A. Agriculture Natural Resources, and Rural Development Sector Road Map

1. Sector Performance, Problems, and Opportunities

1. Environmental pressure and climate change. The unprecedented speed of economic development in the People’s Republic of China (PRC) has beneficially transformed the lives of all people in the country and made the PRC economy the second largest in the world. These achievements, however, have not been without adverse environmental consequences, and the ongoing development is considered not environmentally sustainable. Availability of sufficient clean water is increasingly a concern, and land resources are declining because of urbanization, pollution, and degradation. Frequent water pollution incidents, rising reports of soil pollution and land degradation, long-lasting haze and smog pollution occurrences, and concerns about food safety and human health have become challenges for national and local governments. According to recent estimates by the Ministry of Environmental Protection (MEP), the national cost of pollution damage is equivalent to around 6% to 9% of gross domestic product (GDP).

2. The agricultural sector provides food and employment but also contributes to increased environmental degradation, greenhouse gas (GHG) emissions, and air pollution. In 2015, the sector produced 20% of the PRC’s GHG emissions, or 0.82 billion equivalent tons carbon dioxide (CO₂). Ammonium salts (i.e., ammonium sulphate and ammonium nitrate) released as by-products of chemical fertilizer use and livestock farming account for about 7% to 57% of the total ambient particulate matter less than 2.5 microns in diameter (PM₂.₅), a hazardous air pollutant that poses severe health risks. Nitrous oxides, another by-product of excessive fertilizer use, also contribute to PM₂.₅ formation, GHG imbalance in the atmosphere, as well as stratospheric ozone loss. Its terrestrial impacts include soil acidification and freshwater eutrophication that threaten long-term food security; and marine ecosystems.

3. Agricultural production. Agriculture has developed rapidly and has made substantial contributions to the overall economic development of the PRC. Total grain production has grown for 11 consecutive years since 2004. Meanwhile, agricultural production has become more diversified and product quality has improved. As a result, farmers’ incomes have increased substantially, supporting inclusive growth. Contributing factors include better introduction of market mechanisms and participation of multiple private stakeholders in the sector; larger scale production facilitated by land transfer practices, as well as increased application of equipment and advanced technologies.

4. However, the transition to modern agriculture has not been able to keep pace with urbanization and industrialization in the PRC. Natural disasters, which have become more severe and frequent because of climate change, have severely impacted agriculture in the country because of weak agricultural infrastructure and facilities. There is an urgent need to improve the resilience of the sector to climate change. The sector is also facing challenges such

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1 Mainly from rice paddies, livestock, manure management and nitrous oxide (N₂O) emissions from fertilizer application, and energy-related CO₂ emissions which account for about 8% of the total CO₂ emissions.
2 Studies conducted in Europe indicate that the contribution from agricultural ammonia to PM₂.₅ ranges between 10% to 40%. In Europe, total emissions of ammonia from the agricultural sector are around 94%, thus control strategies to reduce ammonia emissions can considerably influence particulate matter concentrations.
as (i) rising prices of labor and inputs; (ii) increasing demand for safe; (iii) high-quality agricultural products; and (iv) constraints on environmental and land resources.

5. **Agriculture sector in the greater Beijing–Tianjin–Hebei (BTH) region.**³ In 2014, agricultural contributions to provincial GDP in Hebei Province and Henan Province were 11.7% and 11.9% respectively, higher than the national average of 9.2% in the same year. Seasonal stalk burning is one of major sources for air pollution in Hebei and Henan Provinces especially in harvesting seasons of wheat and corn in June and November. Shandong Province is the largest agricultural province in the PRC, producing about 10% of the country's biomass stalk. The utilization of the biomass resources for energy recovery will be one of the focused areas to reduce air pollution in Shandong Province. The utilization of the biomass resources for energy recovery will also reduce unnecessary on-field biomass burning.

2. **Government’s Sector Strategy**

6. **Overarching objectives.** The government recognized the massive environmental and ecological challenges that the country is facing, and placed building of an “ecological civilization” as one of the most important policy areas for the country in the Third Plenary Session of the 18th Central Committee of the Communist Party Congress.⁴ Renewed emphasis has been placed on control of air, water, and soil pollution. The unprecedented level of new actions plans and investments provides the timing and opportunity to accelerate the transition to the new path of addressing environmental and ecological challenges. The government’s rural focus under the 13th Five-Year Plan is to continue its efforts to (i) improve resource conservation; (ii) undertake environmental friendly development; and (iii) use and manage land, water, and other natural resources more sustainably.

7. **Agricultural transformation.** Given its fundamental contribution to food security and improvement of rural livelihood, agricultural modernization has been prioritized by the Government of the PRC. The primary objectives are to ensure adequate supply of agricultural products and continuously raise farmers’ incomes so as to close the rural-urban gap. Policies to promote agricultural modernization will focus on (i) improving the capacity, competitiveness, and resilience of agricultural production; (ii) supporting development of agri-business and agricultural value chain systems; (iii) promoting investment in technology, human resources, and innovative management for sector upgrading; and (iv) encouraging participation of private entities and partnership among multiple stakeholders in the sector.

8. The 2015 Decree No. 1 issued by the central government identified several approaches and tasks for accelerating agricultural modernization. They include (i) protecting farmland and upgrading, developing, or rehabilitating large or medium-sized irrigation districts, and constructing on-farm infrastructure to strengthen agricultural production capacity; (ii) developing agriculture suited to local geographical conditions; (iii) establishing information platforms to trace and share quality and safety information of agricultural products; and (iv) promoting water-saving techniques, eco-friendly fertilizers and pesticides, and other pollution-mitigating measures.

³ The greater Beijing–Tianjin–Hebei region includes Beijing and Tianjin municipalities; Hebei, Henan, Shandong, Shanxi and Liaoning provinces; and Inner Mongolia Autonomous Region.

⁴ According to the PRC Government, “ecological civilization” refers to achieving harmony between growth, people, and nature, requiring people to respect, protect, and maintain a harmonious relationship with nature. It includes activities to mitigate ecological damage, relieve pressures on natural resources, and improve the balance between the environment and the economy.
9. The PRC Government has acknowledged the environmental risks posed by the agricultural sector and has committed to promoting and introducing mitigation and adaption strategies to combat climate change. In its Intended Nationally Determined Contributions on climate change, the government has committed to (i) promote the low-carbon development in agriculture, making efforts to achieve zero growth of fertilizer and pesticide utilization by 2020; (ii) control methane emissions from rice fields and nitrous oxide emissions from farmland; and (iii) construct a recyclable agriculture system, promoting comprehensive utilization of straw, reutilization of agricultural and forestry wastes and comprehensive utilization of animal waste by 2030.

3. ADB Sector Experience and Assistance Program

10. The PRC Government and the Asian Development Bank (ADB) have developed a diverse portfolio of projects in agriculture, natural resources, and rural development. Environmental sustainability and climate resilience have been promoted through projects supporting water resource management and conservation, ecosystem management and biodiversity conservation, lake and wetland protection, renewable biomass energy development, and support for dryland farming. Sovereign lending in the natural resources and agricultural sector in the PRC increased sharply during 2011–2015. Non-sovereign lending to agribusiness was also initiated with two transactions (one in cold storage and one in greenhouse agriculture) during 2012–2015.

11. ADB’s sector strategy. ADB will support the PRC to realize its “ecological civilization” ambitions and will assist in identifying and applying innovative interventions that demonstrate increased climate resilience and environmental sustainability through more sustainable use and better protection of natural resources, in particular for those areas where environmental degradation and climate change most impact rural and urban livelihoods. ADB will promote inclusive growth and improve rural livelihoods by helping to increase agricultural productivity, strengthening agricultural and rural infrastructure, promoting application of information technologies, and expanding financial services in rural areas, in line with ADB’s Operational Plan for Agriculture and Natural Resources. Support will be provided for developing value chains, including linking agribusinesses and local entrepreneurs with poor farmers through extension services, rehabilitating rural infrastructure, food safety and possibly food security, environmental sustainability and climate resilience, sustainable agribusiness mitigating soil and water pollution, and access to credits and markets. Non-sovereign assistance will be targeted to farming companies including large-scale livestock farms, food processors, logistics companies, financial intermediaries, and to other projects that enhance productivity and standardization, inclusion of smallholder farmers in value chains, food safety, and pollution control.

