

# ADB

## Technical Assistance Consultant's Report

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Project Number: 49388-001  
December 2020

### People's Republic of China: Developing Cost-Effective Policies and Investments to Achieve Climate and Air Quality Goals in the Beijing-Tianjin-Hebei Region

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For: The Ministry of Industry and Information Technology, and the Asian Development Bank

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## Acronyms and Abbreviations

ADB	Asian Development Bank
BTH	Beijing-Tianjin-Hebei
CCID	China Center for Information Industry Development
CO <sub>2</sub>	Carbon Dioxide
CP	Current Policies
C-REM	China Regional Energy Model
EGA	Environmental Goals Attainment
NDC	Nationally Determined Contributions
MEE	Ministry of Ecology and Environment
MIIT	Ministry of Industry and Information Technology
PM <sub>2.5</sub>	Fine Particulate Matter
PRC	People's Republic of China
REACH	Regional Emissions Air-quality Climate and Health
TA	Technical Assistance

# 1 Executive Summary

The Beijing-Tianjin-Hebei (BTH) and its surrounding areas are one of the most polluted regions in the People's Republic of China (PRC), with high average annual fine particulate matter (PM<sub>2.5</sub>, particulate matter with a mean aerodynamic diameter of 2.5 µm or less) concentrations and high carbon dioxide (CO<sub>2</sub>) emissions. The region is subject to more stringent air pollution and CO<sub>2</sub> emission controls than other regions in the PRC. Ongoing control efforts in the region have improved air quality substantially, but there is still a long way to go. Integrated solutions are needed to address the region's air pollution and climate change because the same underlying fossil emissions sources contribute to both problems.

Launched under the cooperation framework of the Ministry of Industry and Information Technology (MIIT) and the Asian Development Bank (ADB), this research project has been carried out by Tsinghua University. The study develops climate and air quality goals for the BTH and Shandong region through 2035 and identifies a package of policies that can achieve these goals. An integrated modeling framework is used to evaluate the effects of these policies on the economy, the environment, and human health.

The technical assistance (TA) outputs are (i) the adequacy of the model framework has been assessed and improved; (ii) constraints for effective policy implementation have been analyzed and synthesized; (iii) interplays of climate and air quality co-benefits in the BTH region and their sequencing have been assessed; and (iv) a set of policy recommendations and investment choices for the BTH region have been prepared.

Policy scenarios are simulated using the Regional Emissions Air-quality Climate and Health (REACH) framework. Within this research, the REACH framework integrates an energy-economic model, the China Regional Energy Model (C-REM), with a Chinese emission inventory and an air quality simulation model. Relative to prior applications of the REACH framework, the version used for this analysis includes several improvements: 1) the updating of the C-REM's benchmark provincial input-output data with the latest available data (2012) to replace the 2007 benchmark data used in earlier versions; 2) the disaggregation of 13 production sectors in the original version into 21 production sectors within each region to better resolve energy-intensive industries; 3) the adoption of a newer version of Chinese emissions inventory, with a more detailed resolution of regions, pollutants, and technologies; 4) the calibration of diffusion possibilities for end-of-pipe control technologies by sector to reflect prior adoption status; 5) the updating of the module that captures the health impacts of air pollution; and 6) the incorporation of uncertainties associated with different health valuation methods.

The TA consultant team ran several scenarios, which vary with the application of two broad categories of interventions: energy efficiency and fuel switching, and end-of-pipe control technologies applied across the BTH and Shandong region, and focused on reporting two scenarios: The Current Policies (CP) Scenario and the Environmental Goals Attainment (EGA) Scenario. The CP Scenario considers the impact of implementing additional policies that government offices have already announced. The EGA Scenario implements a package of policies that limit PM<sub>2.5</sub> concentrations to no higher than 35 micrograms per cubic meter by 2035 for the whole region and reduce CO<sub>2</sub> emissions in line with the 2°C climate change target.

The analysis examines the benefits and costs of the measures in the EGA Scenario relative to the CP Scenario. The contribution of individual EGA Scenario measures in achieving both the air quality and climate goals is quantified. The scenario comparisons form the basis for the policy recommendations.

