Cover Story

Out of Breath

Tackling Asia's Air Crisis

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GLOBAL ASIA Vol. 14, No. 4, December 2019

Asia's extraordinary economic growth since the Second World War has come at an enormous price to the environment, and above all, on its air.

For this cover package, Associate Managing Editor John Delury and Editorial Board member Peter Hayes assembled an international team of experts to look at the challenges posed. In particular, we sought to look at both the science and the policy-making behind the problems.

A short package of essays on an issue of this complexity cannot hope to be comprehensive, but we do aim to highlight key issues and how they might be addressed. One major conclusion is that air pollution in Asia is a problem that cries out for regional cooperation, precisely because it is transboundary in nature, as numerous authors in this cover package point out.

ESSAYS BY

The Seven-Year Battle: China's Fight Against Air Pollution

By Jiang Kejun

China's rapid development created a powerhouse economy but left in its wake some of the worst air pollution in the world. Tackling the problem head-on from 2013, the central government set targets for reducing emissions and transitioning toward cleaner energy. President Xi Jinping even called for a 'revolution' in energy.

By signing the Paris Agreement in 2016, China announced to the world that it was serious about climate change. Since the campaign began, writes Jiang Kejun, substantial progress has been made, with more on the way.

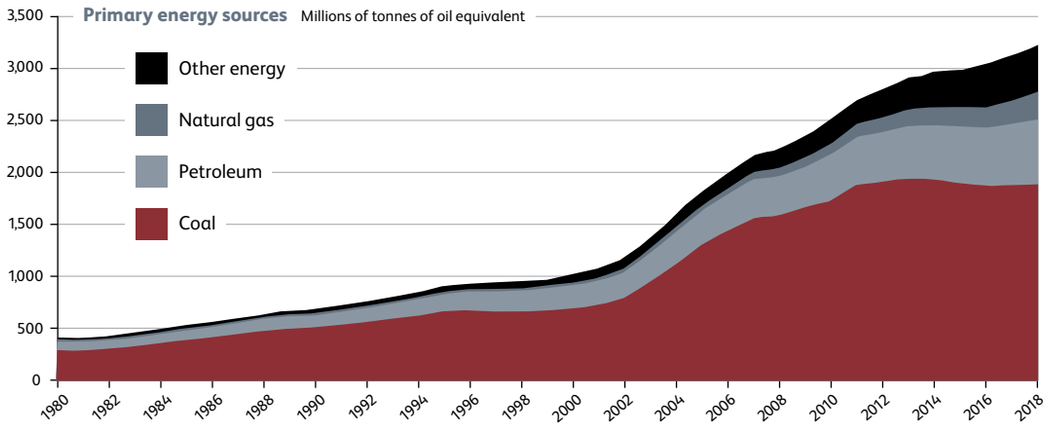
WITH CHINA'S rapid economic development came widespread heavy industry and rising use of fossil fuels, especially coal, as is easily seen in graphs of energy-intensive production output and primary energy use in China (see figure 1).[1]

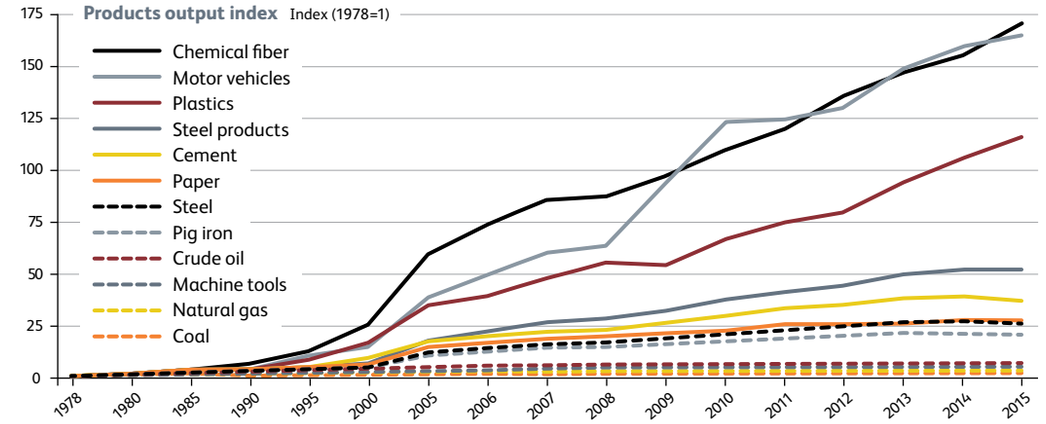
Despite environmental protection being one of China's key strategies, air pollution in the country worsened over the course of many years. A report from China's environmental protection ministry in November 2010 showed that about a third of 113 cities could not meet national air quality standards. According to the World Bank, 16 of the world's 20 cities with the worst air were in China in 2009. According to Chinese government sources, about a fifth of urban Chinese breathe heavily polluted air. In 2013, a report from the Ministry of Environmental Protection showed that among 74 large cities, only 4 percent could reach national standards — an average concentration of 72μg/m^3 for fine particulate pollution, known as $PM_{2.5}$.

