into the calculation would add the same amount of emissions to both scenarios (e.g., adding the

Figure 7 | **Beijing ETS Could Reduce GHG Emissions by 4.87 Mt of $CO_2$, 2012-2015**




Source: Authors.

Figure 8 | **Impact of Beijing ETS on Electricity-Related Emissions**




Source: Authors.
Note: "imported electricity" refers to the emission reduction impact on power systems outside of Beijing. "Beijing electricity" refers to the emission reduction impact on the power industry within Beijing.

emissions that would be generated in the absence of offset projects to the baseline scenario, and adding the emissions that are generated by key emission institutions and offset by carbon offsets to the policy scenario), the impact of offsets would not make a difference in the outcome.

According to this assessment, emission reductions attributed to ETS made up 0.60, 2.30, and 4.37 percent of the $CO_2$ emissions reductions in the policy scenario for 2013, 2014, and 2015 respectively. These ratios are lower than the offset use limit of 5 percent allowed by Beijing ETS (meaning the amount of offsets used must not exceed 5 percent of the total allowances allocated). In reality, many offset projects were still in the early phase of development or had not yet achieved the credit issuance stage, plus Beijing set limits on the origin of the carbon offsets. Thus the number of carbon offsets available was much lower than that allowed under Beijing ETS. If there had been an adequate supply of low-priced carbon offsets, it is possible that the emission reductions under the policy scenario could have been entirely achieved through offsetting, and could have impacted the price of emission allowances (e.g., driven down the allowance price).

This study also analyzed electricity-related emission reductions caused by management at the demand-end and the production-end. Figure 8 shows the ETS-driven emission reductions in Beijing's power industry and the power system outside Beijing of 0.29 $MtCO_2$, 0.67 $MtCO_2$, and 1.22 $MtCO_2$ for each year between 2013 and 2015, equivalent to 70.7, 43.1, and 42.1 percent of the total emission reductions for each year. The impact on emission reductions from production-end management (see the red bars in Figure 8) was limited. Because Beijing's power industry has achieved or is about to achieve a high level of advanced technology required by other policies and regulations aiming at lowering emissions, there was little room for Beijing ETS to further reduce emissions in this area. In contrast, emission reductions resulting from demand-end management were significant (see the orange and blue bars in Figure 8). The impacts of demand-end management on emission reductions of Beijing's power industry and external power systems were comparable and both grew each year.

Table 1 | **Qualitative Description of Uncertainties for Major Parameters of the Baseline and Policy Scenarios**

| Parameters of Baseline Scenario | Description of Uncertainty |
|---|---|
| Gross domestic product (GDP) growth in Beijing | Factors including national economic strategy, status of the national economy, regional industry development, and short-term fluctuations in the economy can potentially bring uncertainty to mid- to short-term predictions about GDP growth. The model used to predict mid- or short-term GDP itself may have some embedded errors. |
| Annual consumption of fossil fuels in Beijing (excluding electricity or heat supply sectors) | In this assessment, estimates for fossil fuel consumption in each industrial sector were based on the energy mix in these sectors in 2012. We assumed that consumption of all energy resources were reduced based on energy conservation targets while the energy mix stayed the same. Actually, changes in the sectoral energy mix between 2013 and 2015 are possible, given that the conservation potentials for different energy resources may differ due to the costs, technologies, and policies. |
| Consumption of fossil fuels in Beijing's electricity and heat supply sectors | The growth of total installed generation capacity in Beijing, and the declining trend in energy intensity of coal- and natural- gas-fired generating units contributed to the uncertainty of this parameter. |
| Annual electricity consumption in Beijing | The ratio between electricity consumption and the total energy consumption in different sectors may change with the degree of electrification they experience. This study used the ratios of power consumption in the 2012 energy mix. |
| Emission factor for imported electricity | This factor was calculated by multiplying the average emission factor of the North China grid in 2010 published by the National Development and Reform Commission (NDRC)[a] by the 2012 imported electricity ratio of Beijing. This emission factor was applied for years 2011 through 2015. In fact, the emission factor of the North China grid will probably fall because of government plans for increasing renewable capacities and reducing fuel consumption per unit of generation in thermal power plants. The ratio of power imported from outside Beijing for 2013 to 2015 may also differ from that of 2012. |
| Ratio of total sectoral emissions contributed to the key emission institutions in this sector | The 2012 ratio was used for 2013 through 2015, which may differ from the actual ratio for those years. |
| Parameters of Policy Scenario | Description of Uncertainty |
| Emission allowances | Adjustment of allowances was not taken into account and calculations of allowances for new facilities were simplified. $CO_2$ emissions levels for a specific year were assumed to be equivalent to emission allowances for that year, while situations such as emissions exceeding the allowances, or banking emission allowances for the following years were not taken into account. Emission allowances for new companies that entered the ETS were not considered. |

Source: Authors.

Notes: This table lists only parameters directly related to scenario emissions calculations. Each of the parameters has derivative formulas, which can be found in Appendix B. The emission factor for imported electricity listed in this table was used in calculations of baseline scenario and policy scenario $CO_2$ emissions. The Clean Development Mechanism (CDM) baseline emission factor for the regional power grid in China was used in formula (5) to calculate the emission reductions in the power system outside Beijing as a result of demand-end management. It is important to make the distinction between these two emission factors.

a. The average $CO_2$ emission factors of China regional and provincial grids in 2010, http://www.ccchina.gov.cn/archiver/ccchinacn/UpFile/Files/Default/20131011145155611667.pdf

Table 2 | **Sensitivity Analysis: Changes in Key Parameters**

| Sensitivity Scenarios | Emission Factor and Activity Data Variation Assessed | | |
|---|---|---|---|
| | Emission factor for imported electricity in Beijing | Ratio of electricity consumption as part of Beijing's total energy consumption | Gross domestic product growth rate |
| Primary scenario | 0% | 0% | 0% |
| Alternative scenario 1 | -3.0% | -1% | -10% |
| Alternative scenario 2 | +3.0% | +1% | +10% |

Source: Authors.
Note: The "primary scenario" refers to the baseline scenario and the policy scenario used in this paper. "Alternative scenarios" refer to the policy scenarios after adjustments were made to the relevant parameters. The variations for each of the parameters are based on expert judgments that mostly conform to the actual situation. The percentages in the table are the ratio of the variation to the original value of the parameter. These include the emission factor for imported electricity of 3.0 percent, which was based on declines in fuel intensity in nationwide thermal power production as outlined in the 12th Five- Year Plan (first column); the rise or fall in electricity consumption corresponding to changes in other types of energy consumption, or the consumption of coal and petroleum products adjusted based on total consumption volume (second column); and the GDP growth rate (last column).

## Defining Key Performance Indicators

This study also identified input and activity indicators based on the Policy Standard and Tracking Framework to track the implementation of Beijing ETS. It identified effect indicators and key parameters needed for ex-post assessment and drafted an initial monitoring plan. The tracking results of these indicators and parameters provide a crucial data base for ex-post assessment. Section 4 provides more details about identifying and monitoring key performance indicators and parameters.

## Assessing Uncertainty

Uncertainties may arise from parameters, scenario-setting methods, or calculation models. In the Beijing ETS assessment, the main parameters for calculating the baseline scenario $CO_2$ emissions included fossil fuel consumption, the $CO_2$ emissions factors of different fossil fuels, electricity consumption, the emission factors for imported electricity, and the ratio of total sectoral emissions contributed by the key emission institutions. In the policy scenario, $CO_2$ emissions were calculated using Beijing ETS's emission allowance ratification method.

### Qualitative Descriptions of Uncertainties

The uncertainties of the parameters for the baseline and policy scenarios are described in Table 1. Assumptions about the sectoral energy mix and the emission-reduction strategies for different types of energy may also affect the accuracy of the calculation of electricity-related emission reductions.

### Sensitivity Analysis

To better determine the specific impact of uncertainty, and to determine the credibility of the research results, it is necessary to assess the level of influence the uncertainties in Table 1 had on the research results. Sensitivity analysis can reflect how variations in key parameters influence the assessment results. This study conducted sensitivity analysis on emissions factors for imported electricity, the ratio of electricity consumption as a part of Beijing's total energy consumption, as well as GDP growth rates, examining the overall emission reductions when values of these parameters fluctuated within a certain range. We assumed that values for the three key parameters varied based on the ranges shown in Table 2, and calculated the related $CO_2$ emission reductions. The results of sensitivity analysis are shown in Table 3.

The sensitivity analysis results in Table 3 show that the assessment is sensitive to assumptions about the emission factors for imported electricity and GDP growth rate, while hardly sensitive to assumptions of the ratio of electricity consumption. The variation in emission factors for imported electricity was 3 percent of current values, which could result in a change of 7.9 percent in emission

Table 3 | **Sensitivity Analysis Results**

| Sensitivity Scenarios | GHG Emission Reductions and Variations between Scenarios ( megatonnes of $CO_2$ [percent] ) | | |
|---|---|---|---|
| | Emissions factors for imported electricity in Beijing | Ratio of electricity consumption as part of Beijing's total energy consumption | Gross domestic product growth rate |
| Primary scenario | 4.87 | 4.87 | 4.87 |
| Alternative scenario 1 | 4.48 (-7.9) | 4.97 (+2.2) | 4.29 (-11.7) |
| Alternative scenario 2 | 5.25 (+7.9) | 4.76 (-2.2) | 5.43 (+11.7) |

Source: Authors.
Note: The numbers represent total emission reductions for 2013 through 2015. The percentages represent the relative change between the primary scenario and each alternative scenario. The "primary scenario" refers to the baseline scenario and the policy scenario used in this paper. "Alternative scenarios" refer to the policy scenarios after adjustments were made to the relevant parameters.

reductions. Meanwhile, a change of 1 percent in the ratio of electricity consumption as part of Beijing's total energy consumption could result in a change of 2.2 percent in emission reductions. GDP growth rates usually involve a considerable degree of uncertainty. A variation of 10 percent in Beijing's GDP growth rate could result in a range of adjustments to related parameters, ultimately resulting in change of 11.7 percent in emission reductions compared with primary levels.

Overall, assumptions about the ratio of electricity consumption to Beijing's total energy consumption has little impact on the assessment results, while assumptions of emission factors for imported electricity and Beijing's GDP growth rate can invite an uncertainty larger than 5 percent for total emission reductions. Therefore, these two parameters should be monitored via improved data collection processes in future research to reduce data uncertainty. This research conducted sensitivity analysis of only three key parameters. We recommend that researchers conduct sensitivity analysis on all the main parameters to reach a well-rounded understanding of the credibility of results.

## Verification and Reporting

Third-party verification can strengthen the credibility of the assessment results. However, as the purpose of this study was not to sell emission reduction credits or obtain official recognition of the emissions reduction effects, we have not engaged in verification.

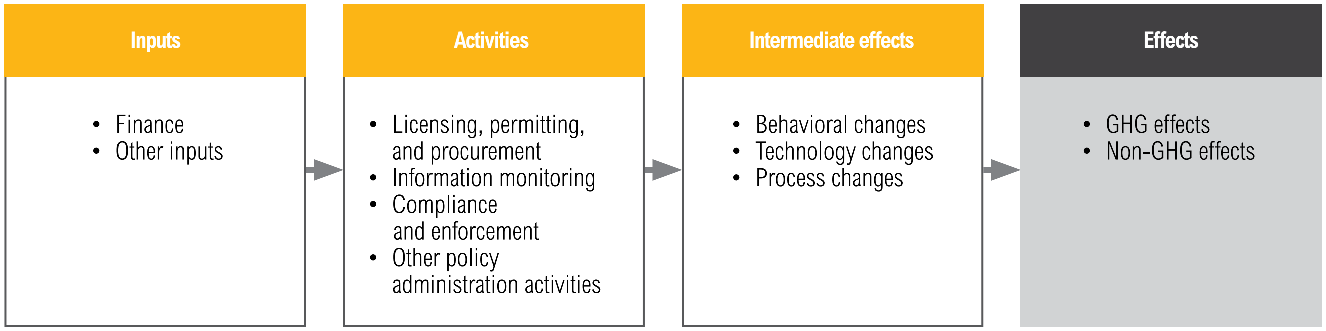
The Policy Standard has specific requirements for reporting the GHG effects of policy, the identification and description of the policy, the causal chain map, the GHG assessment boundary, the description of the baseline and policy scenarios, and the calculation methods and parameters. Appendices A and B show the assessment results of Beijing ETS in conformance with the Policy Standard.

## Section Summary

Assessment results show that Beijing ETS will result in emission reductions of 0.41 $MtCO_2$ in 2013, 1.56 $MtCO_2$ in 2014 and 2.90 $MtCO_2$ in 2015, accounting for reductions of 0.60, 2.25, and 4.19 percent of the baseline scenario $CO_2$ emissions for those years respectively. Emission reductions will gradually increase over the three-year period, but we found that the quantity of the emission reductions will always be lower than the largest amount of carbon offsets allowed by the ETS. This may eventually create an impact on the price of emission allowances if the supply of carbon offsets is sufficient and the price is low. In reality, because Beijing's current supply of carbon offsets is very limited—much less than that allowed by regulations—such a price impact is not yet a problem.

This study also examined the impact of electricity-related emission reductions under the ETS policy. Assessment results showed that over three years, Beijing ETS will result in 2.18 Mt of electricity-related $CO_2$ emission reductions, 98 percent (2.13 $MtCO_2$) of which will be achieved

Figure 9 | **Key Performance Indicators Corresponding to Each Segment of the Causal Chain**




Source: Barus et al. 2014

through demand-end management. Previous efficiency improvements in power generation has allowed little room for further improvement in limiting GHG emissions; direct power-plant $CO_2$ emissions were reduced by only 50 kilotons in the policy scenario. This study also analyzed and explained uncertainties related to major parameters, and conducted a sensitivity analysis of three parameters: the emission factors for imported electricity, the ratio of electricity consumption as a part of total energy consumption in Beijing, and GDP growth rate.

## TRACKING IMPLEMENTATION OF BEIJING EMISSION TRADING SCHEME

The main steps of conducting a GHG impact assessment of a policy were described in Section 3. The policy tracking step, which was discussed only briefly, is explained more fully in this section. Policy tracking can provide important information for comprehensive assessment of policy effectiveness, and it also identifies important parameters for ex-post impact assessment.

As noted in previous sections, the Policy Standard requires a "causal chain map" to show the course from initial policy inputs and activities through various intermediate effects to the final GHG or non-GHG effects. Whether each segment of the causal chain is carried out as expected will influence the GHG effects. To track the policy effects, the Policy Standard recommends that researchers identify key performance indicators based on causal chain map.

Key performance indicators corresponding to each segment of the causal chain for Beijing ETS are shown in Figure 9 and discussed below. The Tracking Framework provides guidelines and examples to help researchers identify indicators such as finance, permitting, procurement, compliance, and enforcement that correspond to policy instruments. The Policy Standard provides guidance on how to identify indicators for intermediate and final effects, and also suggests that researchers identify other key parameters for ex-post assessment and monitoring plans.

This section briefly reviews the existing tracking system for Beijing ETS, and identifies three categories of key performance indicators: input, activity, and effects. It also recommends several key parameters for ex-post assessment and develops a primary monitoring plan. The tracking results of key performance indicators and key parameters in this section can serve as supplementary information to help interpret Section 3's ex-ante assessment of GHG impact; it can also serve as basic data to be used later in an ex-post assessment.

### Overview of Existing Beijing ETS Tracking System

The Beijing Municipal Commission of Development and Reform (Beijing MCDR) is responsible for most of the administrative functions related to Beijing ETS. Currently, Beijing MCDR's Division of Resource Conservation and Environmental Protection (also known as the Division of Climate Change) and Beijing Energy Conservation Supervision Group are in charge of implementing and monitoring Beijing ETS. The Beijing Municipal Bureau of Finance Work, the Finance Bureau of Beijing, and the Beijing Municipal Bureau of Statistics facilitate monitoring, funding, and analyzing the carbon market.

The Beijing Center of Climate Change Strategy Research, a department within Beijing MCDR, is responsible for executing allowance auctions and buybacks.

Policy progress such as the required submissions of corporate GHG emissions reports and allowance allocations, as well as lists of companies that have not surrendered allowances or not submitted emissions reports as required, are intermittently posted on the official websites of Beijing MCDR and the Beijing Municipal Government. The China Beijing Environment Exchange provides real-time data on carbon trading and a weekly report on carbon trading. Media, including the Beijing Daily and Legal Evening News, also report on the implementation status (i.e., enforcement) of Beijing ETS. Information platforms such as Sino Carbon and Crystal Carbon in WeChat (a system similar to Twitter) also post information on the progress of Beijing ETS.

Based on information released by the Beijing Government and media reports, we believe that the government has tracked and disclosed to a certain degree the implementation status of the ETS policy, including monitoring of compliance progress and penalties for noncompliance. However, the tracking system is still imperfect in terms of being systematic, consistent, and comprehensive. External parties have not yet been engaged in monitoring policy implementation. The level of transparency in disclosing policy tracking information should be improved.

