

SECTOR ASSESSMENT (SUMMARY): ENERGY

A. Sector Performance, Problems, and Opportunities

1. **Overview of the chemical industry—an important sector for demand side energy efficiency and conservation in the People’s Republic of China.** The chemical industry, a highly diversified industrial sector, converts raw materials and chemicals into more than 70,000 different products such as fertilizers, inorganic salts, acids, alkali, synthetic rubber, plastics, and fuels. Sectors downstream of the chemical industry include the building and automobile sectors, and the consumer products (electronics, textiles, pharmaceuticals, and food) sector. The chemical industry has become a pillar of industrial growth in the People’s Republic of China (PRC). In 2012, the industry directly employed 5.1 million people and had a gross output of CNY7.2 trillion, 7.8% of total gross industrial output. Long-term investment in the chemical industry remained strong in 2013, accounting for almost 12.0% of total fixed asset investment in industry in the PRC.

2. **Total energy use in the People’s Republic of China’s chemical industry.** Energy use in the PRC’s chemical industry doubled from 2001 to 2010, and by an additional 19.0% year-on-year in 2011–2013 to reach 457 million tons of coal equivalent (tce), 11.7% of the PRC’s energy consumption in 2013. Total energy consumption of only six countries in the world was higher in 2013 than the energy use of the PRC’s chemical industry alone.¹

3. **Energy intensity reductions since 2006.** As a result of aggressive measures (para. 8) undertaken since the period covered by the 11th Five-Year Plan, 2006–2011, energy intensity in the PRC’s chemical industry has declined by 46.0% since 2006. In 2013, it stood at 1.78 tce per CNY10,000 value added produced (in 2010 prices). Even so, energy use per unit of output value is still more than double compared to that in fully industrialized countries.

4. **Need for further growth.** The PRC now leads the world in the production of many key chemical products, but production has to grow further to serve the needs of its growing middle-income population.² To reach the per capita level in other countries, value added in the PRC’s chemical industry would have to increase sixfold in the case of the Republic of Korea, sevenfold to eightfold in the case of Japan or Germany, and almost twelvefold in the case of the United States. Industry investments in the PRC are thus focused on growth and product transformation. However, continued growth without significant improvements in energy efficiency and emissions reduction may lock in this industry in an environmentally not sustainable growth path.

5. **Future development priorities.** The current policies of the Government of the PRC underline the need to (i) transform the extensive growth model to a more intensive growth model; (ii) reduce resource intensity per unit of value added by developing high-quality, diversified, and specialized end products; (iii) address serious environmental issues; and (iv) develop production technologies that are both energy and natural resource efficient. In addition, the chemical and petrochemical industry provisions of the PRC’s 12th Five-Year Plan, 2011–2015 place priority on (i) increases in effective production capacity for chemical categories where domestic shortages persist, such as olefins, certain organic raw materials, composite and new chemical materials, and many specialized chemical products, including low- or no-mercury catalysts for the polyvinyl chloride (PVC) industry; (ii) strict controls on the rate of output growth

¹ These countries are the PRC, Germany, India, Japan, Russia, and the United States.

² The PRC is the world’s largest producer of sodium carbonate, sulfuric acid, calcium carbide, polyvinyl chloride, rubber tires, synthetic ammonia, caustic soda, chemical fiber, synthetic rubber, and pesticide.

for caustic soda, PVC, sodium bicarbonate, and agricultural chemicals, among others; (iii) faster elimination of outdated production processes, particularly calcium carbide and calcium carbide-based PVC production applying mercury-based catalyst that is used to make calcium carbide, chlor-alkali chemicals, yellow phosphorus, and other products; and (iv) gradual elimination of the use of hydrochlorofluorocarbons and other ozone-depleting substances, as well as persistent organic pollutants and other toxic substances.

