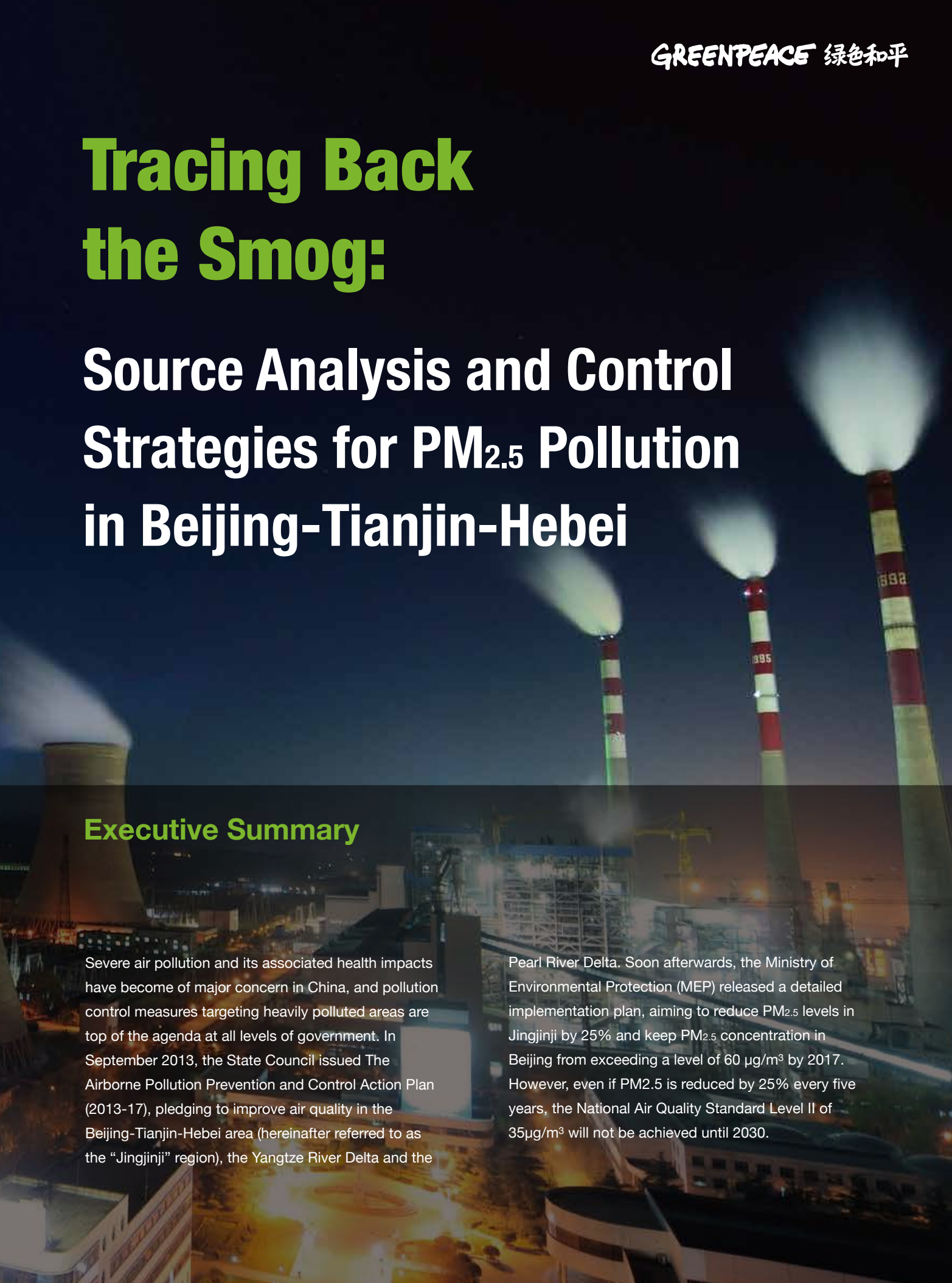
GREENPEACE 绿色和平

Tracing Back the Smog:

Source Analysis and Control Strategies for $PM_{2.5}$ Pollution in Beijing-Tianjin-Hebei