12. Financial assistance could play a role in emission reduction efforts, offsetting the higher costs that, at least initially, farmers will face to convert to more sustainable agricultural methods. Investment will target (i) provision of financing to farmers to purchase low-carbon equipment and agriculture inputs; (ii) increase farmer access to and adoption of technology and information; (iii) promote agroforestry and sustainable livestock practices by improving the quality and utilization of crop residues and fodder; (iv) enhancing manure management; and (v) capture of the biogas produced during the anaerobic decomposition of manure in biogas digesters and replace traditional coal and biomass burning in rural PRC.

B. Energy Sector Road Map

1. Sector Performance, Problems, and Opportunities

13. Rapid economic development has accelerated energy demand growth in the PRC. In 2009, the PRC surpassed the United States to become the world’s largest energy consumer. In 2014, the PRC’s energy consumption accounted 23% of global energy consumption, or 4.26 billion tons of standard coal equivalent (tce). Because more than 70% of the PRC’s primary energy consumption comes from coal, economic growth has also been carbon-intensive. From 1990–2013, CO₂ emissions from the PRC increased by 287%, from 2.572 to 9.945 billion tons per year.6

14. The government recognizes the negative and long lasting impacts of high-carbon development and in 2006 started to introduce energy saving and emission control strategies, especially in the energy sector. The government has also set targets to reduce the share of coal in primary energy consumption to 62% by 2020. Since then, substantial progress has been made. From 2011 to 2014, energy intensity in production improved by 13.4% while CO₂ emissions intensity has decreased by 17% from 2010 to 2015.7 In 2014, annual coal consumption declined for the first time in the last 2 decades by 2.9% compared to 2013.8

15. The PRC has also made significant progress in increasing the share of renewable energy generation in its energy mix from 7.8% in 2009 to 11.3% in 2014 and is a world leader in wind power, hydropower generation, and in solar photovoltaic manufacturing. In 2013, 8,030 megawatts of coal-fired generation was retired or shutdown, resulting in a reduction of 1,222.69 million tons of CO₂ emissions in 2014. In 2014, CO₂ emissions reduction from non-fossil fuel sources including hydro, wind, nuclear and solar power was 1,176.72 million tons. As a whole, CO₂ emissions have dropped from 12.76 tons in 1990 to 1.62 tons in 2013 per CNY10,000 of GDP, or 87.31%. Emissions intensity of coal-fired power generation has also decreased from 1.149 kilogram per kilowatt hour in 1990 to 0.855 kilogram per kilowatt hour in 2014.9

16. Other achievements in adjusting the PRC’s energy mix include: (i) an optimization of the energy structure, leading to 32.46% of the total national power generation capacity coming from hydro, nuclear, wind and solar, with only 67.54% left from coal in 2014; (ii) an increase in the ratio of large capacity, high parameter and high efficiency units instead of having smaller but fewer;10 and (iii) a significant achievement in energy saving and emission reduction, with the national net coal consumption rate of fossil fuel fired units falling by 109 gram per kilowatt hour to 318 gram per kilowatt hour since 1990.

17. The PRC’s increased renewable energy production has had a positive impact in reducing overall CO₂ emissions, but CO₂ emissions from coal-fired power generation continues to outpace the increase in renewables and efficiency improvements in fossil fuel-based power generation.

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6 CO₂ emission intensity is the ratio between energy consumption and gross domestic product measured at constant prices.
7 Energy intensity is the ratio between energy consumption and gross domestic product measured at constant prices. Average energy intensity in the PRC was 0.709 tce in 2014.
8 There was a 0.7% reduction of greenhouse gas emissions in 2014 compared to 2013.
10 77.7% of fossil fuel fired plants in 2014 had a capacity of 300 megawatts or above.
2. Government’s Sector Strategy

18. The PRC Government recognizes that its commitment to peak CO₂ emissions by 2030 needs low-carbon transformation and sustainable development that will require substantial capital and willingness to refocus industries and energy production away from high emission production and fossil fuel use. In 2014, the Government passed the “National Plan for Addressing Climate Change (2014–2020),” which stresses the importance of promoting climate change through a holistic and integrated approach. The policy framework focuses on key areas such as energy saving, streamlining energy mix, adjusting industrial structure, ecological construction, and environmental protection. On 16 March 2016, the PRC adopted its 13th Five-Year Plan. The 13th plan, building on the success of the previous plan, sets specific emissions reduction goals and for the first time, includes a total energy consumption cap of 5 billion tce. The 13th plan calls for any new coal-fired power plants to be “ultra-low emissions,” a standard that attempts to make coal-fired power plants as clean as natural gas plants. Moreover, the plan calls for the replacement of coal in non-power sectors either with electricity or natural gas. The plan explicitly calls for the PRC’s oil industry to produce gasoline and diesel suitable for vehicles at the China V standard. China V is equivalent to Euro V, a standard adopted in the European Union in 2009.

19. Successful implementation of both plans will require close coordination between policy, technology and capital, especially between the governments at the provincial level. The low carbon development especially in the BTH region needs to include optimizations of energy consumption for end-user, adjustments of energy mix, energy efficiency improvements and CO₂ capture, utilization and storage. While different measures are important for major energy producing regions with low energy efficiency in Hebei Province, Shanxi Province and Inner Mongolia Autonomous Region than in urban centers such as Beijing and Tianjin Municipality, the entire BTH area needs to make efforts.

3. Provincial Energy Sector

3.1 Hebei Province

20. Hebei’s Energy Sector. In 2014, Hebei’s energy intensity was 1.04 substantially higher than the national average of 0.67 and its ferrous metals industry, and power and heating sector accounted for 16% and 15% of the PRC’s total energy consumption respectively. Industry has been identified as a critical sector for intervention as it consumed about 79% of the province’s total energy consumption and produced more than 30% and 44% of the province’s PM₁₀ and CO₂. The province’s other energy intensive heavy industries include power, steel, cement, coking, glass, and other manufacturing industries and should be the key targets for energy conservation and air pollution reduction.

21. Hebei Provincial Government’s Energy Sector Strategy. Since 2010, the province has issued comprehensive policies to improve energy efficiency and reduce emissions especially in energy and carbon intensive industries. Implementation and monitoring of the policies has proved to be challenging as many actions related to upgrading the facilities takes time. In its 12th plan, Hebei Province set targets to (i) reduce its energy intensity by 18%, (ii) reduce coal consumption to below 85% of its primary energy source, and (iii) introduce more than 6% of non-fossil fuel to its energy mix by the end of 2015. The implementation of energy consumption and energy intensity reduction measures has had mixed results. In 2014, the total energy consumption of high revenue generating industrial enterprises was 203 million tce, a
decrease of 4.1%, and energy intensity fell by 7.2%. Non-fossil fuel in the energy mix increased to 4.5% by end of 2014, but falls short of the 6% target.

22. **Focused Areas for the Hebei Province.** The following areas should be considered for Hebei under the proposed project: (i) Industry facilities upgrade to conserve energy and reduce air emission. In Hebei Province, the key industries for both energy conservation and air pollution control are energy intensive heavy industries including power, steel, cement, coking, glass, and other manufacturing industries; (ii) Adjustment of energy mix by reducing coal consumption and promoting clean energy. For medium- and long-term development objectives, Hebei Province needs to intensify efforts to further reduce the share of coal in their energy supply mix and increase the use of low carbon energy sources and cleaner fuels; and (iii) Promotion of biomass and other clean energy in rural area. Hebei is also an agricultural province. Contribution of the agriculture sector to the provincial GDP was 11.7% in 2014, compared to only 0.75% in Beijing and 1.28 in Tianjin with a national average of 9.2%. In the agriculture sector, seasonal stalk burning is one of the major sources for air pollution in Hebei especially in harvesting seasons of wheat and corn in June and November. In 2015, about 9.3% of agriculture stalk was utilized for energy recovery. Increase biomass utilization to reduce unnecessary on-field biomass burning will be one of the focused areas in Hebei energy sector.