The key findings of the TA include: 1) The EGA Scenario represents one feasible pathway to achieve CO<sub>2</sub> mitigation and air quality improvement goals in the BTH and Shandong region, without impeding economic growth; 2) In the EGA Scenario, the energy system in the region undergoes sustained transformation from now until 2035; 3) In the EGA Scenario, the industrial sector contributes 55% of the reduction in SO<sub>2</sub>, 34% of the reduction in NO<sub>x</sub>, 54% of the reduction in primary PM<sub>2.5</sub> and 33% of the reduction in CO<sub>2</sub>; 4) The EGA Scenario involves integrated planning efforts and additional policy interventions to achieve climate and air quality goals in tandem; 5) To implement the EGA Scenario, caps for CO<sub>2</sub> emissions and PM<sub>2.5</sub> concentrations that are translated into legally-binding targets, together with supplementary measures, are recommended to mobilize necessary attention and investments; and 6) Incremental investment needed to achieve a radical green and low carbon transformation in the region would be substantial, and would focus on the service and non-energy intensive industry sectors.

During the implementation of the TA, six workshops/seminars were held with the MIIT and ADB to discuss the work with key stakeholders and policymakers in the BTH and Shandong region. The results of the TA have been highly commended. The MIIT requested the consultant team, based on the TA findings, to draft a policy proposal as the input of drafting the 14<sup>th</sup> Five-Year Plan of Industrial Green Development for the MIIT's consideration, using the draft style of a policy planning document. Tsinghua University agreed to take on this task, with ADB support, to add this new output. The Policy Proposals on Industrial Green and Low-Carbon Development in Beijing-Tianjin-Hebei and Shandong Region have now been submitted to the MIIT.

The MIIT also required the consultant team to further develop a policy proposal on 'Achieving CO<sub>2</sub> Emission Peak in the Industrial Sector' at the national level. The consultant team put forward several recommendations based on the output of the TA and submitted these to the MIIT. Furthermore, the consultant team has also been invited by the MIIT to attend the drafting of the 14<sup>th</sup> Five-Year Plan on Industrial Green Development during the implementation of the TA.

Meanwhile, the consultant team has been substantially involved in the formulation of National Earlier Peak Initiatives by the Ministry of Ecology and Environment (MEE). A scheme on setting provincial level CO<sub>2</sub> emission reduction targets has been designed preliminarily by the TA consultant team. The TA outputs also support the drafting of Beijing's Medium and Long-term Air Quality Improvement Plan.

The TA results align with the latest strategies on CO<sub>2</sub> emission reduction and air quality improvement in PRC. On September 22<sup>nd</sup>, 2020, Xi Jinping, President of the PRC, addressed the General Debate of the 75<sup>th</sup> Session of the United Nations General Assembly and committed that PRC will scale up its nationally determined contributions (NDC) by adopting more vigorous policies and measures to peak CO<sub>2</sub> emissions before 2030 and achieve carbon neutrality before 2060. The analysis results of the TA confirmed the significance and timeliness of the accelerated efforts. According to the TA results, current policies under the CP Scenario, designed in line with NDC, will reduce the annual mean PM<sub>2.5</sub> concentration in 2035 to 42 micrograms per cubic meter in Beijing, 45 micrograms per cubic meter in Tianjin, 43 micrograms per cubic meter in Hebei, and 46 micrograms per cubic meter in Shandong falling short of national air quality standard (35 micrograms per cubic meter). With additional measures in the EGA Scenario, the annual mean PM<sub>2.5</sub> concentration will decline to 30 micrograms per cubic meter in Beijing, 34 micrograms per cubic meter in Tianjin, 32 micrograms per cubic meter in Hebei, and 33 micrograms per cubic meter in Shandong, achieving the regulated levels.

The analysis results of the TA on the estimation of the relative contribution of the CO<sub>2</sub> emission reduction measures and the end-of-pipe control measures are also aligned with the current strategy of the government. Just recently, Huang Runqiu, Minister of Ecological

Environment, said at the 2021 National Conference on Ecological Environment Protection that it is necessary to give prominence to CO<sub>2</sub> emission reduction and implement the coordinated treatment of other pollutants reduction. One of the key findings of the TA is that the energy efficiency and fuel switching measures, focusing on controlling the CO<sub>2</sub> emissions, will contribute up to 68-77% of the PM<sub>2.5</sub> concentration reduction across provinces in 2035 under the EGA Scenario compared to the CP Scenario, while, the end-of-pipe control measures deliver 23-32% of the total reduction across provinces at the same time. It implies the important role that energy efficiency and fuel switching measures play in improving air quality in the BTH and Shandong region.

## 2 Introduction

The Report is the deliverable under the Policy and Advisory Technical Assistance Project 'Developing Cost-Effective Policies and Investments to Achieve Climate and Air Quality Goals in the Beijing–Tianjin–Hebei Region' (TA-9034 PRC), financed by the ADB and carried out by Tsinghua University. The TA is implemented in close collaboration with the Government of the PRC through the Department of Energy Conservation and Resources Utilization of the MIIT.