Executive Summary

Severe air pollution and its associated health impacts have become of major concern in China, and pollution control measures targeting heavily polluted areas are top of the agenda at all levels of government. In September 2013, the State Council issued The Airborne Pollution Prevention and Control Action Plan (2013-17), pledging to improve air quality in the Beijing-Tianjin-Hebei area (hereinafter referred to as the "Jingjinji" region), the Yangtze River Delta and the Pearl River Delta. Soon afterwards, the Ministry of Environmental Protection (MEP) released a detailed implementation plan, aiming to reduce $PM_{2.5}$ levels in Jingjinji by 25% and keep $PM_{2.5}$ concentration in Beijing from exceeding a level of 60 $\mu g/m^3$ by 2017. However, even if PM2.5 is reduced by 25% every five years, the National Air Quality Standard Level II of 35$\mu g/m^3$ will not be achieved until 2030.

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As clear and concrete pollution reduction goals at the central and local government levels are being set, public concern for a deteriorating living environment continue to mount. Due to a lack of detailed analysis on $PM_{2.5}$ composition and emission sources, little information is available on trends in $PM_{2.5}$ concentrations, and answers to the questions how much air pollution should be reduced and how to accomplish this reduction remain unclear. The reality is that achieving the proposed $PM_{2.5}$ target remains a challenging task, especially considering the need for control measures that reflect the various characteristics of the region. Therefore Greenpeace has been co-operating with a team from the University of Leeds, UK, led by Dr. Dabo Guan, with the aim to study $PM_{2.5}$ sources and control strategies in Jingjinji, since the end of 2012.

This project report is the first of its kind to comprehensively analyze $PM_{2.5}$ sources in the Jingjinji region and to assess to what extend the region should do to reach the air quality targets set by the MEP. The report aims to provide insight into $PM_{2.5}$ pollution in the region, to fuel public debate, and more importantly, to inform and influence decision-makers and stakeholders and provide rationale and support for actions that reduce $PM_{2.5}$ levels.

Research Methodology

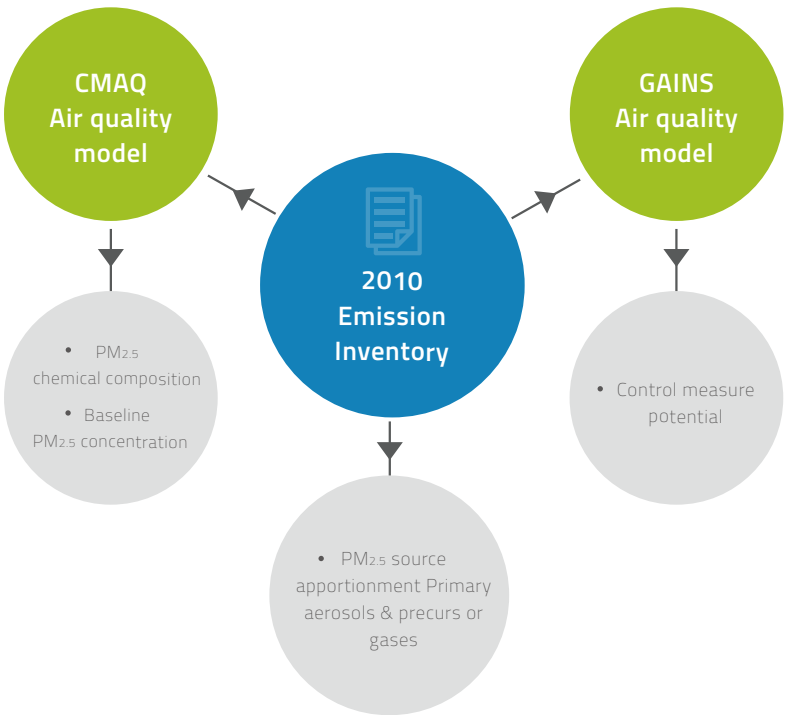
Specifically, this study tries to answer the following questions for the Jingjinji region:

- How much are the annual $PM_{2.5}$ emissions? What sources are contributing to $PM_{2.5}$ in the region? Which sectors are emission-intensive?

- Can we become more ambitious in our aims and meet national standards in a decade instead of by 2030? To what extend should the region be willing to make changes in order to achieve that? What key measures are required to reduce emissions?