## Input Indicators

The input indicators as shown in Figure 9 are finance and other types of inputs. In this study we used finance indicators as an example.

### Finance

Beijing ETS needs financial support to create trading scheme platforms, conduct verifications, and take market interventions. The institutional development of ETS requires a considerable investment. The carbon trading platform is the core electronic platform for the transactions on the exchange. The carbon emission registry is the electronic platform for allocating, transferring, and surrendering emission allowances. Creation of these two platforms required funding.

In terms of data collection and verification, in the preparatory phase of Beijing ETS, the government collected historical emission data from 504 key energy consumption companies, [27] and required third-party verification for these emissions reports. The government paid the verifying institutions Y 80,000 to Y 120,000 per report based on the quality of the reports. In 2014, more than 500 key emission reports institutions were selected from the list of key energy consumption companies. The government will select 20 percent of these institutions for a second round of verification. The double verification of one company costs about Y 100,000.

In terms of market intervention, the Beijing Municipal Bureau of Finance was designated to fund the emission allowance buy-back and manage these transactions with the specific management methods to be formulated by Beijing MCDR and the Bureau of Finance. However, the methods have not yet been published. [28]

This research has identified financial indicators for Beijing ETS implementation including financial supports for setting up trading platforms, verifying emission reports, and making market interventions, and has conducted tracking based on the Beijing ETS official document “Management Measures of Beijing Emission Trading Scheme (Trial)” and relevant fiscal information from the Beijing MCDR website. For more details, refer to Table D.1 in Appendix D.

## Activity Indicators

The four categories of activity indicators in Figure 9 are discussed below.

### Licensing, Permitting, and Procurement

Licensing and permitting indicators in Beijing ETS are mainly related to the approval and publication of the key emission institution list, allowance ratification and allocation, and the approval and issuance of carbon offsets. Within the policy implementation period, every year the government shall publish a list of key emission institutions and a list of reporting institutions according to the most recent emission data and companies’ operating situations. Reporting institutions are institutions whose annual energy consumption reach 2,000 metric tons of standard coal but do not reach the threshold of key emission institutions; reporting institutions are potential candidates for becoming key emission institutions and should be closely monitored. The government adds companies as they qualify to the  reporting institution or key emission institution lists, and informs these companies about their emission accounting, reporting, and compliance requirements. These steps are important to ensure the smooth implementation of ETS.

The ratification and allocation of emission allowances for existing and new facilities are necessary ETS-related functions. When companies apply for an adjustment of their emission allowances for existing facilities, the government needs to handle these requests in a timely manner. Additionally, permitting the use of carbon offsets is a flexible design of ETS. It requires procedures such as examination, approval, and publicity of offset projects, followed by the issuance of carbon offsets.

Specific indicators of licensing, permitting, and procurement in Beijing ETS are listed in Table D.2 in Appendix D.

### Information Collection and Tracking

Beijing ETS information collection and tracking involved two levels: the individual company and the carbon market. Companies' emissions information must be collected in a timely manner. Because allowance allocations are based on emissions data, it is necessary to establish mechanisms to guarantee the accuracy and credibility of corporate-level emissions data. In addition to collecting the emission reports directly from key emission institutions, the government must also collect third-party verification reports to ensure the quality of emission data. Emissions monitoring plans can help companies avoid error, increase data quality in the initial stages of data collection, and serve as the basis for third-party verification. Therefore, emissions monitoring plans are also collected by the government.

Tracking the general implementation status of Beijing ETS mainly involves monitoring the operation of the carbon market, as well as monitoring and reporting on the policy's implementation results. Indicators for information collection and tracking can be found in Table D.3 in Appendix D.

### Compliance and Enforcement

Beijing ETS relies mainly on fines to ensure that companies submit emissions data and surrender their allowances as prescribed. In addition, the "Notice of Beijing Municipal Commission of Development and Reform on Carrying out the Emission Trading Scheme Pilot Work", issued on November 22, 2013, proposed "policy guidance and supportive measures," including preferential consideration in providing financial support to energy-savings and carbon-reduction projects for companies that actively participate in carbon trading and comply on time. The government also plans to support financial institutions' ETS matching services and introduce advanced emission mitigation technologies to key emission institutions. These measures all encourage compliance, but the government has yet to disclose how these measures are being implemented.

Some key emission institutions did not carry out their responsibilities as prescribed partly because of a misunderstanding about the nature of allowance surrender and compliance. [29] Government-proposed guidance and training for the regulated enterprises to improve their understanding of the requirements and the nature of compliance in ETS should help them carry out their responsibilities in a correct and timely manner. The Tracking Framework provides a template of compliance and enforcement indicators. The Beijing ETS compliance and enforcement indicators can be found in Table D. 4 in Appendix D.

### Other Administration Activities

Implementing Beijing ETS also involves examining and supervising emission reports and emission control efforts, reviewing disputes in the emissions data verification processes, carrying out essential market intervention measures, organizing and supervising trading activities, and arbitrating trade disputes. Other administration indicators are found in Table D.5 in Appendix D.

## Effect Indicators

Based on guidelines in the Policy Standard, we identified effect indicators [30] that concern the intermediate-effect segments of the casual chain, and developed a primary framework for a monitoring plan (Table 4).

## Key Parameters for Ex-post Assessment and Monitoring Plan

Ex-post assessment requires a series of parameters, some of which may not have been included in the key performance indicators listed in the previous section. Identification of these parameters are related to the calculation methods used in ex-post assessment. We assumed that the same calculation method would be used to estimate the $CO_2$ emissions of the baseline and policy scenarios in the ex-post assessment, and suggested monitoring the key parameters following the monitoring plan in Table 5. The monitoring period was from 2013 to 2015.

Table 4 | **GHG Effect Indicators and Monitoring Plan for Beijing ETS**

| Indicator (unit) | Source of Data | Monitoring Frequency | Measured, Modeled, Calculated, or Estimated (and uncertainty) | Responsible Entity |
|---|---|---|---|---|
| Actual $CO_2$ emissions from key emission institutions | Annual emissions report by key emission institutions | Annually | Calculated | Beijing Municipal Commission of Development and Reform (Beijing MCDR) |
| Fossil fuel consumption by key emission institutions | Annual emissions report by key emission institutions | Annually | Measured | Beijing MCDR |
| Electricity consumption by key emission institutions | Annual emissions report by key emission institutions | Annually | Measured | Beijing MCDR |
| Carbon offsets used | Compliance report | Annually | Measured | Beijing MCDR |
| $CO_2$ emissions from new facilities | Allowance allocation report and compliance report | Annually | Calculated | Beijing MCDR |

Source: Authors

Table 5 | **Key Parameters for Ex-post Assessment and Monitoring Plan**

| Indicator (Unit) | Source of Data | Monitoring Frequency | Measured, Modeled, Calculated, Estimated (and Uncertainty) | Responsible Entity |
|---|---|---|---|---|
| GDP growth rate of Beijing | Beijing Statistical Yearbook | Annually | Calculated | Beijing Bureau of Statistics |
| Industry structure (as percent of GDP) | Beijing Statistical Yearbook | Annually | Calculated | Beijing Bureau of Statistics |
| Energy mix in each sector | Beijing Statistical Yearbook | Annually | Calculated | Beijing Bureau of Statistics |
| Energy intensity of each sector | Beijing Statistical Yearbook | Annually | Calculated | Beijing Bureau of Statistics |
| Energy mix in the power sector | Beijing Statistical Yearbook, China Electric Power Yearbook, Beijing Energy Report | Annually | Calculated | Beijing Bureau of Statistics, Beijing Municipal Commission of Development and Reform (Beijing MCDR) |
| Emission factors for imported electricity | Beijing MCDR website | Annually | Calculated | Beijing MCDR |
| Number of enterprises that enter/quit from Beijing Emission Trading Scheme (ETS) per year | Beijing MCDR website | Annually | Calculated | Beijing MCDR |
| Historic annual emissions for enterprises that enter/quit from Beijing ETS per year | Beijing MCDR website | Annually | Calculated | Beijing MCDR |

Source: Authors

### Section Summary

Beijing ETS runs smoothly following a set of procedures and expects to complete the task of gaining experience on emission trading scheme development and operation. The Beijing government discloses the tracking results of Beijing ETS predominantly through the Beijing MCDR website, including updates on allowance allocation, lists of enterprises that have not fulfilled their compliance responsibilities or have not submitted emissions reports, and report submission reminders. This tracking process can be improved to be more comprehensive, consistent, and systematic. Newspapers, other websites, as well as the WeChat platforms of environmental companies are also important channels for tracking the implementation of Beijing ETS.

Based on guidance from the Policy Standard and the Tracking Framework, we identified key performance indicators and other key parameters for ex-post assessment of Beijing ETS. With respect to finance indicators, we found that the information related to finance of ETS implementation disclosed on websites is limited. We recommend that such information be systematically organized, then tracked and disclosed to help stakeholders determine whether there are financial barriers to policy implementation. In terms of permitting, procurement, and information monitoring, the government did not make clear and timely releases of progress, such as adjustments made to emission allowances, updates of emissions data submitted or allowances surrendered, and the settlements of disputes in carbon trading. We recommend that the government improve tracking and transparency in these areas. In terms of compliance and enforcement, fines are the main measure used to encourage the compliance of the key emission institutions and reporting institutions. Incentive measures for energy conservation and emission reductions have either not been used, or the implementation information has not been disclosed. We recommend that the government monitor and track the imposition of penalties to ensure that they are having the desired effects, while at the same time track and analyze the implementation of incentive measures, or determine why such incentives have not been implemented.

This section also summarized effect indicators and other key parameters related to ex-post assessment, and offered an initial monitoring plan that can serve as a reference for other researchers conducting more in-depth research into Beijing ETS.

## DISCUSSION AND RECOMMENDATIONS

This study used the World Resources Institute's Greenhouse Gas Protocol: Policy and Action Standard and the Climate Policy Implementation Tracking Framework to assess the greenhouse gas (GHG) impact and track the implementation of Beijing Emission Trading Scheme (Beijing ETS). While data availability and the complexity of quantification models can vary for different types of policies, the study demonstrated that the Policy Standard can provide a feasible, practical, and meaningful framework to assess the GHG impact of climate and energy policies in China.

Based on the assessment findings, various issues in the design of Beijing ETS are discussed here and recommendations provided for further policy impact assessment.

### Discussion of the ETS Design

The discussion centers on the use of emission trading to reduce emissions in the power sector and on the smart use of carbon offsets in the emission trading scheme.

#### Emission Trading Scheme and Power Sector Mitigation

Emission reductions in the power sector made a significant contribution to the environmental benefits achieved by Beijing ETS, by accounting for 45 percent of the total emission reductions.

Beijing ETS counted both production-end emissions of power companies and demand-end emissions of companies that use power. Beijing ETS manages to avoid double counting by defining direct emissions and indirect emissions with different geographic boundaries: emissions associated with electricity production within the city were counted as power plants' direct emissions, while emissions associated with imported electricity from outside of Beijing were counted as indirect emissions and considered demand-end emissions from power-consuming companies within Beijing.

The impact on emission reductions from production-end management was limited (only 50,000 $tCO_2$ over three years). In contrast, emission reductions from demand-end management were significant — a reduction of 2.13 megatonnes of $CO_2$ ($MtCO_2$). The impacts of demand-end management on emission reductions of Beijing's power industry and external power systems were comparable and both grew each year.

Emission reductions on the production end are limited because of the lenient cap on power plants, which may be the result of three considerations. First, many policies already drive emission reductions in Beijing's power sector. Second, power plants cannot pass on carbon costs to consumers because the electricity price is heavily regulated. Third, power plants in Beijing have already completed or are conducting technical upgrades required by strict local regulations, leaving little room for further technical improvements.

To gain further production-end emission reductions, Beijing ETS might consider changing the allowance allocation methodology for power plants. Instead of using the historical emission intensity of individual thermal power plants as the basis for allocation, Beijing could benchmark the emission intensity of all electricity produced by these power groups, and use this data as the basis for allocation. This way, power companies could mitigate emissions by switching fuels or increasing their renewable portfolios.

Alternatively, Beijing may consider excluding the power sector from ETS coverage altogether. Since other administrative measures have been implemented to reduce emissions from power plants, and the current design of ETS does not drive further emission reductions, the power sector could be spared the effort of participating in ETS. As noted, the biggest reductions in emissions from power production came from the reduction in the demand for electricity by other companies as they made efforts to meet their own emissions caps.

Beijing is unique in terms of its energy mix, economic structure, and level of power-related emissions. Although a national emission trading scheme cannot be a simple extrapolation of the Beijing assessment results, three points from this analysis can inform key decisionmaking.

First, the national ETS should seriously consider adopting Beijing's practice of including indirect emissions associated with electricity consumption. In 2013, excluding the power and heating production sectors, electricity accounted for 42 percent of the industrial sector's total energy consumption. [31] The design of including indirect emissions results in significant reductions in Beijing ETS will probably have a similar impact at the national scale given the considerable ratio of electricity consumption in the energy consumption mix. This feature would be especially appealing if the current electricity pricing mechanism does not change in the future, because capping indirect emissions from electricity consumption can send price signals of the external cost of carbon emissions to end-consumers.

Second, if the national ETS plan caps direct emissions from electricity production, the cap should be quite stringent to be effective and other issues must be considered. Power production accounts for more than one third of China's greenhouse gas emissions, and ETS may provide a market mechanism to help mitigate emissions in such an important sector. However, determining the appropriate emission allowances for power plants is challenging. Around the country, power plants have different levels of technological and management sophistication, therefore varying mitigation potential. The carbon emissions intensity of electricity is also influenced by external factors such as how power is dispatched throughout the grid to meet fluctuations in demand. Therefore, the national ETS will need to invest sufficient time and effort to get the emission allowance allocation method right.

Third, if the national ETS covers both direct emissions from electricity production and indirect emissions from electricity consumption, double counting may become an issue. Unlike Beijing, China as a whole does not import significant electricity, and therefore cannot adopt Beijing ETS's GHG accounting arrangement to solve the issue. The national ETS design will need to address this issue, possibly by tracking and distinguishing emission allowances allocated to electricity producers and consumers.

## Use of Carbon Offsets in the Carbon Emission Trading Scheme

Beijing ETS allows companies to use carbon offsets approved by relevant authorities to meet compliance obligations. In Beijing, the use of offsets cannot exceed 5 percent of a company's total allowances, and at least 50 percent of the carbon offsets must originate from projects within Beijing. According to this study's estimation, annual emission reductions achieved under Beijing ETS accounted for 0.60, 2.30, and 4.37 percent of total annual allocated allowances from 2013 to 2015 respectively. During the entire ETS pilot period, the 5 percent allowed for carbon offsets was larger than these emission reduction rates.

In other words, theoretically Beijing ETS could rely entirely on carbon offsets to achieve reductions. If the market has an adequate supply of carbon offsets, it is likely that offsets would affect emission allowance prices. This is less than ideal because a low allowance price does not provide a clear signal for companies to mitigate emissions. What is more, the mitigation impact of carbon offsets is somewhat controversial and has a relatively large degree of uncertainty.

In reality, fewer carbon offsets entered the Beijing carbon market than allowed. The availability of carbon offset credits originated by projects within Beijing was particularly limited. In the 2013 compliance cycle, no certified carbon offsets entered the ETS market. During this period, the average price for carbon emission allowances in Beijing ETS was Y 60.4 per $tCO_2$ and 931,000 t allowances were traded.[32] Given the continued limited supply of Beijing-originated offsets, carbon offsets have had no observable impact on the allowance price in 2014 compliance cycle so far.

The underlying cause for the limited supply of offsets was authorities' cautious approach to approving certified credits and the considerably long process of generating carbon offsets. While controlling the approval of offsets allows the government flexibility in managing the emission allowance price, this approach lacks the transparency and certainty that market participants seek. In the long term, it is important to make sure that the allowed use of carbon offsets does not exceed estimated reductions in the same period. To do so, the government needs to conduct ex-ante assessment of emission reductions, and consider the results when setting the limits of using carbon offsets.

## Recommendations on Policy Impact Assessment and Tracking

Policy impact assessment can provide useful information on policy design, implementation, and adjustment, as well as help us understand and increase policy effectiveness. Using impact assessment to develop policy can make the process more scientific and efficient. Tracking and monitoring indicators of inputs and activities can provide important information for ex-post assessment, as well as corroborate whether a policy has achieved its objectives.

Through applying the *Greenhouse Gas Protocol: Policy and Action Standard* and the *Climate Policy Implementation Tracking Framework* to Beijing ETS, this study demonstrated that the two tools can provide a feasible, practical and meaningful framework to assess the greenhouse gas impact of climate and energy policies in China, support the country's policy assessment effort, and help to inform localized and customized studies.

The recommendations of the study team are to:

- Conduct systematic ex-ante impact assessment of ETS and other major energy and climate policies
- Address other existing and planned policies and non-policy drivers in impact assessment
- Improve the tracking of major climate and energy policies' implementation to increase transparency
- Conduct ex-post impact assessment for major climate and energy policies

The recommendations are discussed below.