### 2.1 Project Details

Project Title:	TA-9034 PRC: Developing Cost-Effective Policies and Investments to Achieve Climate and Air Quality Goals in the Beijing–Tianjin–Hebei Region
Project Number:	49388-001
Executing Agency:	Department of Energy Conservation and Resources Utilization Ministry of Industry and Information Technology, PRC
Consultant	Tsinghua University, PRC
Team Leader:	Xiliang Zhang
Completion Date:	December 13 <sup>th</sup> , 2020
Previous Reports:	1) Inception Report 2) Interim Report 3) Draft Final Report 4) Final Report 5) Knowledge Product 6) Policy Proposal on Industrial Green and Low-Carbon Development in the Beijing-Tianjin-Hebei and Shandong Region 7) Preliminary Research Report of Industrial Green and Low-Carbon Technology Investment Projects in the Beijing-Tianjin-Hebei and Shandong Region

### 2.2 Rational and Scope

The BTH region is home to 109.2 million people and accounted for 10% of the PRC's gross domestic product in 2014. Since the 1990s, accelerated economic growth in the region has been accompanied by a disproportionately high increase in primary air pollutant emissions and air quality degradation. In 2013, the PRC promulgated its Action Plan for Air Pollution Prevention and Control(2013–2017), and committed vast amounts of public funds to improve air quality in the region. The action plan aimed at cutting the level of fine particulate matter in the BTH region by 25% from the 2012 level (with the provincial implementation plan aiming for reductions of up to 33% in some Hebei cities) and targeting annual

concentration of fine particulate matter in Beijing of 60 micrograms per cubic meter by 2017. The action plan recognized that to achieve sustainable, long-term air quality improvements in the BTH region, the industrial transformation of heavy industries and the power sector and productivity-enhancing measures were essential.

Climate policy in the PRC is equally focused on heavy, carbon-intensive industries and the power sector, which, when combined, account for more than 80% of the country's total CO<sub>2</sub> emissions. Prominent among these climate policies is a national industrial energy conservation program and inefficient capacity phase-out initiatives, and an emissions trading system for CO<sub>2</sub>.

To date, measures under the action plan and climate and clean energy policies have achieved notable successes, but a lack of coordination among them has raised questions regarding their cost-effectiveness. These issues are even more challenging in the BTH region, where individual municipalities and provinces are at different development stages and have varying capacities to manage policy implementation. Assessments of interplays among low-carbon and clean air policies in different sectors—such as energy, transport, agriculture, urban construction, and waste management—on a common analytical platform have become essential to fully capture co-impacts and identify proper sequencing of interventions.

### **2.3 Expected Impact, Outcome, and Outputs**

The expected impact of the project is aligned with the accelerated carbon intensity reduction and air quality improvements in the BTH region. The key project outcomes are for more cost-effective policies and investments to improve air quality and reduce CO<sub>2</sub> emissions in the BTH region. In particular, the following specific outputs are expected to be achieved:

- I. Adequacy of model framework assessed and improved;
- II. Constraints for effective policy implementation analyzed and synthesized;
- III. Interplays of climate and air quality co-benefits in the BTH region, and their sequencing assessed;
- IV. A set of policy recommendations and investment choices for the BTH region prepared;
- V. Knowledge products on co-impacts between climate change mitigation and air quality improvements.



## 3 Project Phases

The implementation of the TA has been broken down into five main phases to support the production and delivery of the project outcomes:

- ✓ Inception phase – Inception Report and work plan
- ✓ Interim phase – Interim Report, field investigation, and modeling framework
- ✓ Final report development phase – Draft Final Report and Final Report
- ✓ Knowledge product development phase – Knowledge Product Report
- ✓ Policy proposal development phase – Policy Proposal on Industrial Green and Low-carbon Development in the Beijing-Tianjin-Hebei and Shandong Region, and Preliminary Research Report of Industrial Green and Low-Carbon Technology Investment Projects in Beijing-Tianjin-Hebei and Shandong Region.

The main activities, findings, recommendations, and outputs of the different project phases are accounted for and described in the following sections.

### 3.1 Inception Phase

#### 3.1.1 Activities

The inception phase was initiated after the contract for consultant services between ADB and Tsinghua University was made on September 6<sup>th</sup>, 2016. During the inception phase, the consultant team focused on (i) identifying core industries and sectors as the focus for the study, (ii) defining model adjustments, and (iii) outlining the research plan.