We have tackled these questions by first compiling a sector and fuel-specific $PM_{2.5}$ emission inventory① including primary sources and precursor gases (SO_2, NOx, NH_3 and VOCs), then plugged this inventory into air quality models, in order to analyze $PM_{2.5}$ chemical composition, and evaluate the trends of $PM_{2.5}$ concentration in different baseline scenarios. On that basis, we have been able to suggest how much emissions to reduce so that the national standard can be met by 2022, and recommend a list of effective control measures that are in line with sub-regional profiles; e.g. structure of the economy, industrial composition, energy mix, and emission sources.

A detailed methodology is presented in the following flow chart:



① *Emission inventory covers over 150 sectors and is based on data from 2010. According to the China Energy Statistical Yearbook 2011 and 2012 and public information released by the MEP, our analysis on sector apportionment based on the 2010 emission inventory still holds for the situation in 2011 and 2012.*

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Main Findings

[1] Efforts to reduce $PM_{2.5}$ level in the Jingjinji region should consider simultaneous control of primary sources and precursor gases. Sulfate-nitrate-ammonium (SNA) aerosols that are transformed from SO_2, NOx and NH_3 and are the major constituents of $PM_{2.5}$, making up 50 – 70% of the total mass concentration. In Beijing, primary source emissions contribute to 40% of $PM_{2.5}$ concentration, while precursors contribute to 60% of the mass concentration. In Tianjin, the percentages are 47% vs. 53%, and in Hebei 41% vs. 59%, respectively.

[2] Over-reliance on coal is the most important factor of high levels of $PM_{2.5}$ in Jingjinji. If we break down the source contribution by fuel types ①, emissions from coal combustion constitute 25% of primary $PM_{2.5}$ emissions and account for 82% of SO_2 and 47% of NOx emissions in that region. In comparison, combustion of oil products accounts for 4% of primary $PM_{2.5}$, 31% of NOx and 18% of VOCs emissions.

[3] By sector ② contribution, coal-fired power generation is the largest single source for industrial $PM_{2.5}$ pollution in Jingjinji with coal-fired power stations emitting 9% of primary $PM_{2.5}$, 69% of SO_2 and 47% of NOx. Industrial production of steel, cement and brick are other major sources of $PM_{2.5}$ emissions that account for 49% of primary $PM_{2.5}$, 12% of SO_2 and 17% of NOx in that region.

[4] Contribution by the transport sector to $PM_{2.5}$ pollution appears more substantial in Beijing than in Tianjin and Hebei. That sector accounts for 45% of total NOx emissions in Beijing. This makes the transport sector the second largest single source of industrial air pollution in the capital, following the power generation sector.

[5] The iron and steel, cement and brick-making industries take a greater toll on ambient air quality of Tianjin and Hebei than of Beijing. In particular, industrial processes in Hebei province are the most important source of primary fine particles and account for 50% of direct emissions.

[6] To meet the $PM_{2.5}$ standard level of 35 $\mu g/m^3$ by 2022, it is necessary to reduce $PM_{2.5}$ emissions in the region by 80%, SO_2 by 60%, NOx by 75%, NH_3 by 85% and VOCs by 90%.

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① *In this research, we considered five types of fuel for source apportionment, i.e. coal, oil, non-fuel emissions (escaped from industrial processes), biomass and gas.*

② *The research divides sector-specific sources into six subcategories, i.e. transport, industrial processes, energy (coal-fired power plants), commercial and households, agriculture and fuel production and others.*

A Pathway to Blue Skies

If the Jingjinji region is to meet the National Air Quality Standard Level II (35 μg/m^3), it should focus on the following areas: 1) Limit the use of coal, especially by the utility industry, and ban all approval of any new coal-fired power plants. In its stead the region should tap into renewable energy sources; 2) Shutdown polluting and energy-intensive industries such as cement plants and iron and steel mills, and replace coal-fired boilers with gas-fired ones; 3) Upgrade existing small-scale boilers for domestic and commercial use by replacing coal-fired boilers with gas-fired ones, increase proportion of gas consumption in the domestic sector, and ban agricultural waste incineration; 4) Improve the quality of oil products and emission standards for vehicles.