### Conduct systematic ex-ante impact assessment of ETS and other major energy and climate policies

Assessing the GHG impact of major energy and climate policies can facilitate a better understanding of their actual impact, and support the design, adoption, and implementation of new policies.

Ex-ante GHG impact assessment should be carried out in the design, formulation, and revision phases for major energy and climate policies because it can help increase the feasibility and effectiveness of policies. Assessment results of greenhouse gas impact can be integrated with other assessment results for a comprehensive and objective understanding of the input and output of related policies.

For example, this paper provides an ex-ante impact assessment framework for ETS in China. It raises several issues regarding the design of the emission trading scheme, such as how to incorporate the power sector and how to smartly use carbon offsets. Because of limited data availability as well as the model we used, there is still a relatively large degree of uncertainty in the findings. However, government bodies and other researchers can adopt the framework developed through this paper as the foundation for improvement and customization.

### Address other existing and planned policies and nonpolicy drivers in impact assessment

Besides the policy in question, other existing and/or planned policies may also influence emissions levels. By analyzing the interactions of different policies, impact assessment can provide an accurate picture of the net impact of the policy in question while helping to improve coordination among policies. Nonpolicy drivers, such as macroeconomic conditions, that influence emission reduction results should also be considered in the assessment.

For example, this study found that other policies in Beijing, such as the energy-saving target allocation policy, coal-consumption-reduction plan, renewable-power-generation targets, as well as adjustment of the economic structure, could have significant impacts on future emissions. By incorporating other policies and nonpolicy drivers, this assessment determined the additional contribution of Beijing ETS.

Therefore, we recommend that researchers and government agencies consider other existing and planned policies and nonpolicy drivers when estimating impacts of specific policies. This can be done by incorporating those factors into the baseline scenario as demonstrated by this study. The Policy Standard provides more guidance on this issue.

### Improve the tracking of major climate and energy policies' implementation to increase transparency

Policy implementation tracking can provide updated information on key performance indicators associated with inputs, activities, and intermediate effects. By increasing transparency, it can help companies and stakeholders better understand and respond to relevant policies.

This study identified and tracked Beijing ETS's key performance indicators. These indicators correspond to the input and activities sections of the casual chain map and help corroborate quantification results. The tracking results show that Beijing ETS made public only limited information on financial inputs. Information on permitting and other implementation activities were published on the website of Beijing Municipal Commission of National Development and Reform (Beijing MCDR) from time to time, but not in a systematic and complete manner. Occasionally, the government released piecemeal information on enforcement and compliance, but failed to provide a clear picture. If the government can improve information disclosure, researchers will be able to assess the impact of ETS policy more accurately and objectively while broader stakeholders will better understand how ETS works.

Therefore, we recommend government bodies publish policy implementation information in a transparent, timely, and systematic manner. Relevant information includes financial and nonfinancial inputs as well as information on activities related to licensing, permitting, and procurement; information monitoring; compliance and enforcement; and other policy administration activities. Based on such information, the government can work with research institutes, civil society organizations, companies and other stakeholders to identify implementation barriers and solutions leading to better policy design and implementation.

Appendix D proposes a framework for tracking the implementation of ETS policy, which can help the government improve transparency of ETS implementation.

### Conduct ex-post impact assessment for major climate and energy policies

Because of limited data availability, model limitations, and other unforeseeable factors, there remains a relatively large degree of uncertainty in ex-ante assessment. Ex-post assessment, in contrast, provides more accurate conclusions, and can generate recommendations for continued improvement. To collect data for ex-post assessment, one needs to identify key performance indicators and track them during the policy implementation period. We recommend making ex-post impact assessment a significant and permanent part of policymaking. Doing so will benefit future policymakers by sharing the experience of policy design and implementation.

The Policy Standard provides a framework to conduct ex-post impact assessment. This paper identifies key performance indicators and the main parameters needed to conduct ex-post assessment for Beijing ETS, and proposes an initial monitoring plan, which can assist the government or other researchers to collect data and conduct ex-post impact assessment for ETS pilots.

# APPENDIX A DESCRIPTION OF POLICY

Appendix A describes Beijing Emission Trading Scheme (ETS) according to the requirements of the Policy Standard.

### Table A.1 | Information Required for Policy Description

| Reporting Requirement | Reporting Content |
|---|---|
| Status of the policy or action (planned, adopted, or implemented) | Implemented |
| Date of implementation | 11/28/2013 (official launch of carbon trading) |
| Date of completion (if applicable) | This carbon trading scheme pilot will be completed by the end of 2015 |
| Implementing entity or entities | Beijing Municipal Commission of Development and Reform (Beijing MCDR)<br>Other supportive organizations:<br>Beijing Municipal Committee of Carbon Emission Trading Policy, Beijing Municipal Committee of Carbon Emission Trade Technology, Beijing Center of Climate Change Strategy Research, Beijing Municipal Leading Group for Climate Change and Energy Saving, Beijing Municipal Joint Conference of Carbon Emission Trading Pilot, China Beijing Environment Exchange, Beijing Municipal Commission of Economy and Information Technology |
| Type of policy or action | Emission trading program<br>Type of limitation: absolute cap<br>Type of emission trading: mandatory |
| Policy or action objectives | Gradually build a regional carbon emission trading scheme with a “completed structure, active trading, strict supervision, and established market rules” to promote GHG emission reductions; achieve the 12th Five-Year Guideline’s goal for $CO_2$ reduction per unit of GDP; gain experience and set an example for carbon emission trading at the national level. |
| Geographic coverage | Beijing |
| Primary sectors, subsectors, and emission source/sink categories targeted | Companies whose annual average emissions (including direct and indirect $CO_2$ emissions) equal or exceed 10,000 metric tons are covered by Beijing ETS and are known as “key emission institutions.” In 2014, about 500 companies in Beijing were covered by ETS in the following sectors:<br><br>• Heat production and supply<br>• Thermal power generation<br>• Cement manufacture<br>• Petrochemical production<br>• Other industries<br>• Services, including schools, research institutions, health care organizations, financial organizations, public service agencies, property managers, shopping malls, and supermarkets.<br><br>Additionally, legal entities in Beijing’s jurisdictive area whose annual energy consumption equals or exceeds 2,000 metric tons of standard coal (known as “reporting institutions”) must submit annual carbon emission reports to Beijing governmental climate change department.<br><br>Beijing ETS covers the following emission sources: direct emissions from fossil fuel consumption by stationary facilities, direct emissions from industrial processes or waste treatment, and indirect emissions from electricity consumption by stationary facilities. |
| Targeted greenhouse gas (if applicable ) | Carbon dioxide ($CO_2$) |

Table A.1 | **Information Required for Policy Description**

| Reporting Requirement | Reporting Content |
|---|---|
| Description of the specific interventions included in the policy or action | **Data collection and allowance allocation**[a]:<br>• Key emission institutions shall submit stamped hard copies of annual carbon emission reports and verification reports for the preceding year to Beijing MCDR by March 20 each year. Reporting institutions should submit annual emission reports online by February 28.<br>• Based on *Beijing Pilot Emission Trading Scheme Allowance Ratification Method (provisional),* Beijing MCDR sets the emission allowances for heat supply/ thermal power generation, and other enterprises using methods such as historical emission intensity, total historical emissions or advanced emissions intensity value in different industries etc. The emission allowances would be allocated for free to key emission institutions by June 30 through the Beijing ETS registry system in the form of electronic certificates. Allowances for facilities existing as of 2015 will be allocated by April of 2015. If companies are undergoing restructuring, reorganization, mergers, divisions, new construction or reconstruction and expansion, they may apply for allowance adjustment to Beijing MCDR within one week after the allowance allocation. Allowances for facilities built in 2014 and 2015 that have been approved will be allocated respectively in April 2015 and April 2016.<br>**Market supervision:**<br>• When abnormal fluctuations of allowance trading prices occur, Beijing MCDR would stabilize carbon prices by conducting an allowance auction or buy-backs based on *Measures of Open Market Operation and Management in Beijing Carbon Emission Trading (Trial).*<br>**Compliance management:**<br>• Key emission institutions should surrender emission allowances (including carbon offsets) by June 15 of the following year through the registry system to offset their carbon emissions of the preceding year.<br>• Key emission institutions that fail to comply with ETS requests or show other illegal activities, would be fined by Beijing MCDR according to *Provisions on Administrative Penalty Discretion in Carbon Emission Trading.*<br>• Beijing MCDR will randomly check on third-party verification reports and regularly release information on key emission institutions' compliance performance for the preceding year.<br>**Supports to energy saving and emission reduction**<br>• The government would offer financial support to energy- saving and emission-reduction projects of key emission institutions, provide support to financial institutions' ETS matching services, and facilitate adoption of advanced adaptation technologies. |
| Other related policies or actions that may interact with the policy or action assessed | • *Energy Conservation Target Allocation Plan in Key Sectors during the 12th Five-Year Plan Period*<br>• *2013-2017 Working Plan for Accelerating Reduction in Coal Use and Development of Clean Energy in Beijing*<br>• *Beijing Energy Development and Construction Working Plan during the 12th Five-Year Plan Period*<br>• *Beijing Heat Supply Development and Construction Plan during the 12th Five Year Plan Period*<br>• *12th Five-Year Plan for National Economic and Social Development in Beijing* |

Table A.1 | **Information Required for Policy Description**

| Reporting Requirement | Reporting Content |
|---|---|
| Related resources and links | • *Notice of Beijing Municipal Commission of Development and Reform on Launching Carbon Dioxide Emission Reporting and Third-Party Verification*<br>http://www.bjpc.gov.cn/tztg/201308/t6508700.htm<br>• *Beijing Corporate (Organization) $CO_2$ Emission Accounting and Reporting Guidance (2014 Edition)*<br>http://project.bjpc.gov.cn/energyCAS/tphs-bgzhn.pdf<br>• *Notice of Beijing Municipal Commission of Development and Reform on Carrying out the Emission Trading Scheme Pilot Work*<br>http://www.bjpc.gov.cn/tztg/201311/t7020680.htm<br>• *Carbon Emission Trading Rules of Beijing Environment Exchange (Trial)*<br>http://www.bjets.com.cn/base/file/jygz.pdf<br>• *Decision of the Standing Committees of the People's Congress of Beijing Municipality on Launching Carbon Emission Trading Pilots with a Strict Control of the Total Emissions*<br>http://zhengwu.beijing.gov.cn/gzdt/gggs/t1336104.htm<br>• *Beijing Pilot Emission Trading Scheme Allowance Ratification Method (Provisional)*<br>http://www.bjpc.gov.cn/tztg/201311/t7020680.htm<br>• *Notice of Publication of the Implementing Rules of Beijing Carbon Emission Allowance Over-the-Counter (Trial)*<br>http://www.bjpc.gov.cn/tztg/201312/t7095551.htm<br>• *Notice of Beijing Municipal Commission of Development and Reform on 2014 Carbon Emission Reporting, Verification and Related Work.*<br>Appendixes includes:<br>*Application materials and related requirements for allowances of newly added facilities, approaches of developing advanced valued of carbon emission intensity in different sectors, application materials and related requirements of allowance adjustment, allowance adjustment method.*<br>http://www.bjpc.gov.cn/tztg/201403/t7419200.htm<br>• *Notice of Beijing Municipal Commission of Development and Reform on Publishing Advanced Value of Carbon Emission Intensity in Different Sectors*<br>http://www.bjpc.gov.cn/tztg/201405/t7684245.htm<br>• *Provisions on Administrative Penalty Discretion in Carbon Emission Trading*<br>*http://www.bjpc.gov.cn/tztg/201405/t7691323.htm*<br>• *Notice of Beijing Financial Bureau under Beijing Municipal Commission of Development and Reform on Publishing Measures of Open Market Operation and Management in Beijing Carbon Emission Trading (Trial).*<br>http://www.bjpc.gov.cn/tztg/201406/t7851003.htm<br>• *Notice of Beijing Municipal Government on Publishing Management Measures of Beijing Emission Trading Scheme (Trial)*<br>http://zhengwu.beijing.gov.cn/gzdt/gggs/t1359070.htm |

Source: Authors and website of Beijing Municipal Commission of Development and Reform
Note:
a. Part of milestones here are updated according to the message "Beijing collects public feedbacks on carbon emissions monitoring guide and other related documents," from Carbon News Platform of Sino-Carbon Innovation & Investment Company on November 19, 2014, earlier than the relevant milestones listed in the 2013 official documents.

Table A.2 | **Optional Information for Policy Description**

| Reporting Information | Reporting Content |
|---|---|
| Background and significance of policy or action (if applicable ) | As a major greenhouse gas emitter, China is putting more emphasis on issues related to climate change and the necessity to take action. The plan, "Making Active Responses to Climate Change," was first proposed in China's 12th Five-Year Plan for National Economic and Social Development. It consisted of three main parts: controlling GHG emissions, strengthening adaptive capacity to climate change, and encouraging international cooperation.<br><br>Additionally, China has made a significant step in controlling GHG emissions by launching a carbon emission trading market. China has accumulated experience by participating in international carbon emission trading (mainly Clean Development Mechanism projects), but still lacks experience in operating domestic cap-and-trade scheme. The first round of carbon emission trading pilots, including Beijing, will test out monitoring, reporting, and verification (MRV) systems, transaction rules, market intervention, management, and legislation, etc., and gain experiences for the design and implementation of a national carbon emission trading program.<br><br>On February 2014, the National Development and Reform Commission issued the Notice on Conducting GHG Emission Reporting of Key Enterprises and Public Institutions, requiring companies whose GHG emissions reached 13,000 metric tons of $CO_2$ equivalent ($CO_2e$) in 2010, or whose total energy consumption reached 5,000 metric tons of standard coal in 2010, to submit annual emission reports on six types of GHGs. This nationwide GHG emission reporting program also lays the foundation for a national carbon trading scheme. |
| Intended level of mitigation to be achieved and/or target level of key indicators | During the pilot period of 2013 to 2015, total emission allowance of key emission institutions within Beijing ETS is about 200 megatonnes (Mt) of $CO_2$.<br>The 12th Five-Year Plan set a goal for Beijing of reducing $CO_2$ emissions by 18 percent per Y 10,000 of GDP compared with 2010. Beijing ETS will also contribute to achieving the goal. |
| Title of establishing legislation, regulations, or other founding documents (if applicable ) | • *Work Plan for Greenhouse Gas Emissions Control during the 12th Five-Year Plan Period*<br>• *Notice of General Office of the National Development and Reform Commission on Launching Carbon Emission Trading Pilots*<br>• *Beijing's Plan of Climate Change, Energy Saving and Consumption Reduction during the 12th Five-Year Plan Period*<br>• *Decision of the Standing Committees of the People's Congress of Beijing Municipality on Launching Carbon Emission Trading Pilots with a Strict Control of the Total Emissions*<br>• *Notice of Beijing Municipal Commission of Development and Reform on Carrying out the Emission Trading Scheme Pilot Work* |
| Monitoring, reporting and verification (MRV) procedure (if applicable) | Notice of Beijing Municipal Commission of Development and Reform on Launching Carbon Dioxide Emission Reporting and Third-Party Verification established procedures for reporting emissions data, expert consultation and the third-party verification, etc.<br>Beijing MCDR published Beijing Corporate (Organization) $CO_2$ Emission Accounting and Reporting Guidance (2014 edition) to facilitate companies' emissions accounting and reporting. |
| Enforcement mechanism (if applicable) | According to the Law of the People's Republic of China on Administrative Penalty, Decision of the Standing Committees of the People's Congress of Beijing Municipality on Launching Carbon Emission Trading Pilots with a Strict Control of the Total Emissions, and other laws, rules, regulations, and normative documents, Beijing MCDR developed Provisions on Administrative Penalty Discretion in Carbon Emission Trading, and will implement appropriate administrative penalties for illegal activities related to carbon emission trading accordingly. |
| Outline of non-GHG effects or co-benefits of the policies or actions (if applicable) | • Providing experiences for developing nationwide carbon emission trading scheme<br>• Promoting industries restructuring in Beijing<br>• Promoting development of clean energy<br>• Promoting development and wide application of energy saving technology<br>• Improving public consciousness of energy saving and emission reduction<br>• Reducing other environmental pollution related to energy consumption, such as particular matter, $SO_2$, and $NO_x$ |

Source: Website of Beijing Municipal Commission of Development and Reform.

# APPENDIX B REPORT ON ASSESSMENT RESULTS

This appendix presents all information required under the Policy and Action Standard, using Beijing Carbon Emission Trading Scheme (ETS) as an example. Other researchers who use the Policy and Action Standard can adopt other report forms according to need. The combination of this appendix and Appendix A, the description of policy, forms a complete assessment report of the policy GHG effect.

## Part 1: Information of GHG Assessment

This part gives the basic information needed for the assessment.