An inception workshop was held on November 4<sup>th</sup>, 2016. At the workshop, the consultant team reported the existing progress and work program for the project, and representatives of the MIIT and ADB discussed the work and agreed on the work program.



Inception workshop on November 4<sup>th</sup>, 2016

#### 3.1.2 Findings

The BTH and its surrounding areas were the regions with the poorest air quality and highest frequency of heavy pollution in the country. In 2013, the average annual PM<sub>2.5</sub> concentration in every subregion was roughly equal to or higher than 90 micrograms per cubic meter.

The power sector is one of the most important air pollutants and CO<sub>2</sub> emitters in the region. To significantly reduce air pollutant emissions in the power sector, ultra-low emissions standards, stricter than those in developed countries/regions such as the United States, are being promoted rapidly. With the rapid deployment of renewable energy and efficiency

improvements, the CO<sub>2</sub> emission per kWh and main air pollutants emissions per kWh in the power sector saw a continuous decline in recent years.

However, the emission reduction potentials of the industrial sector have not been fully considered. The high industrial share in economic activity and continuing reliance on coal as a fuel for industrial production and heating are major causes of severely degraded air quality in the region. In 2015, the industry contributed 54% of SO<sub>2</sub> pollution, 38% of NO<sub>x</sub> pollution, 54% of primary PM<sub>2.5</sub> emissions, and 44% of CO<sub>2</sub> emission in the region. The potential for emission reduction needs to be assessed. Therefore, key energy-intensive industries, including the iron and steel industry, nonferrous industry, non-metallic mineral industry (i.e., cement, flat glass), and petrochemical and chemical industries, are selected as the key industries that need to be analyzed in detail.

The improvement needs of the integrated assessment model REACH framework are defined from (i) a review of the status quo of clean energy, clean air, industrial as well as climate policies; (ii) a review of relevant international and national literatures; (iii) discussions with the government, management from selected core industries, and academia, and (iv) updating of emission inventories in the BTH region.

An overall work program of the TA was formulated through multiple discussions with key stakeholders.

### 3.1.3 Output

The consultant team submitted the Inception Report as the first deliverable of the project:

- ✓ Inception Report, submitted to ADB in November 2016.

## 3.2 Interim Phase

### 3.2.1 Activities

In the interim phase, the TA consultant team focused on (i) conducting a field survey in the BTH region, (ii) analyzing constraints for effective policy implementation, (iii) reviewing existing policies on CO<sub>2</sub> emission reduction and air pollution prevention at both the national level and the provincial level in the BTH region, and (iv) summarizing the potential interplays of climate and air quality co-benefits in the BTH region.

For this research, the REACH framework was applied and improved, which integrates an energy-economic model, the China Regional Energy Model (C-REM), with a Chinese emission inventory and an air quality simulation model, the Extended Response Surface Model. In this phase, the REACH framework was improved, including:

- 1) the updating of the C-REM's benchmark provincial input-output data with the latest available (2012) to replace the 2007 benchmark data used in earlier versions;
- 2) the disaggregation of 13 production sectors in the original version into 21 production sectors within each region to better resolve energy-intensive industries;
- 3) the adoption of a newer version of Chinese emissions inventory with a more detailed resolution of regions, pollutants, and technologies;
- 4) the calibration of diffusion possibilities for end-of-pipe control technologies by sector to reflect its prior adoption status;
- 5) the updating of the module that captures the health impacts of air pollution;
- and 6) the incorporation of uncertainties associated with different health valuation methods.

In this phase, the MIIT, ADB, and the TA consultants further discussed the work program. On January 12<sup>th</sup>, 2017, Ashok Bhargava, Chair of the Energy Committee and Director of Energy Division, East Asia Department, ADB, visited the MIIT and met with Xiaoyang Wang,

Director of the General Office, Department of Energy Conservation, MIIT, and Fengyuan Guo, Deputy Director of the General Office, Department of Energy Conservation, MIIT. The participants agreed to hold a seminar in the first half of 2017. During this visit, Annika Seiler, the former project officer, suggested involving Shandong Province in the TA, as Shandong Province is located as one of the surrounding provinces of the BTH region and is also suffering from heavy air pollution and high CO<sub>2</sub> emissions. Therefore, Shandong Province is also included as one of the focus provinces during the implementation of the TA.