Based on our analysis of potential control measures, we hereby put forward these suggestions for reducing $PM_{2.5}$ emissions in Beijing, Tianjin and Hebei by 2020:

Beijing

Industrial processes are a major source of primary $PM_{2.5}$, and the precursor gases (SO_2, NOx and VOCs) are mainly emitted by the energy and transport sectors. Thus these three sectors should be the main targets; in terms of emissions by fuel type, combustion of coal and oil products and non-fuel emissions (emissions during industrial processes) are the major sources of gaseous precursors. Emission measures should concentrate on substantial reduction of coal use, improving quality of oil products and raising the emission standards for vehicles.

Actions that should be put into place by 2022 include:

[1] Shutdown coal-fired power plants within the capital boundary, increase percentage of electricity from renewable sources in total energy mix, and boost distributed solar and wind power. Renewable energy can be sourced from surrounding areas;

[2] Shutdown all existing iron and steel plants and most cement plants. Install fabric filters in cement kilns and ban new cement plants;

[3] Apply the National VI Emission Standard to light-duty gasoline cars and heavy-duty diesel cars, and increase the percentage of buses and cabs fueled by clean energy to over 40%;

[4] Escalate the adoption of end-of-pipe treatments in the electric power sector. Install flue gas desulfurization and de-nitration equipment for all fossil fuel power plants. Use low-NOx burners and install fabric filters;

[5] Reduce VOC emissions from industrial processes.

Tianjin

The energy sector (coal-fired power plants) is the biggest source of $PM_{2.5}$ emissions. In terms of fuel contribution, emissions from coal burning and non-fuel escapement (fugitive gas escaped from industrial processes) play a main role. Efforts should be targeted at reducing fuel consumption and fugitive emissions during production of oil products.

Actions that should be put into place by 2022 include:

[1] Increase the use of wind power/distributed solar power and increase the use ratio, and significantly reduce the percentage of coal-fired power in energy provision;

[2] Tighten control of fugitive emissions during production of oil and oil-related products, impose desulfurization measures, and reduce the emission of VOCs;

[3] Shutdown the most polluting cement and steel plants, install fabric filters in existing cement kilns, and ban new cement and steel plants;

[4] Expedite the adoption of end-of-pipe treatment technologies in the electric power sector, realize simultaneous desulfurization and de-nitration of flue gas from all fossil fuel power plants, use low-NOx burners, install fabric filters, and shutdown part of the existing coal-fired power plants.