6. **Key chemical industry subsector challenges.** These challenges are as follows:

- (i) **Coal-dominated fuel and feedstock mix.** The PRC's chemical industry relies heavily on coal, both as feedstock and as fuel, because of the struggle for self-sufficiency and the PRC's unique resource endowment, which is rich in coal but much less so in petroleum and natural gas. The reliance on coal carries substantial penalties in terms of energy efficiency, greenhouse gas (GHG) emissions, and, where strict environmental controls do not operate, air pollution. The emphasis on coal has also led to the continued application of antiquated technologies that carry pollution penalties, such as the use of calcium carbide in PVC production, which has given rise to the intentional use of mercury as catalyst.
- (ii) **High energy intensity.** Despite impressive improvements in energy efficiency (para. 3), the PRC's chemical industry remains twice as energy intensive as its more advanced counterparts in countries like Germany and the United Kingdom. This high energy intensity is due to (a) a product mix heavily weighted toward energy-intensive, basic, often intermediary commodities; and (b) technical energy inefficiencies, owing to suboptimal plant scale and the use of antiquated technology in some cases, including the continuing use of coal as a key feedstock and fuel.
- (iii) **Greenhouse gases and other pollutant emissions.** The chemical industry is a major emitter of wastewater, local air pollutants, GHGs, heavy metals, and other pollutants. In 2011, it discharged 4.39 billion tons of wastewater, 2.31 million tons of sulfur dioxide, and 983,000 tons of nitrogen oxides, and was the top industry emitter of all these pollutants.³ According to PRC sector statistics, in 2013, the PRC produced nearly 140 million metric tons of carbon dioxide (CO₂) equivalent; equal to the total CO₂ emissions of 24 gigawatt-scale coal-fired power plants.
- (iv) **Need for technological improvements and breakthroughs.** Increasingly, many relatively simple, easily replicated technical approaches used in the past can no longer meet the required energy efficiency improvements. This is especially true of many well-established subsectors of the coal-based chemical industry. Opportunities to improve energy efficiency through incremental renovation or equipment upgrading have been nearly exhausted. There is now a need for major or more difficult changes, such as integrated and comprehensive system optimization; changes in key process technology; or major technical restructuring leading the industry to abandon certain product lines altogether in favor of others.

7. To improve energy efficiency and reduce emissions further, new technologies that can have suitable impact on the PRC's chemical industry must be developed and demonstrated, and their delivery and take-up in projects must be encouraged. Meeting the following two needs listed below would help achieve these objectives:

³ Ministry of Industry and Information Technology. 2013. *Guidelines on Energy Conservation and Emission Reduction in the Petroleum and Chemical Sectors*. Beijing.

- (i) **Need for the development of domestic technology.** To be able to use energy more efficiently and reduce environmental damage, the PRC's chemical industry needs technological innovations different from those introduced abroad to match its largely coal-based production base. The challenge of adapting existing plants to the emerging new environmental and technological improvements in coal-based processes does not arise in countries where petroleum-based chemical processes dominate. Technical innovations in calcium carbide-based PVC production and the related move to non-mercury catalysts, for example, are not relevant topics outside the PRC. Since 2010, there has been significant research and development (R&D) activity in the PRC in an effort to meet the very diverse and often sophisticated technology challenges facing the country's chemical industry.
- (ii) **Need for mechanisms to move promising research and design results through commercialization to scale-up.** A prevailing concern is the necessity of moving promising R&D ideas toward commercial demonstration and then toward replication and technology diffusion. During the period covered by the PRC's 12th Five-Year Plan, 2011–2015, and almost certainly also during the period covered by the 13th Plan, 2016–2020, the government hopes to lower the barriers between successful R&D, commercial project demonstration, and new technology delivery through innovative project development and implementation. A technology diffusion platform, like that proposed for demonstration under the project, offers just such a potential mechanism. The proposed wholly owned energy service companies will have access to the R&D institutes of the state-owned enterprises and, with their knowledge of market demand, can identify promising technologies to answer the specific needs of the chemical industry.