A seminar was held on April 25<sup>th</sup>, 2017, in the phase. Tiesheng Yang, Deputy Director-General of the Department of Energy Conservation, MIIT, and Ashok Bhargava, Chair of the Energy Committee and Director of the Energy Division, East Asia Department, ADB, addressed remarks. The preliminary results were discussed with stakeholders and policymakers in the BTH region and other experts at the seminar. The participants invited were from:

- ✓ provincial industry and information technology administrations: Tianjin Municipality Commission of Industry and Information Technology, Industry and Information Technology Department of Hebei Province, Shanxi Provincial Commission of Economy, and Information Technology, Shandong Economic and Information Technology Committee, Commission of Industry, and Information Technology of Henan Province, and Langfang Municipal Development and Reform Commission;
- ✓ research institutes: Central University of Finance and Economics, and Research Center of the State Council;
- ✓ and financial companies: Ernst & Young, China Energy Conservation and Environmental Protection Financial Alliance, Tsinghua Tongfang Finance Holding Ltd., Industrial Bank, TF Securities, China Minsheng Bank, and ESCO Committee of China Energy Conservation Association State research center.

During the implementation of the TA, several team meetings were also held. Furthermore, to strengthen the field survey, the ADB approved the subcontracting of the field survey to the China Center for Information Industry Development and Molin Huo, senior researcher of State Grid Energy Research Institute.



Seminar on April 25<sup>th</sup>, 2017



Team meeting.

### 3.2.2 Findings

The consultant team conducted field investigations on emission reduction measures at the company level. It was found that the lower penetration of energy-saving and emission-reduction technologies in key energy-intensive industries in the BTH and Shandong region and the lack of market-based instruments for internalization of external benefits from the

CO<sub>2</sub> emission reduction were crucial impediments to reduce CO<sub>2</sub> and air pollutant emissions. The TA consultants identified major energy-intensive industries in Beijing, Tianjin, Hebei, and Shandong and conducted case studies of 60 enterprises. More than 30 advanced energy conservation and emission reduction technologies that could be widely applied in the BTH and Shandong region were sorted out.

The review of current policies and measures revealed a wide variety of policy instruments and increasing ambition over time. However, one of the main shortcomings of the current approach was the lack of an integrated plan to achieve broader air quality and climate goals. For air quality, current policies do not chart a path in achieving the National Ambient Air Quality Standards, nor do they consider interactions with climate mitigation efforts, focusing on reducing CO<sub>2</sub> from many of the same activities. Climate mitigation efforts also bear no clear relationship to the global 2°C target. Moreover, these measures are focused on the near term, whereas targets with a longer-term horizon could allow affected industries to plan.

### 3.2.3 Output

The consultant team submitted the Interim Report, containing the results of field investigations of the BTH and Shandong region, as well as the details of the current situation and trend of five key energy-intensive industries in the BTH region, along with details of the advanced energy conservation and emission reduction technologies, and details of the REACH framework.

- ✓ Interim Report, submitted to ADB in July 2017,

## 3.3 Final Report Development Phase

### 3.3.1 Activities

In this phase, the TA consultant team focused on (i) further improving the REACH framework, (ii) updating the projections on five key energy-intensive industries in the region, (iii) updating the list of applicable energy conservation and emission reduction technologies in the region; (iv) updating the review of existing policies on CO<sub>2</sub> emission reduction and air pollution prevention in the region, (v) conducting a number of scenario exercises, and (vi) finalizing the integrated assessment of policies and investments to achieve climate and air quality goals.

A set of scenarios are run in the phase, which vary the application of two broad categories of interventions: energy efficiency and fuel switching, and end-of-pipe control technologies applied across the BTH and Shandong region. Scenario design was conducted iteratively, each time with stronger assumptions until a scenario that achieved the target using a balanced combination of policy measures was obtained. Among the set of scenarios, two “representative” scenarios-Current Policies (CP) Scenario and Environmental Goals Attainment (EGA) Scenario-are selected to examine the costs and health benefits implied by increasingly ambitious, yet feasible, packages of policies aimed at achieving air quality improvement and climate change mitigation in the BTH and Shandong region. The only scenario that attains environmental goals is the EGA Scenario. The EGA Scenario simulates a package of policies that limit PM<sub>2.5</sub> concentrations to no higher than 35 micrograms per cubic meter by 2035 for the whole region, and reduce CO<sub>2</sub> emissions in line with the 2°C climate change target. The contribution of EGA Scenario measures toward achieving both the air quality and climate goals are quantified. The scenario comparisons form the basis for the policy recommendations.

During this phase, the consultant team held three workshops to further gather experts' and stakeholders' comments.