### 3.2 Shanxi Province

23. **Shanxi’s Energy Sector.** In 2014, the province’s overall energy intensity at 1.56 was the worst within BTH region and more than double the national average. The province’s industrial sector consumed about 82% of Shanxi’s total energy consumption in 2014 with mining and washing of coal accounting for 31%, and processing of petroleum, coking, processing of nuclear fuel accounting for 10% of the PRC’s respective total energy consumption in the same year. Apart from the power sector, energy intensive heavy industries including steel, cement, coking, glass, and other manufacturing industries should be the key targets to address both energy conservation and air pollution issues in Shanxi.

24. **Shanxi Provincial Government’s Energy Sector Strategy.** Since 2010, the Shanxi Province has issued a number of policies to improve energy efficiency and reduce emissions, including comprehensive measures for energy and carbon intensive industries. In its 12th plan, Shanxi Province set targets of PM$_{2.5}$ reduction of 20% by 2017, energy intensity reduction by 16% and CO$_2$ emission reduction of 17% by the end of 2015. By implementing measures, both energy consumption and energy intensity fell during the planning period. In 2014, the total energy consumption in high revenue generating industrial enterprises was 160.7 million tce, a reduction of 5.24% and energy intensity fell by 4.2% compared to 2013 levels.

25. **Focused Areas for the Shanxi Province.** The following areas should be considered as the focused areas for Shanxi under the proposed project: (i) Industry facilities upgrade to conserve energy and reduce air emission. In Shanxi Province, the key industries for both energy conservation and air pollution control are energy intensive heavy industries including mining, washing of coal, processing of petroleum, coking, processing of nucleus fuel, power, steel, cement, coking, glass, and other manufacturing industries. Shanxi set target to phase out (a) coal-fired boilers with capacity below 20 tons per hour by 2016, (b) 6.7 million tons of excessive capacity in iron and steel sector by 2017, and (c) 18 million tons of excessive capacity in coking sector by 2017; and (ii) Adjustment of energy mix by reducing coal consumption and promoting clean energy. Shanxi needs to intensify efforts to further reduce the share of coal in their energy mix and increase the use of low carbon energy sources and cleaner fuels.
3.3 Inner Mongolia Autonomous Region (IMAR)

26. **IMAR’s Energy Sector.** In IMAR, the industrial and power sectors are key sectors for intervention as they produced more than 24% and 68% of IMAR’s emissions, respectively. In 2014, IMAR’s overall energy intensity was 1.04, the second highest within the BTH region and higher than the national average. IMAR’s industrial sector consumed about 80% of IMAR’s total energy consumption in 2014 and mining and washing of coal accounted for 12% of the PRC’s respective total energy consumption during the same year.

27. **IMAR Government’s Energy Sector Strategy.** Since 2010, IMAR has issued a number of policies to improve energy efficiency and reduce emissions. In its 12th plan, IMAR set targets to reduce energy intensity by 15% at the end of 2015 and reduce PM$_{2.5}$ emissions by 10% by the end of 2017. By implementing measures, energy intensity fell during the planning period. In 2014, the total energy consumption of high revenue generating industrial enterprises increased by 7.39% to 129.7 million tce, but energy intensity fell by 3.94% compared to 2013 levels.

28. **Focused area for IMAR.** The following areas should be considered as the focused areas for IMAR under the propose project: (i) Industry facilities upgrade to conserve energy and reduce air emission. In IMAR, the key industries for both energy conservation and air pollution control are energy intensive heavy industries including mining, washing of coal, processing of petroleum, coking, processing of nucleus fuel, power, steel, cement, coking, glass, and other manufacturing industries. IMAR set a target to phase out (a) coal-fired boilers with a capacity below 20 tons per hour by 2016 (b) 0.8 million tons of calcium carbide excessive capacity by 2014, (c) 1.82 million tons of excessive capacity in coking sector by 2017, (d) 4.59 million tons of cement excessive capacity by 2017, and (e) 1.82 million tons of excessive capacity in coking sector by 2017; and (ii) Adjustment of energy mix by reducing coal consumption and promoting clean energy. IMAR needs to intensify efforts to further reduce the share of coal in their energy mix and increase the use of low carbon energy sources and cleaner fuels as IMAR is endowed with rich renewable resources.

3.4 Shandong Province

29. **Shandong’s Energy Sector.** More than 27% of PM$_{2.5}$ emitted in Jinan City is from coal consumption and about 24% from dust production. When looking at CO$_2$ emissions in Shandong Province, 35% of emissions are generated in the industrial sector and 57% in the power sector, clearly highlighting the areas where an intervention is necessary to successfully improve air quality and reach GHG emission targets in Shandong. In 2014, the province’s overall energy intensity was 0.64, almost the same as the national average and the industrial sector alone consumed about 83% of the province’s total energy consumption. Within Shandong’s industrial sector, processing of petroleum, coking, processing of nucleus fuel accounted for 14% and manufacture of raw chemical material and chemical products for 12% of the PRC’s respective total energy consumption in 2014.

30. **Shandong Government’s Energy Sector Strategy.** Since 2010, the province has issued policies to improve energy efficiency and reduce emissions. In its 12th plan, Shandong set targets to reduce energy intensity by 9% in the power and heating sector, 10% in the petrochemical, iron and steel, cement and glass sectors, 15% for refineries, 12% for coking, and 17% for the nonferrous industry by the end of 2015. It also set PM$_{2.5}$ emission reduction targets of 20% by the end of 2015, 35% by end of 2017, and 50% by end of 2020. By implementing

$^{11}$ Shandong’s Clean Air Action Plan is more comprehensive than others and expanded their plan to 2020.
measures, both energy consumption and energy intensity fell during the plan period. In 2014, the energy intensity fell by 5% compared to 2013 levels.

31. **Focused areas for the Shandong Province.** The following areas should be considered as the focused areas under the propose project in Shandong: (i) Industry facilities upgrade to conserve energy and reduce air emission. In Shandong, the key industries for both energy conservation and air pollution control are power generation and energy intensive heavy industries including processing of petroleum, coking, processing of nucleus fuel; (ii) Adjustment of energy mix by reducing coal consumption and promoting clean energy. Shandong needs to intensify efforts to further reduce the share of coal in their energy supply mix and increase the use of low-carbon energy sources and cleaner fuels; and (iii) Promotion the utilization of biomass. As the biggest agricultural province, Shandong produced about 10% of the biomass stalk in the PRC. The utilization of the biomass resources for energy recovery will also be another focused area to reduce air pollution in Shandong.

3.5 Liaoning Province

32. **Liaoning's Energy Sector.** In Liaoning Province, 34% of CO\(_2\) emissions are generated in the industrial sector and 51% in the power sector. These numbers show that an intervention is necessary both in the power and the industrial sector to successfully improve air quality and reach GHG emission targets. In 2014, the province’s overall energy intensity was 0.79, just above the national average. In the same year, the province’s industrial sector consumed 84% of Liaoning’s total energy consumption. In 2014, Liaoning’s mining and washing of coal and production and distribution of electric power and heat accounted for 11% and 30% of the PRC’s respective total energy consumption. Apart from the power sector, energy intensive heavy industries including steel, cement, coking, glass, and other manufacturing industries should be key targets to improve energy conservation and reduce air pollution in Liaoning.

33. **Liaoning Provincial Government’s Energy Sector Strategy.** Liaoning set target of reducing PM\(_{2.5}\) by 10% by 2017 and 17% of energy intensity reduction by 2015. By implementing measures, both air pollution and energy intensity fell during the planning period. In 2014, energy intensity had fallen by 5.08% comparing to 2013.

34. **Focused areas for the Liaoning Province.** The following areas should be considered as the focused areas under the propose project in Liaoning: (i) Industry facilities upgrade to conserve energy and reduce air emission. In Liaoning, the key industries for both energy conservation and air pollution control are energy intensive heavy industries including smelting and pressing of ferrous metals and production and distribution of electric power and heat; and (ii) Adjustment of energy structure by reducing coal consumption and promoting clean energy. Liaoning needs to intensify efforts to further reduce the share of coal in their energy supply mix and increase the use of low carbon energy sources and cleaner fuels.