B. Government Sector Strategy

8. **Key energy efficiency programs.** Effective government programs for industrial enterprises since the 10th Plan, 2001–2005, include:

- (i) government supervision and annual reporting on actual enterprise-level achievements against agreed energy savings targets for all enterprises with energy savings agreements;
- (ii) macro-level targets for energy intensity reduction (the target of 20% set by the Ministry of Industry and Information Technology for the chemical industry during the period covered by the 12th Plan, 2011–2015, is almost equal to the 21% set for industry as a whole);
- (iii) mandatory assignment of enterprise energy managers to all key industrial enterprises, and implementation of large-scale training programs to enhance the capacity of the managers and their staff;
- (iv) issuance of mandatory unit energy consumption standards for key industrial processes and equipment (as of July 2014, the government had established a per unit energy consumption ceiling for each of 25 chemical industry products);
- (v) programs to eliminate backward production capacity that do not comply with national energy use standards;
- (vi) required completion and approval of energy use assessments for all new major fixed-asset investment projects;
- (vii) programs providing national investment subsidies of CNY250–CNY300 per tce savings capacity for qualified energy efficiency investment projects, payable upon project commissioning, with additional matching funds from provincial governments;

- (viii) programs to help build the capacity of third-party energy efficiency service providers, including companies involved in energy diagnostics, energy savings monitoring and verification, and energy saving companies; and
- (ix) green credit policies to encourage increased bank lending for energy efficiency projects.

9. **Emission reduction regulations.** The government has issued regulations for specific energy- and emission-intensive subsectors that cover (i) the phase out at the earliest possible time of the use of mercury as a catalyst in the PVC industry, and (ii) the reduction of chlorodifluoromethane (HCFC-22) emissions by 35.0% by 2020, 67.5% by 2025, and 100% by 2030, compared with the 2010 level. The rule regarding HCFC-22 emissions applies only to the production of the gas to be sold as refrigerant and not to its use in the fluoropolymer industry.⁴ At the end of 2014, the government adopted a policy of subsidizing 40% of capital investment costs for the installation of incineration facilities for fluorocarbon. Additional subsidy policies supporting the operation of such facilities are being prepared, but implementation rules and guidelines have not yet been adopted.

10. For the period covered by the 13th Plan, 2016–2020, there is serious discussion among academics, policy makers, and industries whether the government should set mandatory caps on absolute energy consumption, coal consumption, and CO₂ emissions, at both national and provincial levels. This step would take the PRC beyond its current mandatory energy intensity targets. If the consumption and emission caps were to be imposed, the review and approval of energy assessments for new investment projects would gain additional importance as a key means by which the government can control new energy-intensive projects and allocate “energy use space” under the consumption cap for new projects. The possibility of introducing large-scale trading schemes and allowing enterprises to trade verified energy savings or CO₂ emission reductions is also being discussed.

C. Asian Development Bank Sector Experience and Assistance Program

11. The project is closely aligned with (i) the midterm review by the Asian Development Bank (ADB) of its Strategy 2020,⁵ which puts priority on environmentally sustainable growth as ADB developing member countries move onto a low-carbon growth path, and identifies improved energy efficiency and reduced GHG emissions as core operational areas; (ii) the country partnership strategy, 2011–2015,⁶ which singles out promoting resource efficiency and environmental sustainability as one of the three pillars of ADB assistance to the PRC; and (iii) ADB’s Energy Policy.⁷ Improving energy intensity and reducing carbon intensity are key interventions. Demonstrating energy efficiency improvements through innovative financing mechanisms, in one of the largest GHG-emitting countries on a high-energy growth trajectory, will contribute to global efforts to curb GHG emissions and associated climate change impact—a global public good. ADB priorities and strategies in the energy sector coincide with those of the PRC.