- On September 3<sup>rd</sup>, 2018, a workshop was held in Beijing. Representatives of the MIIT and ADB attended the workshop. Gao Yunhu, General Director of Department of Energy Conservation, MIIT, and Sujata Gupta, Director of the Energy Division,



East Asia Regional Department, ADB, addressed remarks at the workshop. The draft report and policy recommendations were discussed with key stakeholder organizations responsible for policymaking at the workshop. Several experts were invited to attend and give comments on the draft final report. These experts were from the Development Research Centre of the State Council, the Energy Research Institute of the NDRC, the Chinese Academy for Environmental Planning of Ministry of Ecology and Environment, the Institute of Science and Technology Policy and Management of Chinese Academy of Sciences, and the Policy Research Center for Environmental and Economy of the Ministry of Ecology and Environment. The report was highly commended by experts, and recommendations for further study were proposed.

- On January 21<sup>st</sup>, 2019, a workshop was held in Tianjin at the request of the MIIT. Representatives of local governments and enterprises attended the workshop. At the workshop, the consultant team shared existing analysis results with local governments in Beijing, Tianjin, Hebei, and Shandong.
- On November 26<sup>th</sup>, 2019, a workshop was held in Beijing. At this workshop, representatives of the MIIT and ADB, representatives of provincial Industry and Information Technology administrations of Beijing, Tianjin, Hebei, and Shandong, and the invited experts were in attendance.



Workshop, September 3<sup>rd</sup>, 2018



Workshop, September 3<sup>rd</sup>, 2018



Workshop, January 21<sup>st</sup>, 2019



Workshop, November 26<sup>th</sup>, 2019

The consultants of the TA also attended the Workshop on Air Quality Improvement in the Greater Beijing-Tianjin-Hebei Region, organized by the Sustainable Infrastructure Division of East Asia Department, ADB, on November 6<sup>th</sup>, 2018. They were invited to organize a session on the practice and experience of air pollution prevention and control in the greater BTH region, jointly with NAREE International Ltd. At the workshop, the consultant team shared current research progress and gathered comments from participants.

To further improve the final report and knowledge products, an international energy policy

expert, Valerie J. Karplus, was engaged by ADB. Valerie J. Karplus supported the ADB project officer in reviewing and finalizing the final report and knowledge product.

### 3.3.2 Findings

The following are the main findings in the process of summarizing the research results:

- The EGA Scenario represents one feasible pathway to reach CO<sub>2</sub> mitigation and air quality improvement goals in the BTH and Shandong region without impeding economic growth.
- In the EGA Scenario, the energy system in the region undergoes sustained transformation from now until 2035.
- In the EGA Scenario, the industrial sector contributes 55% of the reduction in SO<sub>2</sub>, 34% of the reduction in NO<sub>x</sub>, 54% of the reduction in primary PM<sub>2.5</sub> and 33% of the reduction in CO<sub>2</sub>.
- The EGA Scenario involves integrated planning efforts and additional policy interventions to reach climate and air quality goals in tandem.
- To implement the EGA Scenario, caps on CO<sub>2</sub> emissions and PM<sub>2.5</sub> concentrations, which are translated into legally-binding targets, together with supplementary measures, are recommended to mobilize necessary attention and investments.
- Incremental investment for achieving a radical green and low carbon transformation in the region would be substantial and focus on public transport, electricity, and chemical sectors.

And the following main policy recommendations:

- Set an absolute cap for CO<sub>2</sub> emissions and PM<sub>2.5</sub> concentrations for the 14th Five-Year-Plan and beyond, extending until at least 2035.
- Accelerate efforts to reduce coal consumption through 2030.
- Implement measures to enhance electricity supply stability, with large shares of renewable generation.
- Introduce an adequately high carbon price through the national CO<sub>2</sub> emissions trading program or a carbon tax.
- Increase the stringency of end-of-pipe SO<sub>2</sub>, NO<sub>x</sub>, and PM emissions standards in all industrial sectors.

### 3.3.3 Output

For this stage, the main research methods, content, results, conclusions, and policy recommendations were basically formed and presented in the Final Report:

- ✓ Draft Final Report, submitted to ADB in October 2018
- ✓ Final Report, submitted to the MIIT in January 2020

## 3.4 Knowledge Product Development Phase

### 3.4.1 Activities

At the knowledge product development phase, the consultant team refined the research results of the full report and formed a Knowledge Product Report. Valerie J. Karplus

supported the improving of the contents and conclusions of the knowledge product report.