3.6 Henan Province

35. **Henan’s Energy Sector.** In Henan Province, 22% of CO\(_2\) emissions are generated in the industrial sector and 72% in the power sector. These numbers show that an intervention is necessary both in the power and the industrial sector to successfully improve air quality and reach GHG emission targets. In 2014, the province’s overall energy intensity was 0.68, similar to the national average. The province’s industrial sector consumed about 73% of Henan’s total energy consumption and manufacture of non-metallic mineral products accounted for 11% of the PRC’s respective total energy consumption during 2014.
36. **Henan Provincial Government’s Energy Sector Strategy.** In its 12th plan, Henan set targets to reduce carbon intensity by 24%, PM$_{2.5}$ by 10%, and PM$_{10}$ by 15%. By implementing measures, both energy consumption and energy intensity fell during the planning period. In 2014, the energy intensity fell by 4.06%.

37. **Focused Areas for the Henan Province.** The following areas should be considered as the focused areas under the propose project in Henan: (i) Industry facilities upgrade to conserve energy and reduce air emission. In Henan, the key industries for both energy conservation and air pollution control are energy intensive heavy industries including manufacture of raw chemical material, smelting and pressing of ferrous metals and manufacturing of nonmetallic mineral products. During the 12th plan period, Henan set targets to reduce production in key industries including: 4.07 million tons of steel, 2.47 million tons of iron, 5.9 million tons of coking, and 15.65 million tons of cement; (ii) Adjustment of energy mix by reducing coal consumption and promoting clean energy. During 12th Plan period, Henan set a target to increase non-fossil fuel energy in the energy mix to 5.5% and a target to increase natural gas use in the urban residential sector to at least 95% by end of 2015. Henan needs to intensify efforts to further reduce the share of coal in their energy mix and increase the use of low carbon energy sources and cleaner fuels; and (iii) Promotion the utilization of biomass. Henan is one of the top ten biggest agricultural provinces. Contribution of the agriculture sector to the provincial GDP was 11.9% in 2014. In the agriculture sector, seasonal stalk burning is one of the major sources for air pollution in Henan. In 2015, 9% of the biomass resources were used for energy recovery in Henan, this should be increased to reduce unnecessary on-field biomass burning.
C. Environment (Air Pollution) Sector Road Map

1. Sector Performance, Problems, and Opportunities

38. **Air pollution problems in the PRC.** Decades of economic growth in the PRC have resulted in the severe degradation of the air, water, and soil quality throughout the country. The sustained economic growth has lifted around 500 million people out of poverty, but the growth has been resource- and energy-intensive, driven by heavily polluting industries and coal-fired energy production, and driving an explosion in automobile use. Air quality, in particular, has suffered. In the BTH region, a very dry climate with little precipitation and a high concentration of pollutants, the effects have been pronounced. The region accounts for 42% of total CO\(_2\), 39.7% of sulfur dioxide (SO\(_2\)), 39.4% of total nitrogen oxides (NO\(_x\)), and 44% of total smoke and dust pollution in the PRC in 2014.

39. Recognizing the importance of combating air pollution as part of its wider plan for economic restructuring and sustainable, low-carbon development, the Government of the PRC has taken steps to improve air quality. Significant progress has been made so far, but the region’s air quality is still consistently the worst in the country, and far below World Health Organization (WHO) and national ambient air quality standards (NAAQS). A recent study which analyzed PM\(_{2.5}\) concentration levels in 190 Chinese cities from 2014–2015 found that not one city experienced an annual mean PM\(_{2.5}\) concentration meeting WHO guidelines. The study also found that more than 95% of the urban population in the BTH region resided in cities with annual mean PM\(_{2.5}\) concentrations that exceeded NAAQS. More recently, the MEP, which measures the status of air quality in key regions and 74 prefecture-level cities, reported that the top 10 cities with the poorest air quality in the first 6 months of 2016 were all in the BTH region.

2. Government’s Sector Strategy

40. **Government initiatives, plans, and challenges.** The central government is scaling up its efforts to address this environmental challenge, together with climate change. The NAAQS were updated in 2012 to be equivalent with those in most developed countries. The new environmental protection law came into force in 2015. In 2013, the State Council issued the Action Plan on Prevention and Control of Air Pollution (CAAP) 2013–2017, which sets targets for the key regions including BTH. The CAAP set the toughest targets for the BTH region (Table 1), through 10 key measures (Table 2). In 2013–2014, the central government budgeted CNY15 billion to improve the air quality in six northeastern provinces.

41. On 16 March 2016, the PRC adopted the 13th Five-Year Plan. The 13th plan builds on the success of the previous plan, requiring greater reductions in the emissions of many pollutants and adding a major air pollutant, volatile organic compounds (VOCs), to those with specific reduction goals, or “hard” targets (Table 3). For the first time, the plan includes a total energy consumption cap of 5 billion tce. The plan sets ambitious targets for air quality progress, requiring hundreds of cities to meet “good” or “excellent” standards 80% of the time (meaning they must score below 100 on PRC’s Air Quality Index of 0–500). The 80% target is additional to

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12. A 40% reduction in PM\(_{2.5}\) from 2013 will still be about 50 microgram per cubic meter (\(\mu g/m^3\)) or about 50% higher than the national standard. The air quality standard for PM\(_{2.5}\) (GB 3095-2012) in the PRC is 35\(\mu g/m^3\), compared with 15 \(\mu g/m^3\) in the United States and Japan, and 10\(\mu g/m^3\) recommended by the World Health Organization.


14. Nine out of ten cities were in Hebei Province with one city in Shandong Province.

15. Air quality indicators include the following pollutants: PM\(_{2.5}\), PM\(_{10}\), SO\(_2\), NO\(_x\), carbon monoxide, and ozone.
a target to reduce by 25% the number of polluted days, and to reduce by 18% the number of days when PM$_{2.5}$ exceeds allowable limits. The plan also steps up the reduction targets for SO$_2$ and NO$_x$, two major air pollutants that had been in previous plans.

**Table 1: Average Annual PM$_{2.5}$ Concentration Reduction Targets**

<table>
<thead>
<tr>
<th>Province (key area)</th>
<th>Target (%)</th>
</tr>
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<tbody>
<tr>
<td>Beijing</td>
<td>(25)</td>
</tr>
<tr>
<td>Tianjin</td>
<td>(25)</td>
</tr>
<tr>
<td>Hebei</td>
<td>(25)</td>
</tr>
<tr>
<td>Category 1 polluted cities$^a$</td>
<td>(33)</td>
</tr>
<tr>
<td>Category 2 polluted cities$^b$</td>
<td>(30)</td>
</tr>
<tr>
<td>Shanxi</td>
<td>(20)</td>
</tr>
<tr>
<td>Shandong</td>
<td>(20)</td>
</tr>
<tr>
<td>Henan</td>
<td>(15)</td>
</tr>
<tr>
<td>Liaoning</td>
<td>(10)</td>
</tr>
<tr>
<td>Inner Mongolia</td>
<td>(10)</td>
</tr>
</tbody>
</table>

$^a$ Shijiazhuang, Tangshan, Baoding, Langfang, Dingzhou, and Xinji.
$^b$ Xingtai and Handan.

**Table 2: 10 Key Areas of Air Pollution Prevention and Control Measures**

(a) Reduce coal consumption by 83 million tons in the BTH region. This target is to be achieved by (i) improving energy efficiency in the industrial, power, and building sectors; and (ii) increasing the use of clean energy, particularly natural gas and renewable energy, with specific targets to increase natural gas consumption by 50 billion m$^3$ and the share of non-fossil fuels in primary energy to 15% in the BTH Region by 2017.

(b) Reduce emissions from (i) point sources in the industrial and power sectors by implementing end-of-pipe measures for particulates removal, desulfurization, and denitrification; (ii) area sources to reduce dust emissions; and (iii) mobile sources in the transport sector by increasing public transport, improving fuel quality, phasing out inefficient vehicles, and promoting electric and compressed natural gas.

(c) Increase the use of market mechanisms and expand green financing to energy efficiency, clean energy, and emission reduction investments by scaling up green financing from domestic banks and piloting innovative financing models and products.

(d) Adjust economic structure by closing down inefficient energy-intensive industries.

(e) Accelerate technological innovation.

(f) Strengthen environmental standards and permitting for newly built infrastructure.

(g) Strengthen legal framework and enforcement.

(h) Establish regional collaboration mechanisms, particularly in the BTH Region.