Table B.1 | **Assessment Basic Information**

| Reporting Requirement | Reporting Content |
|---|---|
| The title of the policy or action (or package of policies/actions) assessed | Beijing Emission Trading Scheme (Beijing ETS) |
| The objectives(s) and the intended audience of the GHG assessment | Provide information on improving Beijing ETS and on recommendations for the design of China's national ETS. GHG emission reductions in the power industry are important in achieving China's climate change mitigation goals. This study conducted focused analysis of the ETS policy's emission reduction impact on the power sector.<br><br>National Development and Reform Commission, local Development and Reform Commissions, research project donors, policymakers, and domestic and international research institutions |
| Period of conducting the assessment | 2013 to 2014 |
| Whether the reported assessment is an update of a previous assessment, and if so, links to any previous assessments | This assessment is the first assessment of Beijing ETS |
| The GHG assessment period | 2013 to 2015 |
| Whether the GHG assessment is an ex-ante assessment, an ex-post assessment, or a combined ex-ante and ex-post assessment | Ex-ante assessment |
| Whether the assessment applies to an individual policy/action or a package of policies/actions, and if a package, which individual policies and actions are included in the package | Individual policy |

Source: Authors.

## Part 2: Estimation of GHG Emission or Removal Effect of Policy or Action

Part 2 details the GHG emissions and removals, and emission reductions by district and source in three tables.

### Table B.2 | GHG Emission or Removal Effect during GHG Assessment Period

| Year | Net Change in GHG Emissions and Removals ( megatonnes of $CO_2$ equivalent, $MtCO_2$) |
|---|---|
| 2013 | -0.41 |
| 2014 | -1.56 |
| 2015 | -2.90 |
| Total cumulative change in emissions and removals | -4.87 |

Source: Authors.
Note: When the net change is negative, it means that the policy reduced the emissions

### Table B.3 | Emission Reduction Divided by Districts

| Year | Net Change in Emissions and Removals Occurring ($MtCO_2$ equivalent) | | Total Net Change in Emissions and Removals (A+B) ($MtCO_2$ equivalent) |
|---|---|---|---|
| | Within the implementing jurisdiction's geopolitical boundary (A) | Outside the implementing jurisdiction's geopolitical boundary (B) | |
| 2013 | -0.16 | -0.25 | -0.41 |
| 2014 | -0.94 | -0.62 | -1.56 |
| 2015 | -1.72 | -1.18 | -2.90 |
| Total cumulative net change of emissions and removals | -2.82 | -2.05 | -4.87 |

Source: Authors.

Table B.4 | **Emission Reduction Classified by Emission Sources**

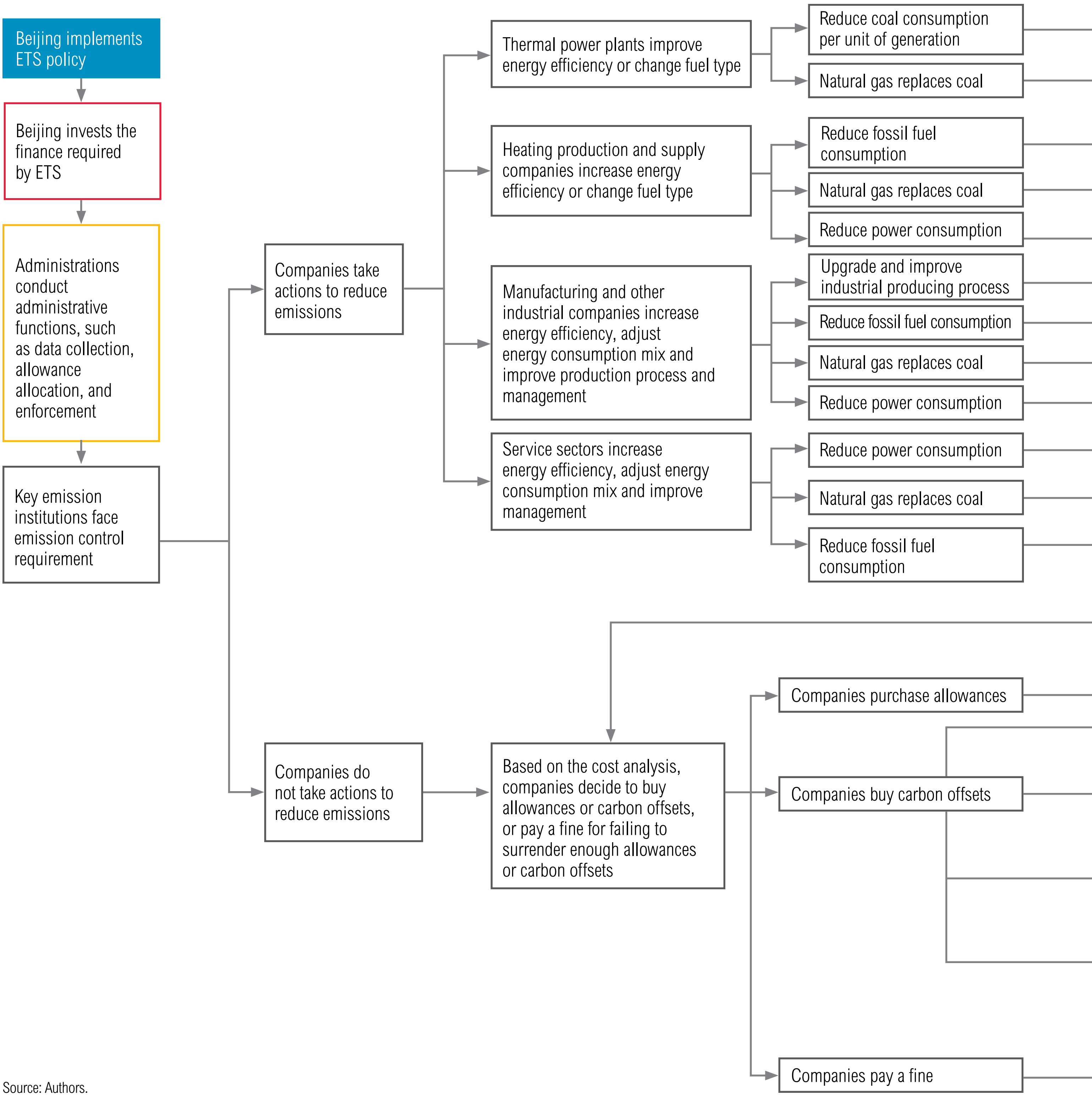
| Year | Total Net Effect of Emissions and Removals under the Policy Scenario (with Beijing Emission Trading Scheme) (A) ($MtCO_2$ equivalent) | | | Total Net Effect of Emissions and Removals under the Baseline Scenario (without Beijing Emission Trading Scheme) (B) ($MtCO_2$ equivalent) | | | Total Net Effect of Emissions and Removals (A-B) ($MtCO_2$ equivalent) |
|---|---|---|---|---|---|---|---|
| | Direct emissions from fossil fuel consumption | Indirect emissions from electricity consumption | Total | Direct emissions from fossil fuel consumption | Indirect emission from electricity consumption | Total | |
| 2013 | 55.99 | 12.28 | 68.27 | 56.15 | 12.53 | 68.68 | -0.41 |
| 2014 | 55.51 | 12.17 | 67.68 | 56.45 | 12.79 | 69.24 | -1.56 |
| 2015 | 54.29 | 12.07 | 66.36 | 56.01 | 13.25 | 69.26 | -2.90 |
| Cumulative change in emission and removal | 165.79 | 36.52 | 202.31 | 168.61 | 38.57 | 207.18 | -4.87 |

Source: Authors.
Note: Subtle differences may exist between the sum of disaggregated data and the aggregated data because of rounding.

## Part 3: Methodology

Part 3 describes the assessment methodology including the causal chain map, a description of the assessment boundary, and the methods for determining the baseline and policy scenario emissions.

Figure B.1 | **Causal Chain Map**




Source: Authors.

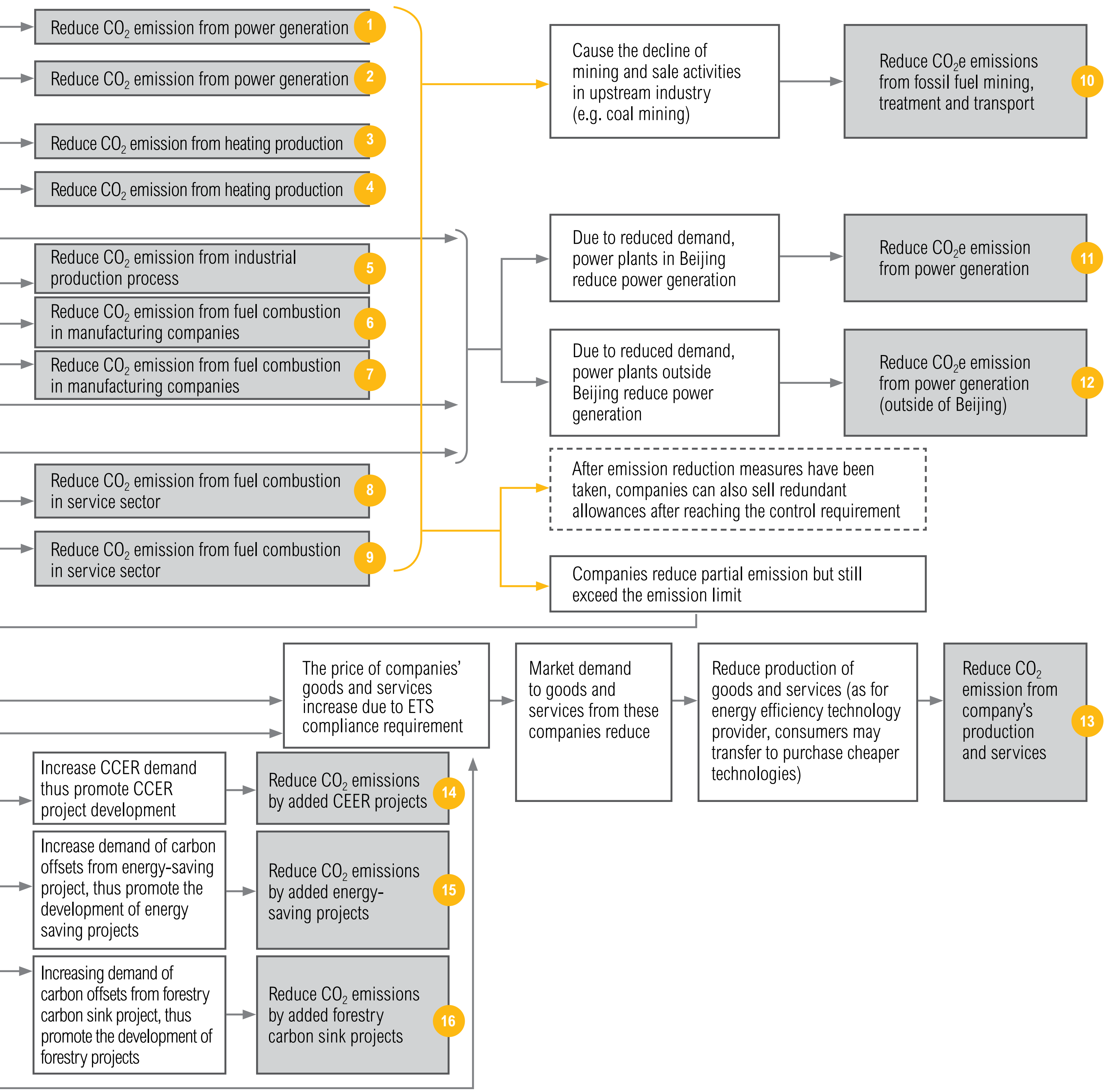

Reduce $CO_2$ emission from power generation 1
Reduce $CO_2$ emission from power generation 2
Reduce $CO_2$ emission from heating production 3
Reduce $CO_2$ emission from heating production 4
Reduce $CO_2$ emission from industrial production process 5
Reduce $CO_2$ emission from fuel combustion in manufacturing companies 6
Reduce $CO_2$ emission from fuel combustion in manufacturing companies 7
Reduce $CO_2$ emission from fuel combustion in service sector 8
Reduce $CO_2$ emission from fuel combustion in service sector 9
Cause the decline of mining and sale activities in upstream industry (e.g. coal mining)
Reduce $CO_2e$ emissions from fossil fuel mining, treatment and transport 10
Due to reduced demand, power plants in Beijing reduce power generation
Reduce $CO_2e$ emission from power generation 11
Due to reduced demand, power plants outside Beijing reduce power generation
Reduce $CO_2e$ emission from power generation (outside of Beijing) 12
After emission reduction measures have been taken, companies can also sell redundant allowances after reaching the control requirement
Companies reduce partial emission but still exceed the emission limit
The price of companies' goods and services increase due to ETS compliance requirement
Market demand to goods and services from these companies reduce
Reduce production of goods and services (as for energy efficiency technology provider, consumers may transfer to purchase cheaper technologies)
Reduce $CO_2$ emission from company's production and services 13
Increase CCER demand thus promote CCER project development
Reduce $CO_2$ emissions by added CEER projects 14
Increase demand of carbon offsets from energy-saving project, thus promote the development of energy saving projects
Reduce $CO_2$ emissions by added energy-saving projects 15
Increasing demand of carbon offsets from forestry carbon sink project, thus promote the development of forestry projects
Reduce $CO_2$ emissions by added forestry carbon sink projects 16

Table B.5 | **Greenhouse Gas Emissions Assessment Boundary**

| Effect Number in Causal Chain | Potential GHG Effects of Policy or Action | Source or Sink Affected | GHGs Affected | Effect of Reducing or Increasing Emissions | Whether Included in the Assessment | Justification of Exclusion or Explanation of Inclusion (if applicable) |
|---|---|---|---|---|---|---|
| 1 | Reduce GHG emissions from power generation (reduce emissions of per unit power generation) | Fossil fuel combustion in power sector | $CO_2$ | Emission reduction | Yes | |
| 3 | Reduce GHG emissions from heat production | Fossil fuel combustion in heat production sector | $CO_2$ | Emission reduction | Yes | |
| 5 | Reduce GHG emissions from industrial processes or waste treatment | Emissions from industrial processes | $CO_2$ | Emission reduction | No | This research lacked data related to emissions from industrial processes and waste disposal. Emissions from industrial processes for the year 2011 account for only 13% of total national direct emissions from energy consumption and industrial processes.[a] Experts estimated that carbon emissions from Beijing's industrial processes make up about 3% of total emissions (both direct and indirect emissions) from companies covered by Beijing ETS. Excluding this emission type from the baseline scenario and policy scenario has a negligible effect on final results. |
| 6 | Reduce GHG emissions from fuel combustion in manufacturing and other industrial sectors | Fossil fuel combustion in manufacturing and other sectors | $CO_2$ | Emission reduction | Yes | |
| 9 | Reduce GHG emissions of fuel combustion in service sector | Fossil fuel combustion in service sector | $CO_2$ | Emission reduction | Yes | |
| 2/4/7/8 | Reduce GHG emission from fossil fuel combustion in various sectors by using natural gas instead of coal | Fossil fuel combustion in all kinds of sectors | $CO_2$ | Emission reduction | No | The *Working Plan for Accelerating Reduction in Coal Use and Development of Clean Energy in Beijing* has strongly encouraged a shift from coal to natural gas. The Beijing ETS does not promote additional efforts to shift companies' energy consumption from coal to natural gas. |
| 10 | Reduce GHG emissions from mining, production, or transportation of fossil fuels | GHG emissions leakage and fossil fuel combustion in fossil fuel mining and other processes | $CO_2$, $CH_4$ | Emission reduction | No | Because it is relatively difficult to determine the impact of reduction in fossil fuel combustion by ETS-covered companies on upstream industries, and the baseline emissions for upstream industries, this paper does not include this emission reduction effect. |

| Effect Number in Causal Chain | Potential GHG Effects of Policy or Action | Source or Sink Affected | GHGs Affected | Effect of Reducing or Increasing Emissions | Whether Included in the Assessment | Justification of Exclusion or Explanation of Inclusion (if applicable) |
|---|---|---|---|---|---|---|
| 11 | Reduce GHG emissions from power generation, (reduce power generation, thereby reducing total emissions) | Fossil fuel combustion in power sector | $CO_2$ | Emission reduction | Yes | |
| 12 | Reduce GHG emission from power generation (outside of Beijing) | Fossil fuel combustion in power generation system outside of Beijing | $CO_2$ | Emission reduction | Yes | |
| 13 | Reduce GHG emission from production and services (reduce production of goods and provision of services, thereby reducing GHG emissions) | Fossil fuel combustion from production of goods and provision of services | $CO_2$ | Emission reduction | No | The implementation period of the Beijing ETS pilot is relatively short, so it may not be possible to fully transfer the cost of carbon emissions to goods and services of key emission institutions. In particular, public service and public utility sectors experience minimal impact from carbon pricing. |
| 14/15/16 | Reduce GHG emission by developing more China Certified Emission Reduction (CCER) projects, energy saving projects and forestry carbon sink projects | Corresponding emission sources of CCER projects, energy saving projects, and forestry carbon sink project | $CO_2$ | Emission reduction | Yes | Emissions that result from the absence of offset projects in the baseline scenario are equivalent to the emissions of key emission institutions that are offset by carbon offsets in the policy scenario. Thus, this part of emission data does not appear in the calculation processes of the two scenarios; however, the emission reduction of the policy scenario relative to the baseline scenario does take into account emission reductions realized by using carbon offsets from CCER projects, energy-saving projects, and forestry carbon sink projects. |