In this phase, a workshop was held on September 28<sup>th</sup>, 2020. Representatives of the MIIT and ADB attended the workshop. Experts from China Metallurgical Industry Planning and Research Institute, Green and Low Carbon Building Materials Branch, China Building Materials Federation, China Nonferrous Metals Industry Association, Beijing Green Industry Development Association, Hebei Electronic Information Technology Institute, and Beijing E-Town International Investment & Development Co., Ltd. were also invited to give comments on the knowledge product. The results of the knowledge product were highly commended at the workshop.



Workshop on September 28<sup>th</sup>, 2020.

### 3.4.2 Output

Having obtained results and output during the entire project process, the consultant team submitted a concise and condensed knowledge product report:

- ✓ Knowledge product, submitted to ADB in December 2020.

## 3.5 Policy Proposal Development Phase

### 3.5.1 Activities

As mentioned above, a workshop was held on November 26<sup>th</sup>, 2019, in Beijing to discuss the draft final report with the MIIT. The representatives of the MIIT gave their comments and suggested that the consultants provide further support in developing the 14<sup>th</sup> Five-Year Plan for the Industrial green development.

A virtual tripartite meeting was held to discuss the implementation on May 18<sup>th</sup>, 2020, where Tsinghua University briefed the TA progress. The MIIT requested the consultant team, based on the TA findings, draft a policy proposal as part of the input in drafting the 14<sup>th</sup> Five-Year Plan of Industrial Green Development for the MIIT's consideration, using the draft style of a policy planning document. Tsinghua University agreed to take on this task, with ADB support, to add this new output. The MIIT also requested that the consultant team work on preliminary research of key investment projects recommended in the Beijing-Tianjin-Hebei and Shandong region to promote industrial transformation development.

In this context, the consultant team conducted researches on this issue and completed the above-mentioned policy recommendations and preliminary research report of industrial green and low-carbon technology investment projects in the region.

### 3.5.2 Findings

The main findings and policy recommendations for industrial green development are provided.

Key findings:

- The region can peak carbon dioxide emissions by 2025 through reinforced efforts, which is also the fundamental guarantee for the Region to achieve its air quality standard by 2035.
- The industrial sector in the Region should peak carbon dioxide emissions before 2025 in a bid to lay a solid foundation for the regional peaking by 2025 and the attainment of air quality standard by 2035.
- Both curbing carbon dioxide emissions and meeting air quality standard involve a profound transformation of the Region's energy mix.

Key recommendations:

- Incorporate the goal of achieving carbon dioxide peak by 2030 into the 14<sup>th</sup> Five-Year Plan for Industrial Development, and formulate dedicated plans for the green and low-carbon industrial development.
- Conduct pilots in the Region to spearhead green and low-carbon industrial manufacturing projects.
- Shape a modern, green, and low-carbon industrial system.
- Introduce a sound investment and financing framework for green and low-carbon industrial development.

As for the investment projects recommendations, the consultant team screened six low-carbon technologies from cement, iron & steel, and synthetic ammonia industries that can be scaled up in BTH and Shandong region. Based on the analysis of demonstration projects that applied these six technologies in PRC, the unit cost for each of the technologies are estimated and the total investment required for the promotion and application of these technologies in the BTH and Shandong region are further calculated using the projected technology penetration rate from 2020 to 2030. The difficulties and obstacles in applying these technologies were also analyzed.

The deployment of the six low-carbon technologies proposed in this study will promote energy conservation and emission reduction in cement, iron & steel, and chemical industries, thus contributing to air pollution prevention and CO<sub>2</sub> emission reduction in the region, which is in line with the loan support areas of ADB and other multilateral financial institutions. Based on the market potential for the six technologies and the features of the demonstration projects, recommendations on choosing financing instruments are also provided.

### 3.5.3 Output

- ✓ Policy Proposal on Industrial Green and Low-carbon Development in the Beijing-Tianjin-Hebei and Shandong Region submitted to the MIIT in December 2020.
- ✓ Preliminary Research Report of Industrial Green and Low-Carbon Technology Investment Projects in the Beijing-Tianjin-Hebei and Shandong Region submitted to ADB in December 2020.



## 4 Conclusion

### 4.1 Project Output

The TA outputs are (i) adequacy of model framework assessed and improved; (ii) constraints for effective policy implementation analyzed and synthesized; (iii) interplays of climate and air quality co-benefits in the BTH region and their sequencing assessed; and (iv) set of policy recommendations and investment choices for the BTH region prepared. The following deliveries have been submitted, including:

- ✓ Inception Report.
- ✓ Interim Report.
- ✓ Draft Final Report.
- ✓ Final Report.
- ✓ Knowledge Product Report.
- ✓ Policy Proposal on Industrial Green and Low-carbon Development in the Beijing-Tianjin-Hebei and Shandong Region.
- ✓ Preliminary Research Report of Industrial Green and Low-Carbon Technology Investment Projects in Beijing-Tianjin-Hebei and Shandong Region.