Due to bad air quality, large numbers of people pushed for strong action. The government responded. In 2013, a large-scale action plan was released by the State Council, the country's cabinet, to fight air pollution. The plan set specific goals for all of China's 338 county-level cities. By 2017, the concentration of $PM_{2.5}$ was to fall by at least 10 percent compared to 2012; even tougher goals have been set for a number of key areas. The region comprising Beijing, Tianjin and Hebei was to reduce the concentration of $PM_{2.5}$ by about 25 percent by 2017. The target for the Yangtze River Delta region was set at around 20 percent, the target for the Pearl River Delta region was 15 percent.

1 *China Statistical Yearbook 2019* (Beijing: China Statistics Press, 2019)

FIGURE 1 PRIMARY ENERGY SOURCES IN CHINA AND ENERGY-INTENSIVE PRODUCTS OUTPUT
Source: National Bureau of Statistics of China





The plan includes a detailed implementation plan covering the 10 national measures and 35 sub-sections that cover:

- Reducing emissions of multi-pollutants;
- Promoting industry upgrades and restructuring;
- Accelerating companies' technology upgrading;
- Accelerating energy restructuring;
- Enforcing energy-saving and environmental protection as market entry requirements;
- Application of market-oriented instruments and environmental economic policies;
- Improving the legal framework for implementation and enforcement;
- Establishing regional collaboration mechanisms;
- Establishing monitoring and emergency response systems for critical air pollution episodes; and
- Defining responsibilities for the government, private sector and public on environmental protection.

Some new and important mandates and initiatives were first promoted in the plan, including controlling coal consumption. By 2017, coal's share of primary energy consumption was to be reduced to 65 percent and that of non-fossil fuels was to rise to 13 percent. Three key regions were to make efforts to replace coal with natural gas boilers in industrial furnaces. Heavily polluting

vehicles were also on the radar. By 2015, "yellow-label" vehicles registered by the end of 2005 were to be phased out in the three key regions. By 2017, all yellow-label vehicles were slated to be phased out nationwide. The action plan also requires the acceleration of monitoring and the disclosure of PM2.5 data, extending monitoring from 119 county-level cities to all 338 before 2015.

The action plan was deemed the toughest ever, not just for its stringent targets, but also for its performance assessment system, which involves the Organization Department of the Communist Party of China in environmental action plans for the first time. Because the department has the power to appoint or dismiss officials, if local governments fail to reach their targets, it may affect the political futures of the officials involved.

In the first two to three years, most measures focus on the installation of filters to reduce $PM_{2.5}$, sulfur dioxide, nitrogen oxides and other substances. With the progress in air pollution control, strict measures were adopted to push energy-intensive sectors to make their emission reductions stronger by making them super clean, or by reducing their output and even shutting down during heavy air pollution days.

There has been significant progress on air quality. By 2017, compared with 2013, $PM_{2.5}$ concentrations in the Beijing-Tianjin-Hebei region, the Yangtze River Delta region, and the Pearl River Delta region were reduced by 40 percent, 34 percent and 28 percent, respectively. By June 2019, $PM_{2.5}$ concentrations in Beijing were reduced to around 42μg/m^3, nearly half of 2012 levels.