(i) Establish environmental monitoring and warning systems.

(j) Specify the responsibilities of the government, enterprises, and citizens.

PM$_{2.5}$ is the air pollutant that brings particular health concern to the population.
Table 3: Key Targets for 13th Five-Year Plan (%)

<table>
<thead>
<tr>
<th></th>
<th>12th Plan Targets (Compared to 2010)</th>
<th>12th Plan Achievements (Compared to 2010)</th>
<th>13th Plan Targets (Compared to 2010)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Intensity (Energy Consumption per Unit of GDP)</td>
<td>(16)</td>
<td>(18.2)</td>
<td>(15)</td>
</tr>
<tr>
<td>Carbon Intensity (Carbon Emissions per Unit of GDP)</td>
<td>(17)</td>
<td>(20)</td>
<td>(18)</td>
</tr>
<tr>
<td>Non-Fossil Fuel Percentage</td>
<td>11.4</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>Sulfur Dioxide (SO₂)</td>
<td>(8)</td>
<td>(18)</td>
<td>(15)</td>
</tr>
<tr>
<td>Nitrogen Oxides (NOₓ)</td>
<td>(8)</td>
<td>(18.6)</td>
<td>(15)</td>
</tr>
<tr>
<td>Ammonia Nitrogen</td>
<td>(10)</td>
<td>(13)</td>
<td>(10)</td>
</tr>
<tr>
<td>Chemical Oxygen Demand (COD)</td>
<td>(10)</td>
<td>(12.9)</td>
<td>(10)</td>
</tr>
<tr>
<td>Forest Coverage</td>
<td>21.7</td>
<td>21.63</td>
<td>23.04</td>
</tr>
</tbody>
</table>

42. One major addition to the 13th plan is the target to reduce VOCs, which are emitted from a wide range of industrial processes not limited to fossil fuels (especially gasoline) such as paints and solvents. This is the first time a VOC target has appeared in a five-year plan, and VOCs are a critical component of both PM₂.₅ and ozone formation. The plan aims to reduce VOCs nationwide by 10% or more, with an emphasis on major cities and industries. Most media coverage of the PRC’s air pollution problems is focused on PM₂.₅, but PM₂.₅ is a secondary pollutant, produced in the air from other pollutants that the PRC regulates, including SO₂ and NOₓ. The addition of a target for VOCs is ambitious because it requires regulating many more sources of pollution than SO₂ and NOₓ.

43. The largest sources of air pollution are coal combustion for electricity and heat, and automobiles. The 13th plan calls for any new coal-fired power plants to be “ultra-low emissions,” a standard that attempts to make coal-fired power plants as clean as natural gas plants. The plan also calls for the replacement of coal in non-power sectors either with electricity (where pollution is easier to treat) or natural gas. The plan explicitly calls for PRC’s oil industry to produce gasoline and diesel suitable for vehicles at the China V standard. China V is equivalent to Euro V, a standard adopted in the European Union in 2009.

3. Air quality and emissions in the BTH Region

44. Sources of pollution in BTH. Among the pollutants, PM₂.₅ has the most severe impact on public health. WHO has concluded that no amount of PM₂.₅ is safe. An epidemiological study by the Chinese Academy of Sciences in Beijing showed the correlation between levels of ambient particulate matter and mortality from cardiovascular and respiratory diseases.¹⁷ The results confirm research findings from the United States and Europe. In the greater BTH region, PM₂.₅ is generated and formed in the atmosphere by emissions from (i) industries, (ii) continuous

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coal burning for electricity generation and heating boilers in urban and rural areas, (iii) motor vehicle emissions, and (iv) the burning of agricultural biomass waste.\footnote{Open burning of harvesting waste and direct burning of biomass, such as crop stalks and firewood, for cooking, water heating, and space heating emit black carbon, an ingredient of PM$_{2.5}$ and short-lived climate forcing agent.}

45. The sources of primary PM$_{2.5}$ in the region, accounting for 54% and 29% of pollution are industrial processes and the residential sector, respectively. Industrial processes include the steel, cement, and coking sectors. The residential sector emissions are from coal and stalk burning. Moreover, the power sector, heating, industrial boiler and the transportation sector represent the other 4%, 3%, 6%, and 4%, respectively, of the primary PM$_{2.5}$ emissions. The sources of secondary PM$_{2.5}$ are SO$_2$, NO$_X$, VOCs, and ammonia (NH$_3$), primary air pollutants that are produced from a wide range of industries. Industrial boilers, industrial processes (sinter and industrial furnaces), the power sector, the residential sector, and the heating sector contribute 39%, 19%, 17%, 15%, and 8% of SO$_2$ emissions, respectively.\footnote{Secondary PM$_{2.5}$, formed through the chemical transformation of gaseous primary pollutants such as SO$_2$, NO$_X$, certain VOCs, and NH$_3$ accounts in Hebei for 59% of the total fine particulate.} The transportation sector, industrial boilers, the power sector, heating and industrial processes (mainly cement industry) are the main sources of NO$_X$ emissions, accounting for 28%, 27%, 24%, 10%, and 7%, respectively. And about 40%, 26%, and 9% of VOCs emissions are from solvent use, industrial process, and residential sector, and transportation sector, respectively. NH$_3$ emissions are mainly from nitrogen fertilizer application and livestock farming. Pollution sources in the region contribute to 28%–36% of PM$_{2.5}$ recorded in Beijing, and under certain weather conditions, to as much as 50%. Much of the pollution is attributable to sources in Hebei Province. Table 4 and Figure 1 show SO$_2$, NO$_X$, and PM$_{2.5}$ emissions in the BTH region and their proportions in 2014. For the BTH region, the most effective control measures for SO$_2$ emission reductions are energy mix adjustment measures,\footnote{Energy accounts for 39.5% of total SO$_2$ reductions.} followed by desulfurization in the power sector (22.8%). The most effective control measures for NO$_X$ emission reductions are power sector denitrification,\footnote{Power sector denitrification is accounting for 46.33% of total NO$_X$ reductions.} followed by reductions from vehicles (19.6%) and energy mix adjustment measures (19.1%). The most effective control measures for primary PM$_{2.5}$ emission reductions are upgrades to dust collectors in the steel industry (28.7%),\footnote{Upgrades to dust collectors in the steel industry contribute to 28.7% of primary PM$_{2.5}$ reductions.} and also measures to adjust the energy mix (20.3%).

### Table 4: SO$_2$ and NO$_X$ Emissions in Greater BTH Region and Their Proportions in 2014

<table>
<thead>
<tr>
<th>Region</th>
<th>SO$_2$ (thousand tons)</th>
<th>NO$_X$ (thousand tons)</th>
<th>PM$_{2.5}$ ($\mu g/m^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beijing</td>
<td>78.9</td>
<td>151</td>
<td>85.9</td>
</tr>
<tr>
<td>Tianjin</td>
<td>209.2</td>
<td>282</td>
<td>83.0</td>
</tr>
<tr>
<td>Hebei</td>
<td>1,190</td>
<td>1,512</td>
<td>102.0</td>
</tr>
<tr>
<td>Total in core BTH Region</td>
<td>1,478.1</td>
<td>1,945</td>
<td>93.0</td>
</tr>
<tr>
<td>Proportion of core BTH to national total</td>
<td>8.9%</td>
<td>9.4%</td>
<td></td>
</tr>
<tr>
<td>IMAR</td>
<td>1,312.4</td>
<td>1,258</td>
<td>44</td>
</tr>
<tr>
<td>Shandong</td>
<td>1,590.2</td>
<td>1,593</td>
<td>72.5</td>
</tr>
<tr>
<td>Liaoning</td>
<td>994.6</td>
<td>902</td>
<td>62</td>
</tr>
<tr>
<td>Henan</td>
<td>1,198.2</td>
<td>1,422</td>
<td>87.6</td>
</tr>
<tr>
<td>Shanxi</td>
<td>1,255.4</td>
<td>1,069</td>
<td>67.7</td>
</tr>
<tr>
<td>National total</td>
<td>19,744</td>
<td>20,780</td>
<td></td>
</tr>
<tr>
<td>Proportion of greater BTH to national total</td>
<td>39.7%</td>
<td>39.4%</td>
<td></td>
</tr>
</tbody>
</table>

$\mu g/m^3 =$ micrograms per cubic meter, NO$_X =$ nitrogen oxides, PM$_{2.5}$ = fine particulate matter, SO$_2 =$ sulfur oxide.