Source: Authors.
Note:
a. World Resources Institute, CAIT 2.0, http://www.wri.org/our-work/project/caitclimate-data-explorer

Table B.6 | **Approach of Determining Assessment Boundary**

| Reporting Requirement | Reporting Content |
|---|---|
| Standards and methodologies used to determine the significance of GHG effects, emission source/ sink categories, and types of GHG | We determined the magnitude and probability of occurring of GHG effect in Table B.5 based on expert consultation and literature research. This research focused on energy- related emissions, thus we included all emission sources related to energy consumption; the type of GHG remained consistent with the type capped under Beijing ETS. |

Table B.7 | **Methodology of Baseline Scenario**

| Reporting Requirement | Reporting Content |
|---|---|
| Description of baseline scenario (description of the events or conditions most likely occur in the absence of the policy) | The baseline scenario shows the $CO_2$ emission scenario of sources within the assessment boundary during 2013, 2014 and 2015 under the influence of current energy policy, technology development trends, and adjustment of industry structure in Beijing, but in the absence of the Beijing carbon emission trading system. That is, $CO_2$ emissions would continue increasing along with economic development, but the rate of increase would be slowed by the impact of energy-saving and emission-reduction policies, and adjustments of industry structure. |
| The methodology and assumptions used to estimate baseline emissions, including the emissions estimation method(s) (including any models) used | The research group adopted the Long Range Energy Alternatives Planning (LEAP) model to estimate energy demand for different sectors and energy types in Beijing between 2013 and 2015. The group adopted $CO_2$ emission factors corresponding to different fuels to estimate the $CO_2$ emissions from energy consumption in Beijing in that period. It then calculated $CO_2$ emissions of key emission institutions in Beijing ETS's coverage area by using a ratio.<br>Main assumptions:<br>• In the baseline scenario, the ratio of total $CO_2$ emissions from the energy consumption of key emission institutions within Beijing ETS coverage from 2013 to 2015 to the total $CO_2$ emissions from the energy consumption of corresponding sectors remained consistent with the ratio in 2012.<br>• Key emission institutions can meet emission reduction targets by reducing their emissions directly or by purchasing carbon offsets.<br>• The emission-control requirements of ETS would reduce the direct emissions of fossil fuel consumption and indirect emissions from electricity consumption by key emission institutions according to the ratios of each type of emissions in 2012. In other words, direct and indirect emissions would be all reduced by the level required by the emission control index.<br>• Of the electricity used by all power consumers in Beijing, the ratio of local generated power to external imported power was consistent. The amount of electricity saved as a result of the ETS will impact power plants and power sectors outside Beijing based on the ratio of electricity supply from these two sources.<br>• Actual emissions of key emission institutions equal to the emission allowances in the compliance year. All emission allowances were used in the compliance year for which they were allocated, rather than being banked for future use.<br>• Beijing ETS will not have an effect on industrial structure within its coverage. |
| Justification for the choice of whether to develop new baseline assumptions and data or to use published baseline assumptions and data | The study team developed new baseline assumptions instead of using existing research results. |
| A list of policies, actions, and projects included in the baseline scenario | *Energy Conservation Target Allocation Plan in Key Sectors during the 12th Five-Year Plan Period,*<br>*2013-2017 Working Plan for Accelerating Reduction in Coal Use and Development of Clean Energy in Beijing,*<br>*Beijing Energy Development and Construction Working Plan during the 12th Five-Year Plan Period,*<br>*Beijing Heat Supply Development and Construction Plan during the 12th Five Year Plan etc.* |
| Any implemented or adopted policies, actions, or projects excluded from the baseline scenario, with justification for their exclusion | No |

| Reporting Requirement | Reporting Content |
|---|---|
| Whether the baseline scenario includes any planned policies and if so, which planned policies are included | No |
| Any relevant nonpolicy drivers included in the baseline scenario (for example, social and economic drivers) | GDP growth: the average annual growth rate of GDP in Beijing during the 12th Five-Year Plan Period should be limited to 7.5%. Actual GDP data was used until 2012.<br>Industrial restructuring: Industrial restructuring in Beijing is the result of policy orientation and industrial self-selection as well as market impact. |
| Any relevant nonpolicy drivers that are excluded from the baseline scenario, with justification for their exclusion | Factors such as price of coal and natural gas are not considered: Beijing has implemented price regulation of natural gas,[a] thus the natural gas price for heating supply, household usage, and industrial usage would be less affected by the external energy market. If the difference between the prices of coal and natural gas were considered, the total coal consumption ratio would be higher than the ratio in the baseline scenario because coal is cheaper than natural gas. However, Beijing municipal government adopted a large-scale policy of coal reduction and clean energy development from 2013 to 2017. In implementing this policy, the government is more concerned with its environmental effects than its economic effects. Thus the influence of energy price on energy consumption is very limited under the coal control policy and was excluded from the baseline scenario. |
| Any potential interactions with other policies and actions and whether and how policy interactions were estimated | The abovementioned policies considered in the baseline scenario, such as energy conservation target allocations, coal reduction and energy development plan, can promote energy saving, shift from coal to natural gas, and renewable energy development. These effects reinforce or overlap with ETS's $CO_2$ emission reduction target. These interactive policies were implemented earlier than Beijing ETS and with mandatory requirements at different levels, under which companies are faced with clear responsibilities. Thus, the study team took into account the emission reduction effects from these policies in the baseline scenario, and assumed these effects will take place prior to the effects of ETS. The ETS would help raise the rate of achieving the energy conservation target. The study team assumed that Beijing's energy conservation target of 12th Five-Year Plan would be achieved, referring to the results of this policy in the 11th Five-Year Plan period. [b] |
| Any sources, sinks, or greenhouse gases in the GHG assessment boundary that have not been estimated in the baseline scenario, with justification, and a qualitative description of those sources, sinks, or gases | No |
| Whether the baseline scenario includes any planned policies and if so, which planned policies are included | No |

Source: Authors.

Notes:

a. Beijing MCDR Website, "Natural gas price in Beijing," http://www.bjpc.gov.cn/ywpd/wjgl/cx/jz/201208/t3884350.htm.

b. Beijing MCDR Website, October 22, 2010, Beijing held an introduction meeting on effect of new energy development the 11th Five-Year Plan Period: http://www.bjpc.gov.cn/gzdt/201010/t699249.htm.

## Parameters and formulas in the baseline scenario emissions estimation method(s)

**Background formula:**

Formula(B.1): $GDP_{2012+i}=GDP_{2012}\times(1+\alpha)^i$

| | |
|---|---|
| $GDP_{2012+i}$ | Beijing GDP from 2013 to 2014<br>Note: i=1,2 |
| $GDP_{2012}$ | Beijing GDP in 2012 |
| $\alpha$ | The annual growth rate of Beijing GDP from 2013 to 2014 |

Formula(B.2): $\alpha=\sqrt[3]{(GDP_{2015} / GDP_{2012})}-1$

| | |
|---|---|
| $GDP_{2015}$ | Beijing GDP in 2015<br>Note: According to the plan of Beijing's municipal government, the average annual growth rate of GDP in Beijing during the 12th Five-Year Plan Period should be limited to 7.5 percent, so $GDP_{2015}=GDP_{2010}\times(1+7.5\%)^5$ |

Formula (B.3): $GDP_{2015,j}=GDP_{2015}\times v_{2015,j}$

| | |
|---|---|
| $GDP_{2015,j}$ | The gross value-added of sector j in 2015<br>Note: $GDP_{2013,j}$ and $GDP_{2014,j}$ are calculated by the interpolation method and adjusted according to the constraint that the sum of all sectors' value-added equals Beijing's GDP value of the year.<br>The value-added in the primary, secondary, and tertiary industries are calculated according to the industrial structure set by *Beijing 12th Five-Year Plan on National Economic and Social Development.* Value-added data in other subdivided industries GDPi,j is calculated by two methods: one refers to Beijing Industrial Development Plan and uses formula (B.3), the other is deduced from the historical data of sectoral value-added (see Table C.1 in Appendix C) |
| $v_{2015,j}$ | The ratio of value-added in sector j to Beijing GDP in 2015 |

Formula (B.4): $EN_{2015,j}=GDP_{2015,j}\times INT_{2010,j}\times(1-\delta_j)$

| | |
|---|---|
| $EN_{2015,j}$ | Total energy consumption of sector j in Beijing in 2015<br>Note: $EN_{2013,j}$ and $EN_{2014,j}$ were calculated using the interpolation method and referring to the difference between actual data for 2012 and predicted data for 2015. Sector j here excludes power production and heating supply sectors. |
| $INT_{2010,j}$ | Energy consumption per value-added in sector j in 2010 |
| $\delta_j$ | The reduction rate of energy consumption per value-added set by Beijing during the 12th Five-Year Plan Period.<br>Note: See data in Table C.2 in Appendix C. Since the governmental plan only provides the reduction rate of energy consumption per value-added for the whole industrial sector, the study team did not further analyze the reduction rates of the industrial subsectors. But, we did conduct in-depth analysis of reduction rates of energy consumption in the subsectors in the service industry. Due to lack of data for public institutions' building area, the study team assumed the energy consumption reduction goal per unit of area equals the energy consumption reduction goal per unit of value added in the calculation. |

Formula (B.5): $EN_{i,j,x}=EN_{i,j}\times m_{j,x}$

| | |
|---|---|
| $EN_{i,j,x}$ | The consumption of energy x in sector j in year i<br>Note: i=2013~2015, sector j here excludes the power production and heating supply sectors. |
| $m_{j,x}$ | The ratio of consumption of energy x in sector j in 2012 to the total energy consumption in sector j<br>Note: The study team studied the share of consumption of different energy types in different sectors. The energy consumption shares in year i were adjusted based on energy shares in different sectors in 2012, and according to the *2013-2017 Working Plan for Accelerating Reduction in Coal Use and Development of Clean Energy in Beijing,* and *Beijing Energy Development and Construction Working Plan during the 12th Five-Year Plan Period.* The ratio of coal in the industrial sector in 2015 will be 3 percent less than the ratio in 2012, and the ratio of natural gas will be 3 percent higher than that of 2012. |

**Explanation:**

The estimation of energy consumption in the household sector was deduced from various data of per capita energy consumption from 2005 to 2012 in Beijing, and also referred to indicators such as per capita electricity consumption and the ratio of households that use natural gas, which are set in *Beijing Energy Development and Construction Working Plan during the 12th Five-Year Plan Period.*

Estimations of fossil fuel consumption in the power production sector and the heating supply sector were based on the Beijing energy balance sheet of 2012, and calculated according to projected Beijing power and heating supply scales, technology selection, efficiency, and other factors described in *Beijing Energy Development and Construction Working Plan during the 12th Five-Year Plan Period, Beijing Heat Supply Development and Construction Plan during the 12th Five Year Plan Period,* and *2013-2017 Working Plan for Accelerating Reduction in Coal Use and Development of Clean Energy in Beijing.* Factors such as the increase in Beijing's total installed generation capacity, the change in the ratio of coal fired capacity to natural gas fired capacity, and decreasing energy consumption for power generation (unit: gram of standard coal/kilowatt hour, gce/kWh) in coal or natural gas generating units, were considered in the calculation. The energy consumption for power generation in natural gas units is constant, and the coal consumption of coal units in 2015 is 2 gce/kWh lower than 2012.

Formula(B.6): $EB_{i,j,d}=EN_{i,j,x}\times EF_x$

| | |
|---|---|
| $EB_{i,j,d}$ | Direct $CO_2$ emissions from fossil fuel consumption in sector j of Beijing in year i under the baseline scenario.<br>Note: the calculation result is in Table C.4 of Appendix C |
| $EF_x$ | $CO_2$ emission factor of energy x<br>Note: x does not include power consumption; the value is in Table C.3 of Appendix C |

Formula(B.7): $EB_{i,j,t}=EN_{i,j,e}\times EF_t$

$EB_{i,j,t}$ Indirect $CO_2$ emissions from power consumption in sector j of Beijing in year i under the baseline scenario

Note: the calculation result is in Table C.4 of Appendix C

$EN_{i,j,e}$ Terminal power consumption in sector j of Beijing in year i

$EF_t$ Emission factor for imported electricity

Note: The emission factor for imported electricity used by Beijing was calculated by multiplying the emission factor in the North China power grid (0.8845 $kgCO_2$/kWh) by the ratio of imported power to total power consumption in 2012 (67 percent). The ratio of imported power to total power consumption in 2012 was calculated using the energy balance sheet in Beijing Statistical Yearbook 2013. The value is in Table C.3 of Appendix C.

Formula(B.8): $EB_{i,j}=EB_{i,j,d}+EB_{i,j,t}$

$EB_{i,j}$ $CO_2$ emissions in sector j of Beijing in year i

$EB_{i,j,d}$ Direct $CO_2$ emissions from fossil fuel consumption in sector j of Beijing in year i

$EB_{i,j,t}$ Indirect $CO_2$ emissions from power consumption in sector j of Beijing in year i

Formula(B.9): $EB_{i,t,ETS}=\sum_{j=1}^{n}(EB_{i,j,t}\times SHA_{2012,j,t,ETS})$

$EB_{i,t,ETS}$ Indirect emissions from power consumption within the coverage of Beijing ETS in year i under the baseline scenario

Note, i=2013~2015

$EB_{i,j,t}$ The total indirect emissions in sector j in year i under the baseline scenario

$SHA_{2012,j,t,ETS}$ The ratio of indirect emissions from key emission institutions to the total indirect emissions of sector j in 2012 under the baseline scenario

Note: The ratio was calculated based on the *2012 Status Report on Energy Usage for Key Energy Consumption Institutions in Beijing,* and related data from the *Beijing Statistical Yearbook.*

Formula(B.10): $EB_{i,E,ETS}=EB_{i,E}\times SHA_{2012,E,ETS}$

$EB_{i,E,ETS}$ $CO_2$ emissions of power sector within the coverage of Beijing ETS in year i under the baseline scenario

$EB_{i,E}$ $CO_2$ emissions of power sector of Beijing in year i under baseline scenario

$SHA_{2012,E,ETS}$ Ratio of $CO_2$ emissions from key emission institutions in power sector to the total $CO_2$ emission in the relevant sector

**Core Formula:**

Formula(1): $EB_i=\sum_{j=1}^{n}[(E_{i,j,d}+E_{i,j,t})\times SHA_{2012,j,ETS}]$

| Parameter | The baseline value used during the GHG assessment period | Methodologies and assumptions used to estimate the parameter | Data resource |
|---|---|---|---|
| $E_{i,j,d}$ | Refer to Table C.4 for the direct emissions from fossil fuel combustion | Refer to background formulas (B.1) to(B.7) | Statistical yearbook, energy and industry development plans of Beijing, Status Report on Energy Usage for Key Energy Consumption Institutions in Beijing, and expert consultation |
| $E_{i,j,t}$ | Refer to Table C.4, the indirect emissions from power consumption | Refer to background formulas (B.1) to(B.7) | Same as above |
| $SHA_{2012,j,ETS}$ | Not available due to information nondisclosure requirement | Calculated the ratio of emissions of key emission institutions to the total emission of the corresponding sector in 2012 | Calculated by the study team group according to historical data |

Table B.8 | **Methodology for the Policy Scenario (Ex-ante Assessment)**

| Reporting Requirement | Reporting Content |
|---|---|
| A description of the policy scenario (a description of the events or conditions most likely to occur in the presence of the policy or action) | The key emission institutions of Beijing ETS realize emission control targets, and the increasing trend of total emissions from companies within the coverage of Beijing ETS is gradually slowed |
| The methodology and assumptions used to estimate policy scenario emissions, including the emissions estimation method(s) (including any models) used | Referred to the methodology adopted by Beijing ETS to account emission allowances for key emission institutions, and evaluated the impact of carbon offsets use on $CO_2$ reduction by key emission institutions |
| Any potential interactions with other policies and actions and whether and how policy interactions were estimated | Other policies that affect the assessed policy were considered under the baseline scenario, and the effects of these policies on emission reduction were taken into account prior to Beijing ETS. This means that the emission reduction effect of Beijing ETS is calculated as additional to these former policies. |
| Any sources, sinks, greenhouse gases, or GHG effects within the GHG assessment boundary that have not been estimated in the policy scenario, with justification, and a qualitative description of the change to those sources, sinks, or gases | Not applicable |

Source: Authors.