While there have been many arguments about the impact of these strict policies on economic development, the central government remained strongly committed to environmental protection as one of the most important factors in national development. More than 6,000 people were sent from Beijing to all key regions to check progress on pollution prevention in 2016, an unprecedented environmental protection effort by China.

However, there is still a lot of tough work ahead. Many cities still suffer from bad air quality and air pollution prevention actions have become more difficult after the easy options were completed. Ozone (O_3) levels are getting worse and more sectors and emissions have to be covered in the future. Energy transition will be vital in order to reduce greenhouse gas emissions.

PREVENTION MEASURES AREN'T HURTING ECONOMIC DEVELOPMENT

It would seem to be common sense that environmental recovery efforts could have a negative impact on the economy. This has resulted in numerous concerns about the economic impact of China's action plan. But some studies argue that improving environmental quality could create a win-win situation for economic development, what is typically called the Porter Assumption. These studies focus on long-term impacts.

We looked at 2018 data in the sectors regarded as most likely to suffer negative economic impact from air pollution controls. In the Beijing-Tianjin-Hebei region, the most targeted area in China for air pollution control, sectors included manufacturing of cement, steel, bricks, glass, ammonia etc. The data show that profits increased during the most serious period for air pollution control, especially in Hebei Province, the most concentrated heavy-industry region in China. The main reason is that supply side reforms — cutting over-capacity — required in the action plan, pushed the price of these products much higher than in 2015 when there was an oversupply. Another positive factor is that companies in the region were developing new technologies demanded to control air pollution. This was especially true in Beijing, the first Chinese city to work hard to improve air quality.

Our analysis shows that some areas in Hebei Province, where many people expected a negative economic impact in 2018, experienced exactly the opposite, if we consider the emerging industries created to battle air pollution. In the future, these will likely take the lead as efforts to improve air quality increase.

These conclusions should inspire other areas, such as Shandong, Shaanxi and Henan, where doubts remain about the economic costs of managing air pollution. It is necessary to make full use of the opportunities created by the fight against air pollution to promote local economic development. However, those regions that arrive late to the campaign are already behind in the development of emerging technologies. Efforts are needed to clarify understanding and combine environmental governance, atmospheric haze control and reducing greenhouse gas emissions with local industrial development.

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THE FUTURE FOR ENERGY TRANSITION

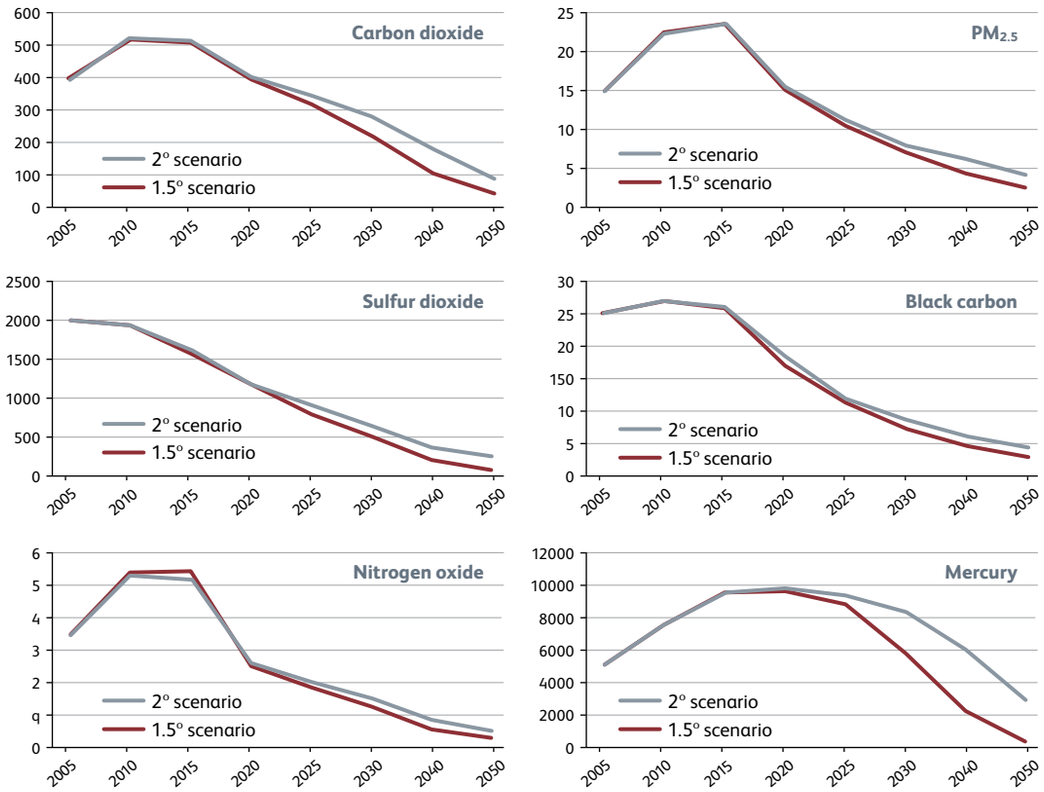
In China, there are already multiple national strategies in place for energy transition, greenhouse gas mitigation and air pollution reduction. Energy transition was first proposed in the 12th Five Year Plan,[2] and it was again strongly pushed as part of the "Energy Revolution" announced by President Xi Jinping in 2014. In the Paris Agreement within the United Nations Framework Convention on Climate Change (UNFCCC), there are targets set until the year 2100 to limit global warming to the ambitious target of 1.5°C. China signed the agreement in 2016, and will support the global target. In the meantime, large-scale actions had already begun in 2013 under the national action plan on air pollution control for the period from 2013 to 2017.