Source: Municipal and Provincial Yearbooks.
Figure 1: Air Pollution Data in 2014 in the BTH Region

- **INNER MONGOLIA**
  - PM$_{2.5}$: 44.0
  - SO$_2$: 1,312.4
  - NO$_x$: 1,258.0

- **BEIJING**
  - PM$_{2.5}$: 85.9
  - SO$_2$: 78.9
  - NO$_x$: 151.0

- **HEBEI**
  - PM$_{2.5}$: 102.0
  - SO$_2$: 1,100.0
  - NO$_x$: 1,512.0

- **SHANXI**
  - PM$_{2.5}$: 67.7
  - SO$_2$: 1,255.4
  - NO$_x$: 1,069.0

- **LIAONING**
  - PM$_{2.5}$: 62.0
  - SO$_2$: 994.6
  - NO$_x$: 902.0

- **TIANJIN**
  - PM$_{2.5}$: 83.0
  - SO$_2$: 206.2
  - NO$_x$: 212.0

- **SHANDONG**
  - PM$_{2.5}$: 72.5
  - SO$_2$: 1,093.2
  - NO$_x$: 1,093.2

- **HENAN**
  - PM$_{2.5}$: 87.6
  - SO$_2$: 1,198.2
  - NO$_x$: 1,422.0

Data from yearbooks.
Annual average concentration of PM$_{2.5}$: $\mu g/m^3$
SO$_2$: thousand tons
NO$_x$: thousand tons
D. **Finance (Green Finance) Sector Road Map**

1. **Sector Performance, Problems, and Opportunities**

46. Green finance pursues coordinated development between financial activities, environmental protection, and ecological balance with the end view of realizing sustainable economic and social development. Green finance in the PRC has been reinforced by a series of policies and institutional arrangements directing public and private capital to support environmental, energy-saving, clean energy, and other green industries through financial services such as loans, private equity, bond and stock issuance, as well as insurance. Roughly 3% of GDP is estimated to be required for investment in green industries per year in the coming 5 years. The PRC Government is expected to fund roughly 10%–15% of this total. The remainder will have to come from private investors. The market currently fails to reward investors for the positive externalities of green projects. Attracting financial resources to green industries therefore remains a major policy challenge.

47. The history of green investment in the PRC can be traced to investments in pollution control made in the 1970s. Between 1973 and 1981, public investment in pollution control was low, amounting to CNY504 million over 8 years; representing 0.05% of national fiscal expenditure. Investment levels rose after environmental protection was formally included in PRC’s 6th plan in 1982, reaching CNY16 billion by 1991. By 2012, investment in pollution control had reached CNY825.3 billion or 1.6% of GDP. More recent investments in waste management, forestry, and low-carbon electricity generation have brought green investment levels in the PRC from CNY717 billion in 2008 to CNY1.642 billion in 2012, with an annual growth rate of 23%.

48. The development of green industries and the restructuring of traditional industries toward more energy saving and environmentally-friendly systems requires substantial investment. State budgetary funds are currently an important source of investment. Most private sector investment comes as commercial loans or from companies’ own revenues. Bond and equity markets for green investment are less developed. The current levels of investment in green development fall far short of what is needed. More diversified and innovative market-based financing mechanisms must be developed to meet the PRC Government’s investment targets. The following issues, among others, are key challenges that will need to be addressed in order to promote green finance in the PRC.

49. **Insufficient channeling of green financing from the financial system.** The PRC’s financial system has yet to provide sufficient support for environmental protection. Green credit is developing rapidly, but it still takes time to establish a fully functioning green credit system in the banking sector. Specific gaps include the inadequate implementation of green credit policy, a lack of institutional capacity, the absence of diverse financial instruments and technical policies, lack of environmental performance evaluation guidelines, and a lack of proper supervision and constraint mechanisms.

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23 Green industries refer to any industries providing products and services that saves energy, and protects and improves the environment.

24 About CNY2 trillion.
50. **Lack of favorable policy and legal framework.** The PRC’s environmental policies and legal systems need to be further improved to support green financing, though there have been achievements. Since the 1980s, the State Council, MEP, and the People’s Bank of China (PBOC) have released a series of policies related to environment protection and credit. In 2007, MEP, PBOC and the China Banking Regulatory Commission jointly released *Opinion on Enforcing Policies and Regulations on Environmental Protection to Prevent Credit Risk (2010)*, aimed at strengthening the coordination between environmental protection and credit management, reinforcing environmental supervision and management, and avoiding credit risks. Building on these efforts, the policy and legal framework needs to be further extended to support the financial sector in providing green finance. The PRC has incorporated energy conservation and emission reduction targets into the performance evaluation index system of local governments, but environmental policies are not being uniformly and consistently implemented.

51. **Lack of incentives to mobilize private capital for green projects.** The current policy framework for green finance is inadequate. It will be critical to mobilize more private capital provide a better enabling environment for green finance. Various policy options must be explored and assessed. Proper systems must be put in place to measure the environmental benefit of green investment projects. Institutional capacity must also be built. Shareholders, investors, and employees of financial institutions in the PRC generally lack awareness of the importance of environmental protection and social responsibility. Relevant supporting systems have not yet been established in the decision-making process of financial institutions’ management, and there is a lack of incentive mechanisms meeting green finance development needs. As a result, financial institutions lack professional environmental assessment, management skills, and knowledge, and are burdened with high information acquisition costs.

52. **Lack of a longer-term strategy and coordinating policy frameworks from relevant authorities.** Currently, green finance policy objectives of financial regulatory authorities are still limited to controlling loan provisions for energy-consuming, high-pollution and resource-based enterprises in order to realize short-term energy conservation and emission reduction targets. There is a lack of longer-term strategy supporting policies and effective coordinating mechanisms among authorities for promoting green finance. In addition, government authorities’ capacity building efforts through various international cooperation opportunities on green finance have been limited. Thus, financial institutions tend to lag behind the latest developments and international best practice on green finance, environmental risks assessment, and management techniques.

53. **Lack of appetite from commercial banks to provide green financing to small and medium-sized enterprises (SMEs).** A mid- and long-term strategy and instrument needs to be established to shift green investment into energy- and resource-intensive SMEs with high polluting emissions. In the PRC, SMEs play an important role in economic development, contributing more than 60% to national GDP and providing more than 80% of new urban jobs. Industrial SMEs have a potential to improve energy
efficiency by more than 25%. SMEs however, generally consume more energy per unit output than large enterprises in the same industry due to lack of economies of scale, use of outdated technologies and poor incentives such as weak monitoring and enforcement regimes. SMEs also face technical and financial barriers to address energy efficiency improvement. Although the Government of the PRC is now trying to accelerate environmentally focused reforms in the overall financial system by introducing various policy initiatives and instruments, commercial banks and private sector financiers are still reluctant to finance green projects and green SMEs. As an effective alternative, an innovative green financing platform could be established to provide various financing options for green projects and SMEs. These include debt, equity, guarantee, and mezzanine financing as a priming tool to mainstream green finance, to demonstrate as a model case, and to catalyze more private sector investments.

54. The challenge of increasing public and private sector investment in green projects is not just a lack of financial resources. There are significant amounts of private capital seeking green investment opportunities. The challenge is efficiently matching this private capital to existing and new green opportunities. Development of the necessary financial infrastructure is the key to mainstream the green finance in the PRC.

55. The PRC Government has been taking initiatives in creating the policy and regulatory environment for attracting private capital. In 2015, the PRC announced its intention to merge its seven experimental carbon exchanges into a national market by 2017. Adding to the existing Green Credit Guideline and Green Bond Guideline, Green Insurance and Green Stock Market Guidelines are being drafted and prepared. With the extensive government support and policy initiatives based on the PRC’s strong commitment to improve overall financial markets by deregulation, the potential growth for green financing is promising.