### 4.2 Outcome and Impact

The outcome of the TA is aligned with the latest CO<sub>2</sub> emission reduction and air quality improvement strategy in the BTH and Shandong region.

On September 22<sup>nd</sup>, 2020, Xi Jinping, President of the PRC, addressed the General Debate of the 75<sup>th</sup> Session of the United Nations General Assembly and committed that PRC will scale up its NDC by adopting more vigorous policies and measures to have CO<sub>2</sub> emissions peak before 2030 and to achieve carbon neutrality before 2060. The analysis results of the TA confirmed the significance and timeliness of the accelerated efforts. According to the TA results, current policies under the CP Scenario, designed in line with NDC, will reduce the annual mean PM<sub>2.5</sub> concentration in 2035 to 42 micrograms per cubic meter in Beijing, 45 micrograms per cubic meter in Tianjin, 43 micrograms per cubic meter in Hebei, and 46 micrograms per cubic meter in Shandong falling short of national air quality standards (35 micrograms per cubic meter). With additional measures in the EGA Scenario, the annual mean PM<sub>2.5</sub> concentration will decline to 30 micrograms per cubic meter in Beijing, 34 micrograms per cubic meter in Tianjin, 32 micrograms per cubic meter in Hebei, and 33 micrograms per cubic meter in Shandong, achieving the regulated levels.

The national and local 14<sup>th</sup> Five-Year Plan (2021-2025) and Action Plan on Achieving CO<sub>2</sub> Emission Peak by 2030 are well under drafting. The insights and recommendations developed in the TA are timely and can be used by policymakers and local governments interested in designing appropriately phased targets and promoting supporting policies.

Based on the outputs of the TA, the consultant team is now supporting the drafting of several key policies in PRC. The key outcomes of the TA include:

- ✓ Development of Policy Recommendations on Achieving CO<sub>2</sub> Emission Peak in the Industrial sector: The MIIT required the consult team to further develop a policy proposal on 'Achieving CO<sub>2</sub> Emission Peak in Industrial Sector' at the national level. The consultant team put forward several recommendations based on the output of the TA and submitted them to the MIIT.

- ✓ Formulation of Industrial 14<sup>th</sup> Five-Year planning: The MIIT is now developing the 14<sup>th</sup> Five-Year Plan for industrial development. The consultant team has been invited by MIIT to attend the drafting of the 14<sup>th</sup> Five-Year Plan on industrial green development during the implementation of the TA.
- ✓ Formulation of National Earlier Peak Initiatives. The consultant team contributed substantially to the formulation of National Earlier Peak Initiatives by the Ministry of Ecology and Environment. The scheme on setting provincial level CO<sub>2</sub> emission reduction targets is designed by the TA consultant team.
- ✓ Development of the 'Medium- and Long-Term Air Quality Improvement Plan of Beijing': The TA outputs also support the drafting of the 'Medium- and Long-Term Air Quality Improvement Plan of Beijing.'

The results on the estimation of the relative contribution of CO<sub>2</sub> emission reduction measures and the end-of-pipe control measures are also aligned with the current strategy of the government. Recently, Huang Runqiu, Minister of Ecological Environment, said at the 2021 National Conference on Ecological Environment Protection that it is necessary to give prominence to CO<sub>2</sub> emission reduction and implement the coordinated treatment of other pollutants reduction. One of the key findings of the TA is that compared to the CP Scenario, the energy efficiency and fuel switching measures, focusing on controlling the CO<sub>2</sub> emissions, will contribute 68-77% of the PM<sub>2.5</sub> concentration reduction across provinces in 2035 under the EGA Scenario. Meanwhile, the end-of-pipe control measures will deliver 23-32% of the total reduction across provinces. It implies the important role that energy efficiency and fuel switching measures play in improving air quality in the four provinces in the BTH and Shandong region.

## **5 Appendices**

Appendix 1: Knowledge Product Report.

Appendix 2: Policy Proposal on Industrial Green and Low-Carbon Development in the Beijing-Tianjin-Hebei and Shandong Region.

Appendix 3: Preliminary Research Report of Industrial Green and Low-Carbon Technology Investment Projects in the Beijing-Tianjin-Hebei and Shandong Region.

Appendix 4: Applicable Energy Conservation and Emission Reduction Technologies in the Beijing-Tianjin-Hebei and Shandong Region.