## Parameters and formulas in the policy scenario emissions estimation method(s)

**Background formula:**

Formula(B.11): $T_i=A_i+N_i+\Delta_i$

- $T_i$ — Total $CO_2$ emission allowances of a company in year i
  Note: According to Emission Allowance Ratification Method in the Beijing Carbon Emission Trading Pilot (Trial), the annual total emission allowances of a company includes three parts: allowances for existing facilities, allowances for newly added facilities and allowances for adjustment. The research took into account only $CO_2$ emissions related to energy consumption in key emission institutions, and did not consider $CO_2$ emissions from industrial processes.
- $A_i$ — $CO_2$ emission allowances of existing facilities in companies in year i
- $N_i$ — $CO_2$ emission allowances of newly added facilities in companies in year i
- $\Delta_i$ — Adjustment allowances in companies in year i
  Note: In cases where there was no allowance adjustment data available, $\Delta$ could not be presented in the research

Formula(B.12): $A_{i,j}=A_b \times C_{i,j}$

- $A_{i,j}$ — Emission allowances of existing facilities allocated to sector j in year i
- $A_b$ — Baseline emissions of sector j
  Note: calculated by the average emissions during 2010-2012
- $C_{i,j}$ — The emission control index of sector j in year i; refer to Table C.5 in Appendix C

Formula(B.13): $N_{i,j}=Q_{i,j} \times B_j$

- $N_{i,j}$ — $CO_2$ emission allowances of newly added facilities in sector j in year i
- $Q_{i,j}$ — Activity data of newly built facilities that correspond to $CO_2$ emissions
  Note: The activity data include the production of main products, output value, and building area etc. Assuming there is no increase in the total production of the manufacturing industry according to the plan and the actual situation; assuming the advanced value of $CO_2$ emission intensity in the service sector is 10 percent [33] lower than the current level. The number of added allowances for the service sector was deduced from the growth rate of added emissions during 2009 to 2012. Activity data for the power production sector and heating supply sector were calculated according to power and heat demands of Beijing, the supply capacity and the corresponding development plan.
- $B_j$ — Advanced value of $CO_2$ emission intensity in sector j that adding new facilities
  Note: Refer to Notice of Beijing Municipal Commission of Development and Reform on Releasing Carbon Emissions Advanced Values of Different Sectors (Beijing MCDR No.[2014]905)

Formula(B.14): $T_{i,E}=ESP_{i,BJ}\times SHA_{BJ}\times(EP_{2012,C}\times EF_x\times SHA_{C,E}\times C_{i,j,x}$
$+EP_{2012,NG}\times EF_x\times SHA_{NG,E}\times C_{i,j,x})$

$T_{i,E}$ — $CO_2$ emission allowances of facilities in power production companies in year i
Note: i=2013~2015

$ESP_{i,BJ}$ — Total power supply in Beijing under policy scenario in year i

$SHA_{BJ}$ — Ratio of power supply from Beijing power production companies to total power supply in Beijing
Note: Assuming the ratio is constant to that of 2012 [34]

$EP_{2012,C}$ — Average fuel consumption intensity of coal generating units from 2010 to 2012

$EF_x$ — Emission factor of energy x
Note: x means coal for the former, and natural gas for the latter, refer to Table C.3 in Appendix C

$C_{i,j,x}$ — Emission control index of facilities using energy x in sector j in year i
Note: x means coal for the former, and natural gas for the latter, refer to Table C.5 in Appendix C

$SHA_{C,E}$ — Power supply share of coal generating units in year i

$EP_{2012,NG}$ — Average fuel consumption intensity of natural gas generating units from 2010 to 2012

$SHA_{NG,E}$ — Power supply share of natural gas generating units in year i

Formula(B.15): $T_{i,E}=HD_i\times(HP_{2012,C}\times EF_x\times SHA_{C,H}\times C_{i,j,x}$
$+HP_{2012,NG}\times EF_x\times SHA_{NG,H}\times C_{i,j,x})$

$T_{i,E}$ — $CO_2$ emission allowances of facilities in heating supply companies in year i
Note: i=2013~2015

$HD_i$ — Heating demand estimated under policy scenario in year i
Note: this value equals heating demand under the baseline scenario

$HP_{2012,C}$ — Average fuel consumption intensity of coal-fired heating supply units from 2010 to 2012

$EF_x$ — Emission factor of energy x
Note: x means coal for the former, and natural gas for the latter; refer to Table C.3 in Appendix C

$SHA_{C,H}$ — Ratio of heating supply from coal fired heating supply unit in year i

$C_{i,j,x}$ — Emission control index of facilities using energy x in sector j in year i
Note: x means coal for the former, and natural gas for the latter; refer to Table C.5 in Appendix C

$HP_{2012,NG}$ — Average fuel consumption intensity of natural gas fired heating supply units from 2010 to 2012

$SHA_{NG,H}$ — Ratio of heating supply from natural gas fired heating supply units in year i

Formula(B.16): $EC_{i,dif}=ECB_i\times SHA_{2012,t,ETS}\times(EP_{i,t,ETS}-EB_{i,t,ETS})/EB_{i,t,ETS}$

$EC_{i,dif}$ — Difference between Beijing power demands under the policy scenario and under the baseline scenario in year i
Note: i=2013~ 2015

$ECB_i$ — Power consumption of Beijing under the baseline scenario in year i

$SHA_{2012,t,ETS}$ — Ratio of indirect emissions from power consumption within the coverage of Beijing ETS to total indirect emissions of Beijing in 2012

$EP_{i,t,ETS}$ — Indirect emissions from power consumption within the coverage of Beijing ETS under the policy scenario in year i

$EB_{i,t,ETS}$ — Indirect emission from power consumption within the coverage of Beijing ETS under the baseline scenario in year i

Formula(B.17): $ESP_{i,ori}=(EN_{i,e}-EC_{i,dif})/(1-L_{ori})\times SHA_{ori}$

$ESP_{i,ori}$ — Power supply volume of Beijing local power sector or imported from external power grid under policy scenario in year i
Note: ori=BJ—local, or out—imported from external power grid

$SHA_{ori}$ — Ratio of power supply from Beijing local power sector or imported from external power grid to the whole power supply in Beijing in 2012
Note: ori=BJ—local, or out—imported from external power grid

$EN_{i,e}$ — Power consumption of Beijing under baseline scenario in year i

$EC_{i,dif}$ — Difference between Beijing power demands under policy scenario and baseline scenario in year i

$L_{ori}$ — Line loss rate
Note: ori=BJ—local; or out—imported from external power grid, the values are 6.54 and 5.92 percent separately

Formula(B.18): $EP_{i,t,ETS}=\sum_j(T_{i,j}\times SHAP_{2012,j,t,ETS})$

$EP_{i,t,ET}$ — Indirect emissions of power consumption in companies within the coverage area of Beijing ETS under the policy scenario of year i
Note: i=2013~2015

$T_{i,j}$ — $CO_2$ emission allowances of key emission institutions in sector j in year I under the policy scenario

$SHAP_{2012,j,t,ETS}$ — The ratio of indirect emissions to total emission of key emission institutions in sector j in 2012
Note: Assuming key emission institutions will reduce various types of emissions according to the emission ratio in 2012, and assuming there is no difference in emission reduction cost among various emission sources

Formula(B.19): $EF_{i,B,es}=EP_{i,C}\times EF_{C}\times SHA_{C,E}+EP_{i,NG}\times EF_{NG}\times SHA_{NG,E}$

| | |
|---|---|
| $EF_{i,B,es}$ | Emissions factor of electricity supply of Beijing's power industry under the baseline scenario |
| $EP_{i,C}$ | Baseline fuel consumption intensity of power supply in Beijing by coal-fired generating units |
| $EF_{C}$ | Emission factor of coal |
| $SHA_{C,E}$ | Ratio of power supply from coal fired generating units in year i |
| $EP_{i,NG}$ | Baseline fuel consumption intensity of power supply in Beijing by natural gas fired generating units<br>Note: Adopted the baseline fuel consumption intensity of power supply under policy scenario, the value equals to the average from 2010 to 2012 |
| $EF_{NG}$ | Emission factor of natural gas |
| $SHA_{NG,E}$ | Ratio of power supply form natural gas fired generating units in year i |

Formula(B.20): $EF_{i,P,es}=EP_{2012,C}\times EF_{x}\times SHA_{C,E}\times C_{i,j,x}$
$+EP_{2012,NG}\times EF_{x}\times SHA_{NG,E}\times C_{i,j,x}$

| | |
|---|---|
| $EF_{i,P,es}$ | Emissions factor of electricity supply of Beijing's power industry for year i under the policy scenario |
| $EP_{2012,C}$ | Average fuel consumption intensity of coal fired generating units from 2010 to 2012 |
| $EF_{x}$ | Emission factor of energy x<br>Note: x means coal or natural gas; refer to Table C.3 in Appendix C |
| $C_{i,j,x}$ | Emission control index of facilities using energy x in sector j in year i<br>Note: x means coal for the former, and natural gas for the latter; refer to Table C.5 in Appendix C |
| $SHA_{C,E}$ | Ratio of power supply from coal fired generating units in year i |
| $EP_{2012,NG}$ | Average fuel consumption intensity of natural gas fired generating units from 2010 to 2012 |
| $SHA_{NG,E}$ | Ratio of power supply from natural gas fired generating units in year i |

Formula(B.21): $ESB_{i,out}=(\sum_{j=1}^{n} EN_{i,j,e})/(1-L_{out})\times SHA_{out}$

| | |
|---|---|
| $ESB_{i,out}$ | Total power supply transferred to Beijing from external power grids for year i under the baseline scenario |
| $EN_{i,j,e}$ | Terminal power consumption in sector j of Beijing in year i |
| $L_{out}$ | Line loss rate of North China power grid |
| $SHA_{out}$ | Ratio of imported power supply to total power supply of Beijing in 2012 |

**Core Formula:**

Formula(2): $EP_i=\sum_j T_{i,j}$

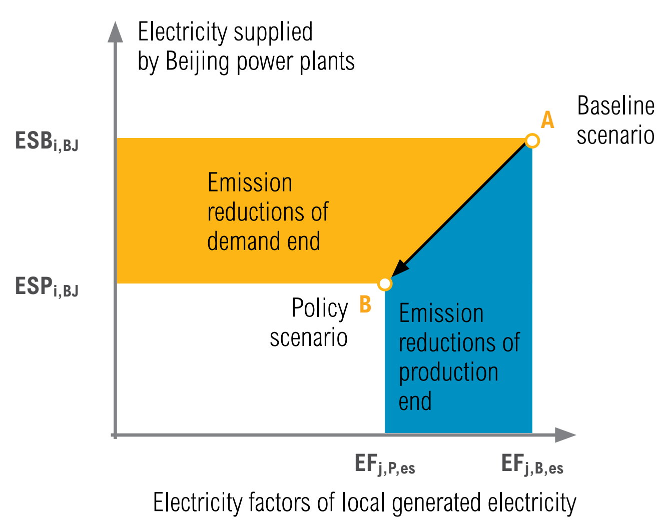
| Parameter | The baseline value used during the GHG assessment period | Methodologies and assumptions used in parameter estimation | Data source |
|---|---|---|---|
| $T_{i,j}$ | 68.27/67.68/ 66.36 $MtCO_2$ respectively from 2013 to 2015 | Referred to background formula (B.11) to (B.16) | Calculated by experts |

Formula(3): $Dif_{i,S}=(EF_{i,P,es}-EF_{i,B,es})\times(ESB_{i,BJ}+ESP_{i,BJ})/2$

Formula(4): $Dif_{i,D1}=(ESP_{i,BJ}-ESB_{i,BJ})\times(EF_{i,P,es}+EF_{i,B,es})/2$

| | |
|---|---|
| $Dif_{i,S}$ | Electricity-related emission reductions resulting from production-end management for year i |
| $EF_{i,P,es}$ | Emissions factor of electricity supply of Beijing's power industry for year i under the policy scenario |
| $EF_{i,B,es}$ | Emissions factor of electricity supply of Beijing's power industry under the baseline scenari |
| $ESP_{i,BJ}$ | Amount of electricity supplied by Beijing's power industry in year i under the policy scenario |
| $ESB_{i,BJ}$ | Amount of electricity supplied by Beijing's power industry for year i under the baseline scenario |
| $Dif_{i,D1}$ | Electricity-related emission reductions in Beijing's power industry resulting from demand-end management for year i |

## Figure B.2 | Illustration of Formulas (3) and (4)




Source: Authors
Note: point A represents the emission factor for electricity supply and power supply under the baseline scenario, and point B represents that factor under the policy scenario.

Formula(5): $Dif_{i,D2}=(ESP_{i,out}-ESB_{i,out})\times EF_{CDM}$

| | |
|---|---|
| $Dif_{i,D2}$ | Electricity-related emission reductions in North China Grid resulting from the demand end management for year i |
| $ESP_{i,out}$ | Total power supply transferred to Beijing from external power grids for year i under the policy scenario |
| $ESB_{i,out}$ | Total power supply transferred to Beijing from external power grids for year i under the baseline scenario |
| $EF_{CDM}$ | Baseline emission factor for regional power grid in China Note: the value adopted is average value (0.8040 $tCO_2$/MWh) of the operating margin factor $EF_{OM}$ and the build margin factor $EF_{BM}$ in 2013 |

## Table B.9 | Uncertainty

| Reporting Requirement | Reporting Content |
|---|---|
| The range of results from sensitivity analysis for key parameters and assumptions | Refer to "Uncertainty Analysis " in Section 3 |
| The method or approach used to assess uncertainty | Qualitative description and sensitivity analysis of key parameters |

# APPENDIX C PARTIAL DATA USED IN ASSESSMENT AND INTERMEDIATE RESULTS

This appendix gives the sources of data and shows part of the intermediate calculation results of the GHG emissions assessment of Beijing Emission Trading Scheme.

Table C.1 | **Value Added in Different Sectors in Beijing**

| Sector | Target |
|---|---|
| Primary Industry | *Beijing Modern Industry Construction and Development Plan in 12th Five-Year Plan Period* provides no clear target of primary industry. Thus, the value added in primary industry is calculated according to the growth rate of current annual value added. |
| Secondary Industry | |
| Sector of basic and new materials [a] | |
| Metallurgy field | The estimated total industrial output of Beijing's primary and new materials sector is Y 650 billion in 2015, with an annual growth rate of 5%. |
| Petrochemical field | Refinery scale should be limited to 10 million metric tons, and cement production scale to 7 million metric tons. |
| Construction material field | Total energy consumption of "above-scale enterprises" should be controlled within 18.4 million metric tons of standard coal. |
| Urban sector [b] | Food and beverage, clothing textile, printing and packaging, arts and crafts, cosmetics and personal care, furniture-manufacturing, stationery, lighting and home appliances, and plastics industries are estimated to achieve total industrial output of Y 210 billion in 2015, with an annual growth rate of 8%. |
| Equipment sector | Energy consumption of above-scale enterprises in the fields of new energy equipment, energy-saving and environmental protection equipment, and advanced manufacturing equipment should be limited to 1.6 million metric tons of standard coal. Total fresh water consumption should be limited to about 30 million cubic meters. |
| Construction sector | The construction scale in 2015 is estimated to be 850 million square meters. Beijing basically is an international aviation hub and the gateway to Asia. |
| Tertiary industry | The share of tertiary industry increased by average 1.1% per year over the past 10 years. This growth rate is relatively fast. |
| Software and information service sector [c] | The value added will account for 12% of local GDP in 2015, and energy consumption in unit value added decreased by 10%, with the total energy consumption limited to 2.1 million metric tons of standard coal. |
| Advanced technology sector | Annual growth rate of the advanced technology sector remains about 15%, and value added in 2015 reaches Y 500 billion, taking up 25% of gross regional production during the same time period.<br>Improvement has been made in industrial structure. The value added of advanced technology service sector should account for over 80% of that in the advanced technology sector. The advanced technology service sector would have a more obvious effect on tertiary industries. Key fields in strategic emerging industries, such as new generation information technology, bio-industry, energy-saving and environmental protection, will develop rapidly, and their shares in total value added of advanced technology sector will significantly increase. |
| Transportation sector | The proportion of public transportation used in full time travel aims to reach 50%, within which urban railway system aims to reach 50% of public transportation. |

Source: Authors. Data estimated based on related governmental plans.

Notes: a. Beijing Municipal Commission of Economy and Information Technology, December, 2011, "Beijing Basic and New Material Industry Adjustment and Development Working Plan during the 12th Five-Year Plan Period."

b. Beijing Municipal Commission of Economy and Information Technology, October, 2011, "Beijing Urban Industry Development Working Plan during the 12th Five-Year Plan Period."

c. Beijing Municipal Commission of Economy and Information Technology, August 2011, "Beijing Software and Information Service Development Working Plan during the 12th Five-Year Plan Period."