2. Government’s Sector Strategy

56. The 13th plan of the PRC, 2016–2020, serves as a main document to help the PRC achieve its development goal of inclusive and sustainable growth by 2020. The government aims to (i) realize an “ecological civilization” to promote sustainable development and help curb costs associated with resource depletion and environmental damage; 25 (ii) promote energy conservation, emissions reduction, and low-carbon development to help address climate change; and (iii) establish a national carbon emission trading system, among others. The government also emphasizes the importance of promoting initiatives to reduce air pollution in the Beijing–Tianjin–Hebei region.

57. Role of the private financial sector. The Government in its 13th plan plans to introduce financial and economic reforms to develop green financing markets and introduce incentives to expand green finance as part of steps to address the dominance of quasi-state owned banks and relatively under-developed capital markets.

25 “Ecological civilization” refers to achieving harmony between growth, people, and nature. It includes activities to mitigate ecological damage, relieve pressures on natural resources, and improve the balance between the environment and the economy.
58. In 2012, the China Banking Regulatory Commission issued the Green Credit Guideline to encourage the banking sector to actively adjust credit structure, fend off environmental and social risks, better serve the real economy, and boost transformation to improve economic growth and adjustment to economic structures. In 2015, PBOC introduced Green Bond Guidelines and a catalog for eligible subprojects to support diversifying green financing channels through capital markets. The PRC now accounts for 50% of the world’s green bond market. In the past 6 months, $80 billion worth of green bonds have been issued. These numbers are expected to grow rapidly, especially if the PRC Government implements its proposed policy and regulatory changes to increase the quantity of high quality green projects.

3. ADB Sector Experience and Assistance Program

59. The proposed project is aligned with the ADB Country Partnership Strategy, 2016–2020, on managing climate change and environment to support Government’s priorities in realizing an ecological civilization in its 13th plan.26

60. ADB has been providing support to promote green finance in the PRC in line with the Government’s shift towards a model of economic growth with environmental management. Specifically, ADB’s targeted support to green finance is expanding access to finance for energy efficiency investments in the industry sector, and financing private sector-led initiatives to support climate change mitigation and adaptation. An emission trading mechanism was developed and tested under a pilot scheme. ADB will further assist in establishing a national emission trading system. In terms of debt instrument, ADB is formulating a technical assistance to promote green bond market development through policy and regulatory improvement that address existing barriers. Furthermore, ADB supported the establishment of green funds to leverage public and private capital for climate change finance. ADB also provided knowledge supports on green finance through various knowledge products including technical assistances such as innovative models for climate change financing27 and Beijing’s green finance development strategy.28

61. Climate change mitigation and adaptation. The PRC’s intended nationally determined contribution committed the PRC to (i) peak CO₂ emissions by 2030; (ii) lower CO₂ per unit of GDP by 60% to 65% from the 2005 level; (iii) increase the share of non-fossil fuels in primary energy consumption to around 20%; and (iv) increase the forest stock volume by around 4.5 billion cubic meters from the 2005 level. ADB will work with the PRC to achieve those targets, or even to advance those targets, earlier than 2030. Among others, ADB will provide support in the areas of green financing to meet the target by (i) expanding access to finance for energy efficiency investments in the industry sector; (ii) strengthening the capacities of cities and rural areas in climate change adaptation and climate resilience, especially in vulnerable areas by helping to improve sustainable use of land and natural resources, strengthen water security, and

enhance green infrastructure and disaster risk management; and (iii) financing private sector-led initiatives to support climate change mitigation and adaptation.
E. Transport Sector Road Map

1. Sector Performance, Problems, and Opportunities

62. Substantial investment at national, provincial, and local levels has led to substantial improvements in the coverage and quality of transport infrastructure in the PRC. Since 1990, motor vehicle use has increased from 5.54 million to 264 million in 2014. In 2013, road transport contributed 93.15% of the total passenger transport volume and 78.49% of the total freight transport volume.

63. Investments in the transport sector have contributed to the PRC’s impressive economic growth, but also resulted in challenges such as increased air pollution, congestion, and accidents. The sector is a large contributor of GHG emissions. In 2012, it produced 8% of the country’s CO\textsubscript{2} emissions and is set to account for 13% of CO\textsubscript{2} emissions by 2040. Within the PRC, GHG emissions by private passenger vehicles, business passenger vehicles, and taxis accounted for 79% of total GHG emissions from transport sector.

2. Government’s Sector Strategy

64. The Government of the PRC is committed to developing a low-carbon transport sector. It has issued many policies including the promotion of public transport, providing subsidies, phasing out yellow label vehicles,\textsuperscript{29} promoting the development and use of efficient and clean vehicles, and limiting fuel consumption for passenger vehicles.

65. Gaps in the enabling environment may slow down the development of a low-carbon transport sector. Several relevant policies need to be amended and the following considered and strengthened:

   (i) **Structure adjustment.** Priorities should be given to promotion of public transport and rail transit. There is a big gap in share of public transport between the PRC and other developed counties. The share of public transport in London is 44%, 67%, 51%, 81%, 63% and 25.7% for Paris, Tokyo, Hong Kong, Seoul and Hangzhou, respectively. This suggests that the PRC should move towards a structural change in the transport sector with promotion of the public transport.

   (ii) **Strengthening Management and Planning and Optimizing Intermodal Connection.** A well designed and managed intermodal transport transfer system in large cities is extremely important. The PRC should strengthen its management and planning in public transport and optimize its connection therefore promote public transport.

   (iii) **Promoting New Energies.** (i) Improving fuel economy could effectively reduce the carbon emission.\textsuperscript{30} It is necessary for the PRC to improve its standards on fuel economy; (ii) There are barriers for the PRC to develop new energy vehicles

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\textsuperscript{29} Yellow label vehicles are the high emitting vehicles that cannot meet National I standard for gasoline vehicles and National III standard for diesel vehicles.

\textsuperscript{30} PRC announced the mandatory “Standard on Fuel Consumption Limit of Passenger Cars” (GBI9578—2004) on July 1, 2005, and remarkable achievements have been seen henceforth on the energy conservation of passenger cars. By the end of 2006, China had saved 1.18 million tons of gasoline in total, leading to more than RMB7 billion of direct economic benefits. After the successful implementation of the “Standard on Fuel Consumption Limit of Passenger Cars”, the NDRC announced on its website the “Standard on Fuel Consumption Limit of Light Commercial Cars” (GB20997—2007, hereafter referred as “The Standard”) on Dec. 13, 2007, which would take effect on Dec. 1, 2008. By implementing “The Standard”, China’s law and regulation system of vehicle energy saving standards could be improved.
such as (a) slower pace of supporting infrastructure, (b) low fuel quality, and (c) different of standards for different authorities and complicated management structure. Those need to be overcome to promote new energy vehicles; (iii) government subsidy policy for purchasing low emission buses and private vehicles should be strengthened. Currently, there are two subsidies to the public transport including direct and indirect subsidies. Most cities in the PRC are directly subsidized by the government for their losses; and (iv) Carbon tax policy should be in place to optimize vehicle management and resource allocation to stop the unreasonable fuel consumption and bring up the economic benefit.

(iv) Application of New Technologies. (i) There are many issues in the PRC for deploying smart transport system including (a) inadequate data collecting and analysis system, (b) road traffic regulations need to be further improved, (c) lack of information provision system for users, and (d) lack of integrated urban planning and transport. The government should establish a coordinated mechanism and enhance the management on smart transport system, and thus create enabling environment for development of smart transport; and (ii) Motor vehicle sharing is emerging in the PRC but is not yet regulated. Vehicle sharing is a good way to reduce energy consumption and emissions, and ease traffic jams. It is recommended that the PRC should set up corresponding policies to encourage vehicle sharing and ensure the security and safety of the service.