The 12th Five Year Plan has several key areas for energy transition including developing both

2 *China's 12th Five-Year Plan of Energy*, National Energy Administration, 2011, www.nea.gov.cn/131398352_11n.pdf

FIGURE 2 DIFFERENCES IN EMISSIONS UNDER 2°C AND 1.5°C WARMING SCENARIOS

Source: Jiang et al., 2019 (see note 9)



renewable and nuclear energy and promoting natural gas development. In 2014, the energy revolution strategy proposed by Xi was a milestone for energy transition. His targets for a "revolution" were energy consumption, supply, technology and governance. Controlling demand, enhancing efficiency, promoting clean and renewable energy, including nuclear and natural gas, developing new technology and establishing a better energy management regime are key components in the energy revolution strategy. This is the fundamental framework to promote energy transition in China.

The Paris Agreement was adopted in 2015, and China signed it in 2016. In the Agreement, there are targets set for 2100 to check global warming at 1.5°C. China has suggested that peak CO_2 emissions will occur by around 2030, and it will make efforts to peak earlier. Carbon intensity reduction will be 60-65 percent by 2030 compared to 2005, and the share of non-fossil fuels in the energy mix will be 20 percent, while in 2005 it was 11 percent.

China's effective target is to support a global warming cap of 2°C, even though there is not yet a specified reduction target. Studies on the 2°C emission pathway for China show that China's CO_2 emissions could peak before 2025, and will be at a 65 percent carbon intensity reduction by 2050, compared with the peak year.[3,4] As for the 1.5°C target, there are few studies showing a reasonable path to attainment, and it is hard to convince people that this target is achievable. In order to answer the question of whether this target is achievable or not, the Intergovernmental Panel on Climate Change (IPCC) began preparing a special report on the 1.5°C target, which was published in October 2018.[5] The study suggested that global emissions will go to zero between 2050 and 2060, and go into negative emissions afterward.[6] The study for China under the 1.5°C target presents a similar emissions pathway to near zero by 2050.[7]

In the meantime, air pollution prevention is also a key target for the Chinese government. The air pollution control policies that began with the action plan in 2013 have had a strong impact on energy use in China. There is a coal consumption cap and specified reductions in the plan, together with energy efficiency, promotion of renewable energy, use of natural gas, etc. By 2017, the targets in the plan were reached,[8] and they match up very well with ongoing CO_2 emission reduction policies. Driven by these air pollution control measures, China started to control coal use and promote clean energy after 2012. Coal consumption peaked in 2013 in physical units and in 2014 based on standard coal equivalents, and then continued to decline. There was a 4.7 percent reduction in 2015, and 3.7 percent in 2016. With the increase in the use of natural gas and petroleum products, CO_2 emissions began to go down after 2014. Based on energy use data from 2016, around 450 million tons of CO_2 emissions were reduced, accounting for 5 percent of total CO_2 emissions from energy-related activities.