Hebei

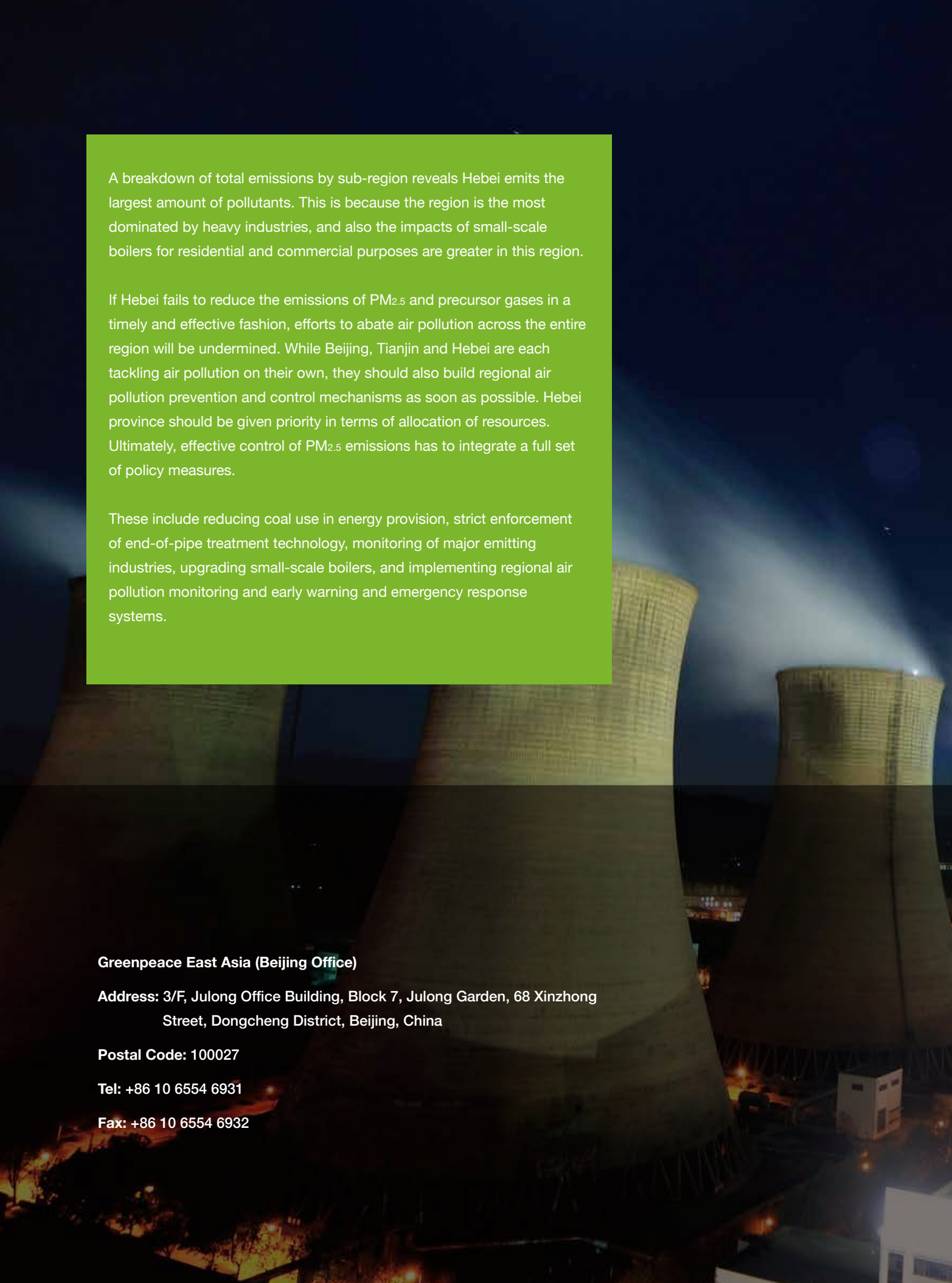
The energy sector (coal-fired power plants) is the biggest $PM_{2.5}$ emitters among all industrial sectors. The industrial-processes sector is the main source of primary $PM_{2.5}$ aerosol, however domestic and commercial sectors also contribute significantly; in terms of emissions by fuel combustion/use, mitigation efforts should focus on the two main fuel types, namely coal and non-fuel (from industrial-process sector). Specifically, actions to put in place by 2020 include:

[1] Invest in renewable power generation to the maximum extent and use them to replace coal-fired power plants;

[2] Accelerate the shutdown of the most polluting iron and steel plants, coking and cement plants and sectors plagued by over-capacity problems. Also, install flue-gas desulfurization equipment and fabric-filters in iron and steel plants, and install fabric-filters in cement kilns;

[3] Expedite the adoption of end-of-pipe treatments in the electric power sector with the goal of installing flue-gas desulfurization and de-nitration technology in all fuel-fired power plants. Use low-NOx burners, install fabric filters, and shutdown part of the existing coal-fired power plants;

[4] Upgrade existing small-scale boilers for domestic and commercial use by substituting gas-fired boilers for coal-fired ones, use more gas instead of coal as household fuel, and ban agricultural waste incineration.



A breakdown of total emissions by sub-region reveals Hebei emits the largest amount of pollutants. This is because the region is the most dominated by heavy industries, and also the impacts of small-scale boilers for residential and commercial purposes are greater in this region.

If Hebei fails to reduce the emissions of $PM_{2.5}$ and precursor gases in a timely and effective fashion, efforts to abate air pollution across the entire region will be undermined. While Beijing, Tianjin and Hebei are each tackling air pollution on their own, they should also build regional air pollution prevention and control mechanisms as soon as possible. Hebei province should be given priority in terms of allocation of resources. Ultimately, effective control of $PM_{2.5}$ emissions has to integrate a full set of policy measures.

These include reducing coal use in energy provision, strict enforcement of end-of-pipe treatment technology, monitoring of major emitting industries, upgrading small-scale boilers, and implementing regional air pollution monitoring and early warning and emergency response systems.

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