(v) Regional Collaborative Transport Development. Transport sector in the PRC has been challenged by rapid urbanization and urban agglomeration (or conurbation) trend such as the Yangtze River Delta region, Pearl River Delta region, and the Beijing-Tianjin-Hebei (BTH) region. Resolving urban mobility needs within and between the cities in urban agglomeration and conurbation area became an urgent task for the governments. Sustainable transport development of urban agglomeration will play an important role for maintain growth momentum. Under the Coordinated Development Plan, Beijing Municipal Commission of Transport announced transport development plan for integrating cities in the BTH region. The plan includes: (i) Developing a suburban rail network: Priority has been placed on developing a 1,000 kilometer (km) suburban rail network. In addition, Beijing Municipality will expand the current subway to 1,000 km from 527 km; (ii) Building highways to link unconnected roads in the six-city metropolis: Administrative barriers within the three administrative regions (Beijing Municipality, Tianjin Municipality, and Hebei Province) have left many highways and roads unconnected. The government targets completion by the end of 2017; (iii) Implement a “single transport pass” program: Residents in Beijing, Tianjin and the 4 cities of Hebei Province will be able to use a single transport pass for public transport across the 6 cities; and (iv) Appoint a committee to oversee the plan: The three governments have established a high-level committee to coordinate the integration of transport facilities in the region. The plan called for the construction of a transport network that would put residents of Beijing, Tianjin and Shijiazhuang, within an hour’s distance; residents of other satellite cities would also be able to reach the major cities within 30 minutes.

(vi) Travel Demand Management (TDM). Implementation of travel demand management measures for shifting private vehicle users to the public transport and non-motorized transport is still a huge opportunity in the PRC cities. Large cities including Beijing, Shanghai, Shenzhen, and Guangzhou introduced TDM measures restricting vehicle ownership and usage, but more active TDM measures including parking management, road user charging, financial measures
and low emission zones, more active public transport priority measures are yet to be introduced to accelerate the public transport and non-motorized transport use.

3. Municipal and Provincial Transport Sector

3.1 Beijing Municipality

66. More than 31% of PM$_{2.5}$ in Beijing is emitted from the transport sector, making it critical to intervene and address the main emission sources within this sector. By 2030, the number of registered vehicles in Beijing should be capped at 6.76 million, and the public transport ratio in urban areas should be over 41%. Additionally, the energy-saving cars, such as hybrids and electric vehicles, should account for more than 50% of the region's passenger car fleet, and electric vehicles more than 40%.

3.2 Tianjin Municipality

67. More than 30% of PM$_{2.5}$ in Tianjin is emitted from dust and 20% is emitted from transport sector, making it critical to intervene and address its main emission sources. By 2030, the number of registered vehicles in Tianjin should be capped at 4.49 million, and the public transport modal share in urban areas should be over 41%. Additionally, energy-saving cars should account for more than 50%, and electric vehicles more than 35%.

3.3 Hebei Province

68. Hebei Provincial Government Transport Sector Strategy. Hebei has 11 prefecture-level cities with population of 3–10 million with a provincial motorization rate of around 8.3 registered passenger vehicles per 100 persons. The urbanization rate remains 49.3% in 2014, with more than half of the population living in rural areas. Accelerated economic integration, urbanization and increased mobility of people within the BTH region will potentially have a large impact on the transport sector. Although it is still less pronounced, there are clear evidences that a number of private vehicles and associated emission from mobile sources are increasing in Hebei. There is a large room for improvement in urban public transport. In 2013, the length of urban public transport under operation in Hebei was 19,647 km, which is at the same level as Beijing which has 19,688 km. However, the length of public transport per 10,000 people is only 2.7 km in Hebei. The figure is only 63% of the PRC’s national average and 28%–29% of Beijing and Tianjin. Hebei's strategy on low-carbon and low pollution policy in transport sector has been mainly focused on replacing high emission vehicles to low emission vehicles and the potential for emissions reduction through travel reduction and shifting to public transport are yet to be implemented. In the Provincial CAAP, Hebei Government set target to (i) phase out all 1.05 million yellow label vehicles, (ii) the number of new energy vehicles in the province exceeds 50,000, and (iii) at least 60% of the newly added buses shall use new energy or clean fuel by 2017. Hebei Province introduced public transport development evaluation criteria for the cities in the province and the implementation enforcement and monitoring of the effectiveness of the criteria needs to be evaluated and expended to other cities in the BTH region and beyond.

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31 The figure is higher than the PRC average of 6.8 vehicles but much lower than that of Beijing (19.7) and Tianjin (14.1).
32 The urbanization rate of Beijing was 86.4% and Tianjin was 78.3% in 2014.
3.4 Shanxi Province

70. **Shanxi Provincial Government Transport Sector Strategy.** Shanxi has a provincial motorization rate of around 11.56 registered passenger vehicles per 100 persons. Shanxi’s urbanization rate remains 53.79% in 2014. In 2014, the length of urban public transport under operation in Shanxi was 140,436 km. However, the length of public transport per 10,000 people is 38.5 km in Shanxi.

71. Shanxi’s strategy on low-carbon and low pollution policy in transport sector has been mainly focused on replacing high emission vehicles to low emission vehicles and the potential for emissions reduction through travel reduction and shifting to public transport are yet to be implemented. In the Provincial CAAP, Shanxi government set target to (i) phase out all 316,000 yellow label vehicles, and (ii) at least 60% of the newly added buses shall use new energy or clean fuel by 2017.

3.5 Inner Mongolia Autonomous Region

72. **IMAR Provincial Government Transport Sector Strategy.** IMAR has a provincial motorization rate of around 15.04 registered passenger vehicles per 100 persons. IMAR’s urbanization rate remains 55.5% in 2014. In 2014, the length of urban public transport under operation in IMAR was 172,167 km. However, the length of public transport per 10,000 people is 69.7 km in IMAR.

73. IMAR’s strategy on low-carbon and low pollution policy in transport sector has been mainly focused on replacing high emission vehicles to low emission vehicles and the potential for emissions reduction through travel reduction and shifting to public transport are yet to be implemented. In the CAAP, IMAR Government set target to (i) phase out all yellow label vehicles, and (ii) at least 90% of the buses and vehicles shall use new energy or clean fuel and 20% of sharing from public transport for city size with more than 1 million population by 2017.

3.6 Shandong Province

74. **Shandong Provincial Government’s Transport Sector Strategy.** Shandong has a provincial motorization rate of around 10.9 registered passenger vehicles per 100 persons. Shandong has the highest registered passenger vehicles among all the provinces in the PRC. Shandong’s urbanization rate remains 56% in 20143. In 2014, the length of urban public transport under operation in Shandong was 259,514 km. However, the length of public transport per 10,000 people is only 26.62 km in Shandong.

75. Shandong’s strategy on low-carbon and low pollution policy in the transport sector has been mainly focused on replacing high emission vehicles to low emission vehicles and the potential for emissions reduction through travel reduction and shifting to public transport are yet to be implemented. In the CAAP, Shandong government set target to (i) phase out all 1.16 million yellow label vehicles, (ii) at least 95% of the taxis and buses, and 13.5% of the heavy trucks using liquefied natural gas in the province, and (iii) at least 1,000 compressed natural gas and 400 liquefied natural gas refilling stations will be constructed by 2020.
3.7 Liaoning Province

76. **Liaoning Provincial Government Transport Sector Strategy.** Liaoning has a provincial motorization rate of around 12.7 registered passenger vehicles per 100 persons. Liaoning’s urbanization rate remains 67.05% in 2014, is the second highest province in the PRC. In 2014, the length of urban public transport under operation in Liaoning was 114,504 km. The length of public transport per 10,000 people is 44.6 km.

77. Liaoning’s strategy on low-carbon and low pollution policy in the transport sector has been mainly focused on replacing high emission vehicles to low emission vehicles and the potential for emissions reduction through travel reduction and shifting to public transport are yet to be implemented. In the Provincial CAAP, Liaoning Government set target to phase out all 600,000 yellow label vehicles by 2017.

3.8 Henan Province

78. **Henan Provincial Government Transport Sector Strategy.** Henan has a provincial motorization rate of around 16.97 registered passenger vehicles per 100 persons. Henan’s urbanization rate remains 45.2% in 2014. In 2014, the length of urban public transport under operation in Henan was 249,857 km. However, the length of public transport per 10,000 people is only 23.4 km in Henan.

79. Henan’s strategy on low-carbon and low pollution policy in the transport sector has been mainly focused on replacing high emission vehicles to low emission vehicles and the potential for emissions reduction through travel reduction and shifting to public transport are yet to be implemented. In the Provincial CAAP, Henan Government set target to (i) phase out all 282,000 yellow label vehicles by 2017, (ii) the number of new energy vehicles in the province exceeds 72,000 by 2020, and (iii) at least 60% of the newly added buses and trucks shall use new energy or clean fuel by 2017.