Table C.2 | **Energy-Saving Target Allocation Plan of Key Sectors during the 12th Five-Year Plan Period**

| Sector | Indicator | Unit | Targeted Value | Indicator Character |
|---|---|---|---|---|
| Agriculture, forestry, animal husbandry and fishery sector | Unit value added, energy consumption decreasing rate | percent | 8 | obligatory |
| | Total energy consumption by the end of the 12th Five-Year Plan period | 10,000 metric tons of standard coal | 125 | instructive |
| Industry | Unit value added, energy consumption decreasing rate | percent | 22 | obligatory |
| | Total energy consumption by the end of the 12th Five-Year period | 10,000 metric tons of standard coal | 2800 | instructive |
| Information transmission, computer service and software sector | Unit value added, energy consumption decreasing rate | percent | 10 | obligatory |
| | Total energy consumption by the end of the 12th Five-Year period | 10,000 metric tons of standard coal | 210 | instructive |
| Construction sector | Unit value added, energy consumption decreasing rate | percent | 10 | obligatory |
| | Total energy consumption by the end of the 12th Five-Year period | 10,000 metric tons of standard coal | 230 | instructive |
| Civil architecture | Power consumption decreasing rate of unit area in public buildings | percent | 10 | obligatory |
| | Energy conservation in building | 10,000 metric tons of standard coal | 620 | prospective |
| Real estate sector | Unit value added, energy consumption decreasing rate | percent | 15 | obligatory |
| | Total energy consumption by the end of the 12th Five-Year period | 10,000 metric tons of standard coal | 410 | instructive |
| Transportation, storage and post sector | Unit value added, energy consumption decreasing rate | percent | 10 | obligatory |
| | Total energy consumption by the end of the 12th Five-Year period | 10,000 metric tons of standard coal | 1600 | instructive |
| | Energy consumption decreasing rate of unit turnover of passenger vehicles' transportation | percent | 6 | obligatory |
| | Energy consumption decreasing rate of unit turnover for freight vehicles' transportation | percent | 12 | obligatory |
| Wholesale and retail sector | Unit value added, energy consumption decreasing rate | percent | 18 | obligatory |
| | Total energy consumption by the end of the 12th Five-Year period | 10,000 metric tons of standard coal | 320 | instructive |
| Leasing and business service sector | Unit value added, energy consumption decreasing rate | percent | 18 | obligatory |
| | Total energy consumption by the end of the 12th Five-Year period | 10,000 metric tons of standard coal | 370 | instructive |
| Accommodation and catering services sector | Unit value added, energy consumption decreasing rate | percent | 18 | obligatory |
| | Total energy consumption by the end of the 12th Five-Year Plan Period | 10,000 metric tons of standard coal | 270 | instructive |

Table C.2 | **Energy-Saving Target Allocation Plan of Key Sectors during the 12th Five-Year Plan Period**

| Sector | Indicator | Unit | Targeted Value | Indicator Character |
|---|---|---|---|---|
| Financial Sector | Unit value added, energy consumption decreasing rate | percent | 10 | obligatory |
| | Total energy consumption by the end of the 12th Five-Year period | 10,000 metric tons of standard coal | 70 | instructive |
| Public Institutions | Energy Consumption reduction rate per unit of construction area | percent | 12 | obligatory |
| | Total energy consumption by the end of the 12th Five-Year period | 10,000 metric tons of standard coal | 200 | instructive |
| Whereby: Education | Energy consumption reduction rate per student | percent | 17 | obligatory |
| | Total energy consumption by the end of the 12th Five-Year period | 10,000 metric tons of standard coal | 65 | instructive |
| Whereby: Hygiene | Energy Consumption decreasing rate per unit of construction area | percent | 8 | obligatory |
| | Total energy consumption by the end of the 12th Five-Year period | 10,000 metric tons of standard coal | 33 | instructive |
| Other public institutions | Energy Consumption reduction rate per unit of construction area | percent | 12 | obligatory |
| | Total energy consumption by the end of the 12th Five-Year period | 10,000 metric tons of standard coal | 102 | instructive |
| Heating Supply | Energy Consumption reduction rate of space heating per unit of construction area12th Five-Year period | percent | 12 | obligatory |
| Power supply | The share of power saving in the total social power sale of last year | percent | 0.3 | obligatory |

Source: Beijing Municipal Government, 2011, "Notice of Issuing Beijing's Comprehensive Working Plan for Energy Conservation and Climate Change Tackling during the 12th Five-Year Plan Period."

Table C.3 | **$CO_2$ Emission Factors of Various Forms of Energy Used in Beijing**

Unit: kilograms of $CO_2$ per kilograms of standard coal ($kgCO_2/kgce$)

| Coal | Coke | Petroleum Products | Natural Gas | Power |
|---|---|---|---|---|
| 2.64 | 3.15 | 2.07 | 1.63 | 4.82 |

Source: Beijing Municipal Commission of Development and Reform, November, 2014, "Beijing Corporate (Organization) $CO_2$ Emission Accounting and Reporting Guidance,"(2014 Edition) National Center for Climate Change Strategy and International Cooperation. October, 2013, "The Average $CO_2$ Emission Factors of China Regional and Provincial Grids in 2010."
Note: These emission factors were calculated by referring to the emission factors adopted in Beijing ETS's corporate emission accounting method. The emission factor for "power," also called the "emission factor for imported electricity," was calculated by multiplying the average emission factor of the North China grid in 2010 (0.8845 kg $CO_2$/kWh) published by the National Development and Reform Commission in 2013 by the share (67 percent) of imported power in the total Beijing power consumption for 2012. The 67 percent share of imported power was calculated according to the energy balance sheet in Beijing Statistical Yearbook 2013.

## Table C.4 | Carbon Dioxide Emissions in Beijing by Sector, 2015

Unit: 10,000 metric tons of $CO_2$

| 2015 | Coal | Oil | Natural Gas | Power | Total |
|---|---|---|---|---|---|
| Agriculture | 88 | 29 | 0 | 91 | 208 |
| Industry | 956 | 1,351 | 240 | 1,662 | 4,210 |
| Construction | 22 | 149 | 14 | 210 | 394 |
| Service | 523 | 2,411 | 663 | 2,682 | 6,279 |
| Household consumption | 448 | 991 | 275 | 1,155 | 2,869 |
| Electricity generation | 424 | 17 | 1,317 | | 1,757 |
| Heating Supply | 747 | 83 | 769 | | 1,599 |
| Total | | | | | 17,316 |

Source: Authors.
Note: Subtle differences may exist between the sum of disaggregated data and the aggregated data because of rounding.

## Table C.5 | Annual Emission Control Index for Various Sectors in Beijing

| Allowance Accounting Method | Sectors or Facilities | 2013 | 2014 | 2015 |
|---|---|---|---|---|
| Based on historical total emissions | Enterprises of manufacturing and other industrial sectors | 98% | 96% | 94% |
| | Enterprises (or institutions) in the service sector | 99% | 97% | 96% |
| Based on historical emission intensity | Natural gas fired facilities in thermal generation enterprises | 100% | 100% | 100% |
| | Coal fired facilities in thermal generation enterprises | 99.9% | 99.7% | 99.5% |
| | Natural gas fired facilities in heating supply enterprises (or institutions) | 100% | 100% | 100% |
| | Coal fired facilities in heating supply enterprises (or institutions) | 99.8% | 99.5% | 99.0% |

Source: Beijing Municipal Commission of Development and Reform, 2013, “Beijing Pilot Emission Trading Scheme Allowance Ratification Method (Provisional).”

# APPENDIX D KEY PERFORMANCE INDICATORS: MONITORING PLAN AND CURRENT SITUATIONS

This appendix lists key performance indicators identified in Section 4 (finance, licensing and procurement, information monitoring, and compliance and enforcement), as well as their monitoring plan and current situations for Beijing Emission Trading Scheme.

These tables provide a reference for setting up a tracking system for monitoring implementation of Beijing ETS. The information is current as of August 5, 2014.

Table D.1 | **Finance: Indicators and Current Status**

| Input Function | Responsible Authority | Source of Funds | Indicator | Status | Data Source | Tracking Frequency |
|---|---|---|---|---|---|---|
| Support infrastructure construction (carbon trading registry system, GHG reporting system) | Beijing Economic Information Center | Fiscal allocation | Capital committed to support infrastructure construction | No available information | Beijing Municipal Commission of Development and Reform (Beijing MCDR) Website | Three times, according to the progress of the project |
| Support infrastructure construction (electronic trading platform) | China Beijing Environment Exchange (CBEEX) | Fiscal allocation | Capital committed to support infrastructure | No information available | Same as above | Same as above |
| Support company capacity building, including subsidy for corporate GHG emission report verification and carbon market training | Beijing MCDR | Fiscal allocation | Capital used for company capacity building | No information available | Same as above | Same as above |
| Supporting carbon market development, including random check of corporate GHG emission reports, and release of pilot ETS management methods and detailed rules | Beijing MCDR | Fiscal allocation | Capital used to support the carbon market development | No information available | Same as above | Same as above |
| Support basic research on carbon trading, including research on advanced value of GHG emission intensity of products (or services) of key industries | Beijing MCDR | Fiscal allocation | Capital used to support basic research on carbon trading | No information available | Same as above | Same as above |
| Support development of offsetting methodologies and piloting offset projects, including the development of offsetting methodologies of energy savings and carbon sinks, and policies for voluntary emission-reduction trading | Beijing MCDR | Fiscal allocation | Capital used for methodology development and operation of piloting offset projects | No information available | Same as above | Same as above |
| Buyback emission allowances to adjust carbon prices | Beijing MCDR | Fiscal allocation | Capital reserved for emission allowance buyback | No information available | Same as above | Monitor when the buyback occurs |

Source: Beijing Municipal Government, 2014, "Management Measures of Beijing Emission Trading Scheme (Trial)."
Notes: In this table, projects for which Beijing MCDR is listed as the responsible authority are actually financially managed by Beijing Economic Information Center under the commission of Beijing MCDR. The appropriation of fiscal funds is often conducted three times along the process: the initiation stage, the interim reporting stage, and the final reporting stage. Therefore, we recommend that monitoring follows this course. Some projects may receive a fourth appropriation after their project result quality inspection; in this case, we recommend conducting monitoring a fourth time.
Information about funding allocation status is not currently available to the public. We recommend monitoring mainly the information on the Beijing MDCR website.
Information in this table was updated to August 5, 2014.

Table D.2 | **Licensing, Permitting, Procurement: Indicators and Current Status**

| Administrative Function | Responsible Authority | Indicator | Status | Data Source | Monitoring Frequency |
|---|---|---|---|---|---|
| Identify and publish lists of key emission institutions and reporting institutions regularly | Beijing Municipal Commission of Development and Reform (Beijing MCDR), Beijing Municipal Bureau of Statistics | A list of key emission institutions and a list of reporting institutions published by Beijing MCDR every year | Lists of key emission institutions and reporting institutions for 2014 have been published | Beijing MCDR website | Annually |
| Verify and allocate emission allowances to existing facilities of key emission institutions | Beijing MCDR | Allowances that have been allocated for the current compliance year | 2014 allowances were allocated by June 30, 2014; however the amounts of the allowances allocated were not disclosed | Beijing MCDR website | Annually |
| Verify and allocate adjusted emission allowances to existing facilities of key emission institutions | Beijing MCDR | Adjusted allowances that have been allocated before the next compliance deadline | No publicly available information | None | Annually |
| Verify and allocate emission allowances for new facilities of key emission institutions before the next compliance deadline | Beijing MCDR | Allowances that have been allocated to new facilities before the next compliance deadline | Information about allowances allocated to new facilities before the 2014 compliance deadline was not disclosed | Beijing MDRC website | Annually |
| Approve China Certified Emission Reduction (CCER) and other offset projects | National Development and Reform Commission (NDRC), Beijing MCDR | Number of CCER projects and other offset projects that have been approved and publicized | Nearly 19 approved CCER projects have been publicized between Aug 19, 2014 and Sep 11, 2014. Before that, 301 projects had been approved; 1 forestry carbon sink project has been registered. | China Certified Emission Reduction Exchange Info-Platform,[a] Beijing Forestry Carbon Sink Project Comprehensive Management Platform[b] | Monitor according to CCER projects' general process |
| Publicize monitoring reports of CCER projects and other offset projects | NDRC, Beijing MCDR | Number of monitoring reports of offset projects that have been publicized | From August 19, 2014 to September 10, 2014, monitoring plans for 10 CCER projects were being publicized. Before that, monitoring plans for 22 CCER projects were publicized | Same as the above | Monitor according to offset projects' general process |
| Issue carbon offsets of CCER projects and other offset projects | NDRC, Beijing MCDR | Carbon offsets that have been issued | No public information available | Same as the above | Monitor according to offset projects' general process |

Sources: Beijing Municipal Government, 2014, "Management Measures of Beijing Emission Trading Scheme (Trial)."
Beijing Municipal Commission of Development and Reform MCDR), 2013, "Notice of Beijing Municipal Commission of Development and Reform on Launching Carbon Dioxide Emission Reporting and Third-Party Verification."
Beijing MCDR, 2013, "Notice of Beijing Municipal Commission of Development and Reform on Carrying out the Emission Trading Scheme Pilot Work."
Beijing MCDR, 2014, "Measures of Open Market Operation and Management in Beijing Carbon Emission Trading (Trial)."
Beijing MCDR, 2014, "Provisions on Administrative Penalty Discretion in Carbon Emission Trading."

Notes: Information in this table was updated to August 5, 2014.
a. China Certified Emission Reduction Exchange Info-Platform: http://cdm.ccchina.gov.cn/ccer.aspx.
b. Beijing Forestry Carbon Sink Project Comprehensive Management Platform: http://register.bcs.gov.cn/.

Table D.3 | **Information Collection and Tracking: Indicators and Current Status**

| Administrative Function | Responsible Authority | Indicator | Status | Data Source | Monitoring Frequency |
|---|---|---|---|---|---|
| Collect emission reports and third-party verification reports of key emission institutions every year | Beijing Municipal Commission of Development and Reform (Beijing MCDR ) | Number of emission reports collected from key emission institutions | From March to July, 2014, the government supervised the status of emission reports and verification reports submitted by key emission institutions[a] The submission status of 2013 was not disclosed | Beijing MCDR website | Annually |
| Collect annual carbon emission monitoring plan from key emission institutions | Beijing MCDR | Number of monitoring plans collected from key emission institutions | Implementation information was not discloseda | Website of Beijing municipal government | Annually |
| Collect annual emission data from reporting institutions | Beijing MCDR | Number of emission reports collected from reporting institutions | From March to July of 2014, the government supervised the submission status of emission reports from reporting institutions. As of June 13, 2014, 140 reporting institutions had not submitted emission reports.[b] | Beijing MCDR website, Clean Development Mechanism in China website | Annually |
| Monitor the market operation status | Beijing MCDR, China Beijing Environment Exchange (CBEEX) | Number of carbon market reports that are published every week | Thirty weekly reports on Beijing carbon emission trading were published between January 13, 2014 and August 1, 2014 | Beijing carbon emission trading e-commerce platform | Weekly |
| Monitor and report overall effect of Beijing ETS policy | Beijing MCDR | Publish or submit a policy assessment report to superior department | No published information available | None | Monitor when Beijing ETS pilot completes |

Sources: The same as Table D.2.
Notes: Information in this table was updated to August 5, 2014.

a. Beijing MCDR Website, March 15, 2014, Notice of Beijing MCDR on Launching 2014 Carbon Emission Reporting Verification and Compliance Supervision. http://www.bjpc.gov.cn/tztg/201404/t7527126.htm

b. Clean Development Mechanism in China website, June 17, 2014, "Beijing Government Issued Notice to Urge Compliance, However a Group of Key Emission Institutions Have Not Even Opened Carbon Emission Accounts," http://cdm.ccchina.gov.cn/Detail.aspx?newsId=46736&TId=1; and
Beijing Business Today, June 13, 2014, 140 Beijing Companies Didn't Report Carbon Emissions on Time: http://www.bjbusiness.com.cn/site1/bjsb/html/2014-06/13/content_258972.htm?div=-1.

## Meaning of Compliance

Before June 15 of each year, key emission institutions are required to turn in emission allowances that equal their carbon emissions of the previous year, and to meet the carbon emission control obligations. Key emission institutions can partially offset carbon emissions by purchasing certificated carbon emission offsets, which can account for up to 5 percent of their emission allowances for that year.

Reporting institutions must submit annual carbon emission reports to the Beijing Municipal Commission of Development and Reform (Beijing MCDR) before the deadline.

## Penalties for Noncompliance

Companies who fail to submit emission reports or third-party verification reports on time face a fine of Y 30,000–Y 50,000, and companies who do not surrender their emission allowances by the deadline face a fine of three to five times the average carbon market price. These penalties are spelled out in "Beijing MCDR's Provisions on Administrative Penalty Discretion in Carbon Emission Trading", which was formulated based on the authority of the "Law of the People's Republic of China on Administrative Penalty," and the "Decision of the Standing Committees of the People's Congress of Beijing Municipality on Launching Carbon Emission Trading Pilots with a Strict Control of the Total Emissions."