Studies in which I have been involved show that the energy transition will be decided by the long-term target for CO_2 emissions reduction, air pollutant reduction and energy security. A paper I co-authored this year presents the analysis from the IPAC model, by setting up a reduction target for CO_2 emissions under the global 2°C and 1.5°C target.[9] Energy transition, CO_2 emissions and air pollutant reductions will be given based on these targets. Sulfur dioxide (SO2), nitrogen oxides, $PM_{2.5}$, black carbon and mercury will be included.

In the 1.5°C scenario, after reaching peak CO_2 emissions around 2020, there would be a quick reduction by 2030, and then deep cuts to reach negative emissions in 2050. After 2020, there would be 483 million tons of CO_2 reduced per year, with nearly 220 million tons of coal and oil reductions per year. Power generation is the key sector for emissions reduction. Its CO_2 emissions reached a peak in 2015, and will begin a rapid reduction after 2020.

In both scenarios, air pollutants are significantly reduced. By 2050, sulfur dioxide will be reduced by between 83 and 88 percent from 2015 levels in the 2°C and 1.5°C scenarios respectively. Similarly, nitrogen oxides will be reduced by up to 89 percent; $PM_{2.5}$ by as much as 92 percent; mercury by up to 95 percent. These emissions reductions would contribute to reaching the national standard for air quality by 2030. From the results, we found the difference in air pollutant emissions between the two scenarios is not large, which means the energy transition in both scenarios will lead to much lower fossil-fuel use, which is the major source of air pollution (see figure 2).

These studies found that in both scenarios, air pollutants are reduced significantly, which will benefit both the climate-change target and the local air pollution targets. The energy transition to much lower fossil fuel use by 2050 will help reach the targets. There are still few studies on reaching the air quality target by 2050, but air quality is expected to reach WHO standards. For this to be realized, emissions of air pollutants must be reduced to a very low level, which would match up well with the 1.5°C scenario.

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3 Kejun Jiang, Xing Zhuang, Ren Miao, He Chenmin, "China's Role in Attaining the Global 2°C Target," *Climate Policy*, Vol. 13, No. Sup1, 2013, pp. 55-69, dx.doi.org/10.1080/14693062.2012.746070

4 Jiang Kejun, "Secure low-carbon development in China," *Carbon Management*, 3(4), April 2012, pp. 333-335. www.doi.org/10.4155/cmt.12.42

5 *Global Warming of 1.5°C*, IPCC Special Report (Geneva: World Meteorological Organization, 2018), www.ipcc.ch/sr15/

6 D.P. van Vuuren et al., "Carbon budgets and energy transition pathways," *Environmental Research Letters*, 11(7), 075002, www.doi.org/10.1088/1748-9326/11/7/075002

7 Kejun Jiang, Chenmin He, Hancheng Dai, Jia Liu & Xiangyang Xu, "Emission scenario analysis for China under the global 1.5 °C target," *Carbon Management*, 9:5, 481-491, www.doi.org/10.1080/17583004.2018.1477835

8 *China's Policies and Actions for Addressing Climate Change*, Ministry of Ecology and Environment, November 2018, english.mee.gov.cn/News_service/news_release/201812/P020181203536441502157.pdf

9 Kejun Jiang, Sha Chen, Chenmin He, Jia Liu, Sun Kuo, Li Hong, Zhu Songli, Xiang Pianpian, "Energy Transition, CO_2 Mitigation and Air Pollutant Emission Reduction: Scenario Analysis from IPAC Model," *Natural Hazards*, 99 (2019), pp. 1277–1293, www.doi.org/10.1007/s11069-019-03796-w