Table D.4 | **Table D.4 Compliance and Enforcement: Indicators and Current Status**

| Responsible Authority | Administrative Function | Indicator | Status | Data Source | Monitoring Frequency |
|---|---|---|---|---|---|
| Beijing Municipal Commission of Development and Reform (Beijing MCDR) | Notify reporting institutions who have not submitted their report on time | Number of reporting institutions who have not submitted emission reports | On April 24, 2014, Beijing MCDR urged 439 reporting companies to submit emission reports before April 28. Information is not available on how many of these companies submitted emission reports. | Beijing MCDR website | Annually |
| Beijing MCDR | Monitor and manage compliance processes of key emission institutions | Compliance ratio of key emission institutions | The compliance ratio for 2013 was 97.1% | Beijing MCDR website | Annually |
| Beijing MCDR, Beijing Energy Conservation Supervision Group | Impose fines on key emission institutions that have not fulfilled compliance obligations by June 15 each year. (If companies comply within 10 days after the deadline, no penalty is imposed) | Number of key emission institutions that are fined | Fines were imposed on 12 companies that did not comply with ETS requirements in 2013 | Beijing MCDR website | Annually |
| Beijing MCDR | Impose fines on reporting institutions that fail to submit emission reports before April 15 every year. | Number of reporting institutions that are fined | No information available | None | Annually |
| Beijing MCDR | Disclose the violations of key emission institutions and third-party verifiers; submit this information to the corporate credit information system | Number of violation notices to key emission institutions and verifiers | No information available | None | Annually |

Source: Beijing Municipal Commission of Development and Reform, 2014, "Provisions on Administrative Penalty Discretion in Carbon Emission Trading."
Note: Information in this table was updated as of August 5, 2014.

Table D.5 | **Other Administrative Activities: Indicators and Current Status**

| Administrative Function | Responsible Authority | Indicator | Status | Data Source | Monitoring Frequency |
|---|---|---|---|---|---|
| Build companies' capacities to report GHG emissions and participate in carbon market | Beijing Municipal Commission of Development and Reform (Beijing MCDR) | Number of trainings and participants | Conducted eight trainings and trained about 2,000 technical staff and officers from key emission institutions and administrators at various levels | Beijing MCDR website | Annually |
| Supervise and check the emission reports , third- party verification reports, and the emission control situations of key emission institutions | Beijing MCDR | Ratio of verification reports that are checked by Beijing MCDR | Beijing MCDR did not disclose the supervision results of the emission reports and verification reports of key emission institutions in 2013 | Beijing MCDR website | Annually |
| Organize expert team to resolve disputes about verification reports submitted by key emission institutions | Beijing MCDR | Number of disputed third-party verification reports that were reexamined and resolved | Some companies questioned third-party verification reports and applied to correct historical emissions data,[a] how these cases were resolved was not disclosed. | Beijing MCDR website | Annually |
| Monitor carbon trading prices, and intervene in market price when necessary | Beijing MCDR, Beijing Research Center for Climate Change, Finance Bureau of Beijing, Beijing Municipal Bureau of Finance Work | Intervention is needed when the daily weighted average price for 10 consecutive trading days is higher than Y 150 or lower than Y 20 per metric ton. Indicators are the numbers of auctions or buybacks conducted by MCDR and the amount of related allowances | As of August 5, 2014, Beijing carbon market price had not yet triggered a buyback or auction[b] | Beijing Carbon Emissions Electronic Trading Platform | Several times a year, according to the carbon market situation |
| Regularly organize and monitor trade settlement and delivery activities | Beijing Municipal Bureau of Finance Work, Beijing MCDR | The number of transactions settled and delivered under supervision | No information available | None | Annually |
| Arbitrate disputes in carbon trading | Beijing MCDR | Number of trade disputes resolved via arbitration | No direct information available on whether trade disputes have occurred or if MCDR has arbitrated disputes | None | Annually |

Source: The same as Table D.2.
Note: Information in this table was updated as of August 5, 2014.
a. Idea Carbon, March 10, 2014, Beijing companies can apply for recheck on the controversial carbon emission accounting reports, http://ideacarbon.org/archives/19430
b. Carbon trading volume and prices in Beijing ETS,
http://www.bjets.com.cn/trans/jydt/index/trans-deal-erver-day.jsp?prodCateId=95182#

# REFERENCES

Barua, P., Fransen, T., Wood, D. 2014. Climate Policy Implementation Tracking Framework. World Resources Institute, Washington, DC. http://wri.org/publication/climate-policy-tracking.

Beijing Municipal Commission of Development and Reform. 2013. "Beijing Pilot Emission Trading Scheme Allowance Ratification Method (Provisional)."

Beijing Municipal Government. 2011. "Beijing Municipal Plan of Energy Conservation, Consumption Reduction and Tackling Climate Change during the 12th Five-Year Plan Period."

The Central People's Government of the People's Republic of China. 2011. 12th Five Year Plan for National Economic and Social Development.

European Commission. 2005. "Impact Assessment Guidelines." http://ec.europa.eu/agriculture/sfs/documents/documents/sec2005-791_en.pdf (accessed July 28, 2014).

Fransen, T., Cronin, C. 2013. "A Critical Decade for Climate Policy: Tools and Initiatives to Track Our Progress." World Resources Institute, Washington, DC. wri.org/publication/criticaldecade-for-climate-policy-tools-and-initiatives-to-track-ourprogress

IPCC. 2014. "Summary for Policymakers." In: Climate Change 2014, Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York. http://report.mitigation2014.org/spm/ipcc_wg3_ar5_summary-for-policymakers_approved.pdf

State Council. 2013. "Interim Assessment Report of the State Council on the Implementation of 12th Five Year Plan for National Economic and Social Development of the People's Republic of China."

State Grid Energy Research Institute. 2013. "The Study of Policies on Controlling Total Energy Consumption." http://www.sgeri.sgcc.com.cn/html/sgeri/col1080000042/2013-12/09/20131209175735971298301_1.html

Jiang, K., Hu, X., et al. 2008. "The Analysis of China Energy and GHG Emission Scenarios and Emission Reduction Cost." Included in Beijing Forum (2008), "The Harmony of Civilizations and Prosperity for All--The Universal Values and Development Trends of Civilization," session on "Ecological Civilization: The Environment, Energy and Social Progress." Environmental branch forum proceedings or abstract book.

Liu, D. 2005. "The Analysis of Consolidation Baseline Methodology for Approved Renewable Energy Grid-Connected Projects." 2004 revision. http://cdm.ccchina.gov.cn/Detail.aspx?news-Id=4331&TId=20

Qi, Y., Dong, W.J., Cai, Q., Chai, Y.H., Gong, M.J., Hu, S., et al.  2012. Annual Review of Low-Carbon Development in China (2011-2012). Social Sciences Academic Press (China).

World Resources Institute. 2014. Greenhouse Gas Protocol: Policy and Action Standard. Washington, DC.

http://www.wri.org/publication/policy-and-action-standard

# ENDNOTES

1. More information on EEA Environmental Policy Assessment can be found at http://www.eea.europa.eu/themes/policy/eea-activities.

2. The Reporting on Environmental Measures (REM) project of EEA is dedicated to working toward "powerful and effective" EU environmental policies. Achievements of this project include Report on Environmental Measures: Are our policies effective? (2001), case research, and research on assessment methodologies of policy effectiveness. For detailed information on this project, see http://www.eea.europa.eu/publications/rem/page001.html.

3. Germany's Umweltbundesamt mentioned its work on policy assessment in "Climate Protection and Energy Policy in Germany" at http://www.umweltbundesamt.de/en/topics/climate-energy/climate-protection-energy-policy-in-germany.

4. For more information on the energy and climate policy assessment of DECC, see https://www.gov.uk/government/policies/using-evidence-and-analysis-to-inform-energy-and-climate-change-policies.

5. DECC's guiding principle for evaluation and evaluation planning template are at https://www.gov.uk/government/policies/using-evidence-and-analysis-to-inform-energy-and-climate-change-policies/supporting-pages/monitoring-and-evaluation.

6. The Magenta Book was edited by the UK Treasury. For details, see https://www.gov.uk/government/publications/the-magenta-book.

7. U.S. EPA has evaluated the different options, costs, and benefits of climate policies. For details, see http://www.epa.gov/climatechange/EPAactivities/economics.html.

8. For example, U.S. EPA set up 10 scenarios based on the American Power Act of 2010, and assessed the multiple impacts of implementation. The assessment considered the impacts of the act on the concentration of GHGs and global mean temperature, the economic costs of GHG emissions, the energy and technology structure of the power industry, and the price and consumption of electricity and their growth trends. This report also analyzes and discusses the source of uncertainty in economic impact assessment.

9. Australia Government Climate Change Authority website: http://www.climatechangeauthority.gov.au/.

10. In the Law on Appraising of Environment Impacts (2003), "designation plan" refers to the plan on land use, plans for regions, river basins, and sea areas' construction and exploitation; and specified plans for industry, agriculture, husbandry , forestry, energy, conservancy , transportation, urban construction, travel, and natural resources.

11. The Regulation on Environmental Impact Assessment of Planning pointed out the need to create an information sharing system to conduct ex-ante environmental impact assessments of comprehensive plans that have environmental impacts, and to monitor and conduct ex-post assessment of the execution of plans that have significant environmental impacts.

12. The Interim Measures for the Administration of National Special Planning also requires departments to strengthen tracking and monitoring in the process of making assessments.

13. Ministry of Finance of the People's Republic of China, April 2, 2011, Notice of Issuing "Interim Measures for the Administration of Performance Evaluation of Fiscal Expenditure," http://yss.mof.gov.cn/zhengwuxinxi/zhengceguizhang/201104/t20110418_538358.html

14. There are no clear assessment requirements in the report for specific climate change plans in the 12th Five-Year Plan. State Council, 2013, "Interim Assessment Report of the State Council on the Implementation of 12th Five Year Plan for National Economic and Social Development of the People's Republic of China."

15. The latest report is the "2014 Annual Report on China's Policies and Actions on Climate Change," November 26, 2014, National Development and Reform Commission (NDRC), http://www.sdpc.gov.cn/gzdt/201411/t20141126_649615.html.

16. The Annual Report on China's Policies and Actions on Climate Change includes industrial structure, energy efficiency, energy structure, agriculture, forestry, ecosystems, water resources, ocean, and meteorological fields.

17. Certified emission reductions include voluntary emission reductions certified by the National Development and Reform Commission (NDRC) or Beijing Municipal Commission of Development and Reform (Beijing MCDR), and emission reductions from qualified energy conservation projects and forestry carbon sink projects, measured in metric tons of $CO_2$ equivalent ($tCO_2e$).

18. Direct $CO_2$ emissions refer to $CO_2$ emissions from fossil fuel combustion of fixed facilities within the Beijing administrative region, or $CO_2$ emissions from industrial processes (including calcium carbonate and carbonate magnesium decomposition emissions from clinker production processes and industrial processing of petrochemical products), or $CO_2$ emissions from waste disposal. Indirect $CO_2$ emissions refer to $CO_2$ emissions from fossil fuel combustion for electricity production for facilities' electricity consumption within the Beijing administrative region.

19. The Beijing Carbon Emission Trading Pilot Scheme has achieved significant effects. See http://www.bjpc.gov.cn/gzdt/201409/t8284787.htm.

20. Refer to National Development and Reform Commission, 2005, "Notice of NDRC on Issuing Methods for Reforming Electricity Pricing."

21. These data are based on expert estimations. Indirect emissions are included in total emissions.

22. Beijing Municipal Government, August 2011, "Beijing Climate Change, Energy Saving and Consumption Reducing Plan during the Twelfth Five-Year Plan."

23. General Office of Beijing Municipal Government, August 12, 2013, "2013-2017 Working Plan for Accelerating Reduction in Coal Use and Development of Clean Energy in Beijing."

24. Beijing MCDR, 2011, "Beijing Energy Development and Construction Working Plan during the 12th Five-Year Plan Period."

25. Beijing MCDR, December 2011, "Beijing Heat Supply Development and Construction Plan during the 12th Five Year Plan."

26. Beijing Municipal Government, 2011, "12th Five-Year Plan for National Economic and Social Development in Beijing."

27. Key energy consumption companies are companies whose annual energy consumption reaches a certain benchmark (e.g., total energy consumption equal to or higher than 5,000 metric tons of standard coal in 2010). In this case, the key energy consumption companies were selected based on their energy consumption during 2009 – 2012 and on whether primary estimates of their $CO_2$ emissions were equal to or higher than 10,000 metric tons. Key emission institutions are recruited from this list of key energy consumption companies. See "Notice of Beijing Municipal Commission of Development and Reform on Launching Carbon Dioxide Emission Reporting and Third-Party Verification." http://www.bjpc.gov.cn/tztg/201308/t6508700.htm.

28. Estimate of relevant Beijing ETS expert.

29. Sina Finance, April 7, 2014, "Beijing Intended to Impose the Fines on Five Non-Compliance Companies Including Microsoft," http://finance.sina.com.cn/chanjing/gsnews/20140704/005619601721.shtml.

30. A policy's non-GHG impacts, such as encouraging technological advancement and creating employment opportunities, have not yet been considered.

31. The figure is calculated based on data from China Energy Year Book 2013 Table 4-3. The process is: to convert electricity consumption data that were estimated using calorific value calculation method to value of coal equivalent calculation method which taking into account to the conversion efficiency of thermal power generation.

32. Due on July 18, 2014. Data source: Carbon Market, 2014 Summer Issue, http://images.bjets.com.cn/www/201408/20140813142314244.pdf.

33. We had no data for the current average emission intensity of each subsector in the service industry. Thus, we used the data from the past five years to extrapolate the average reduction rate of the carbon emission intensity in Beijing's tertiary industry, which is 5 percent. Based on this estimate, experts suggested that the reduction rate of the advanced value of emission intensity of Beijing's tertiary industry should be 10 percent. If other researchers have access to historic average emission intensity of each subsector in tertiary industry covered by Beijing ETS, they could compare these average data with the advanced values of emission intensities issued by the government to get a better estimate of the reduction rate of the advanced value of the whole service industry.

34. According to Beijing Energy Development and Construction Working Plan during the 12th Five-Year Plan Period, local power generation installed capacity will reach 10GW in 2015, and the ratio of power supplied by local sources will reach about 35 percent.

## ABOUT THE AUTHORS

**Jingjing Zhu** is a Research Analyst of WRI China Climate.
Contact: jzhu@wri.org

**Yu Wang** is an Associate Researcher and Doctor in Institute of Energy, Environment and Economy, Tsinghua University.
Contact: y-wang@tsinghua.edu.cn

**Ranping Song** is team lead of WRI China Climate.
Contact: rsong@wri.org

## ACKNOWLEDGEMENTS

Special thanks to external reviewers for their important contributions. Reviewers generously gave of their time, providing important perspectives and valuable insights. They include:

| | |
|---|---|
| **Zhaoli Jiang** | Climate Change Department of the National Development and Reform Commission |
| **Shuang Zheng** | National Center for Climate Change Strategy and International Cooperation |
| **Hong Gao** | Shenzhen Urban Development Research Center |
| **Qing Tong** | Institute of Energy, Environment and Economy, Tsinghua University |

Special thanks also to Xiang Gao of National Development and Reform Commission Energy Research Institute and Yiqiong Lu of ShenHua Group for their valuable suggestions. Special thanks also to the following colleagues for providing invaluable insight and assistance: Lailai Li, Janet Ranganathan, Guiyang Zhuang, Su Song, Hua Wen, Xiaoqian Jiang, Min Yuan, Ziwei Mao, David Rich, Taryn Fransen, Lei Yin, Jing Song and Hyacinth Billings. Thanks also to interns for their support: Zheng Wang, Jiahui Ying, Rebecca Wong, Haiying Sun, Yang Yang. Thanks to Yamin Wang, Mary Paden and Ye Zhang for their efforts in editing and layout.

## ABOUT WRI

WRI focuses on the intersection of the environment and socio-economic development. We go beyond research to put ideas into action, working globally with governments, business, and civil society to build transformative solutions that protect the earth and improve people's lives.

**Solutions to Urgent Sustainability Challenges**
WRI's transformative ideas protect the earth, promote development, and advance social equity because sustainability is essential to meeting human needs today, and fulfilling human aspirations tomorrow.

**Practical Strategies for Change**
WRI spurs progress by providing practical strategies for change and effective tools to implement them. We measure our success in the form of new policies, products, and practices that shift the ways governments work, businesses operate, and people act.

**Global Action**
We operate globally because today's problems know no boundaries. We are avid communicators because people everywhere are inspired by ideas, empowered by knowledge, and moved to change by greater understanding. We provide innovative paths to a sustainable planet through work that is accurate, fair, and independent.

## ABOUT INSTITUTE OF ENERGY, ENVIRONMENT AND ECONOMY, TSINGHUA UNIVERSITY

Institute of Energy, Environment, and Economy, Tsinghua University (3E), established in 1980, is a university-wide interdisciplinary research and education institution, and a joint initiative of Institute of Nuclear and New Energy Technology, Tsinghua University and School of Economics & Management, Tsinghua University. 3E is among the pioneers in terms of research on energy systems analysis and climate change among Chinese universities. 3E creates, develops and disseminates the knowledge, ideas and methodologies needed for building sustainable energy systems and climate change mitigation, and provides scientific solutions to sustainable energy system transformation and low carbon development for China and the world.


WITH SUPPORT FROM:

ALCOA FOUNDATION

ClimateWorks FOUNDATION

On behalf of

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

of the Federal Republic of Germany