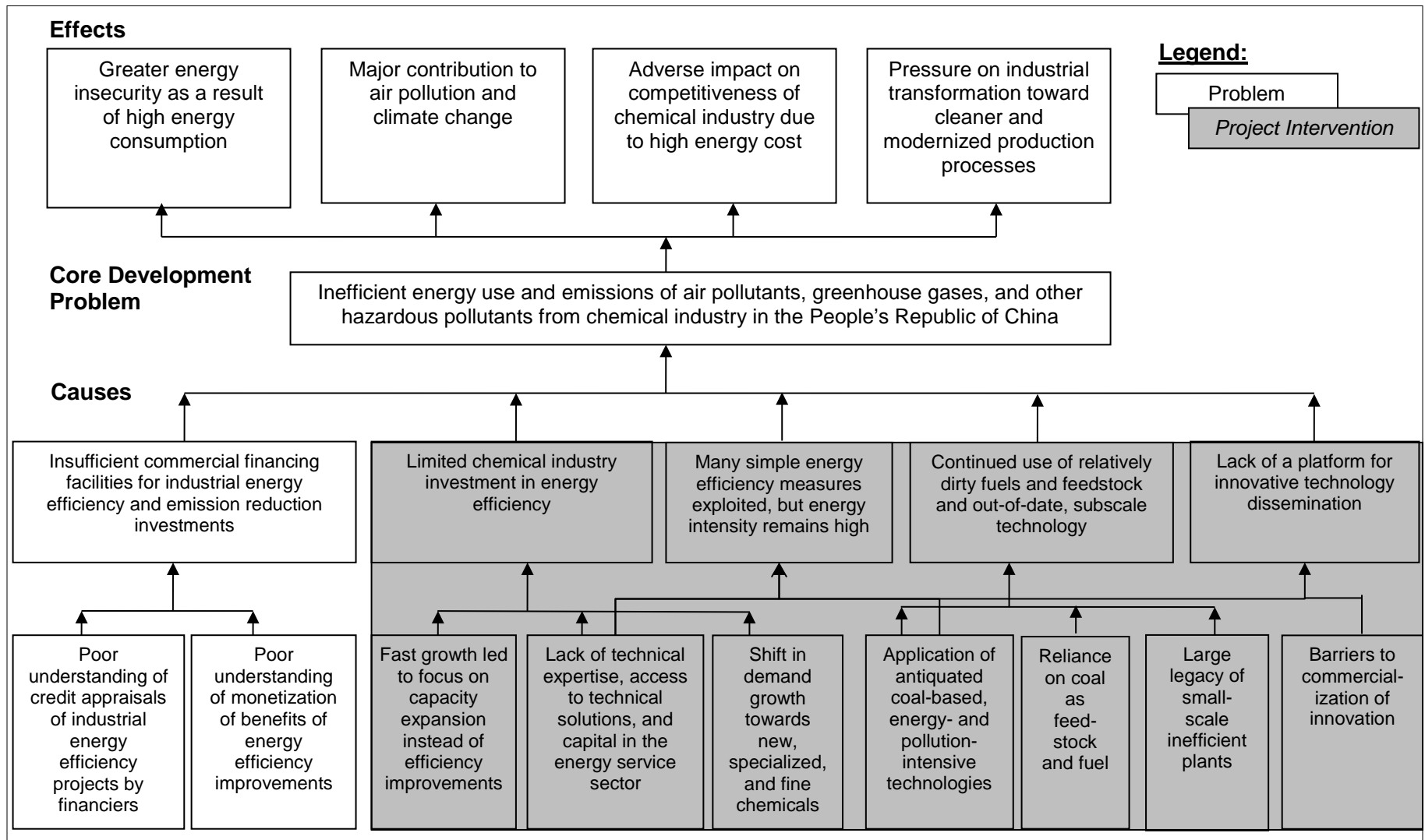
⁴ Under the Montreal Protocol, HCFC-22 is one of the ozone-depleting substances included in the prohibited investment activities list of the Asian Development Bank (ADB) (Annex C, Group I). However, the PRC is among the developing countries that are allowed to exceed the prescribed levels for the domestic consumption and production of HCFC, and, as noted in the text, the HCFC-22 phase out applies solely to the production of HCFC-22 for use as a refrigerant. The Ministry of Environmental Protection has issued notices stating that it will monitor the use of HCFC-22 as feedstock to ensure compliance with the planned phase out of HCFC-22 as refrigerant.

⁵ ADB. 2014. *Midterm Review of Strategy 2020: Meeting the Challenges of a Transforming Asia and Pacific*. Manila.

⁶ ADB. 2012. *Country Partnership Strategy: People’s Republic of China, 2011–2015*. Manila.

⁷ ADB. 2009. *Energy Policy*. Manila.

Problem Tree for Energy



Source: Asian Development Bank.

Sector Results Framework (Energy, 2011–2015)

Country Sector Outcomes		Country Sector Outputs		ADB Sector Operations	
Outcomes with ADB Contribution	Indicators with Targets and Baselines	Output with ADB Contribution	Indicators with Incremental Targets	Planned and Ongoing ADB Interventions	Main Output Expected from ADB Interventions
Improved energy efficiency and reduced emissions	<p>Carbon intensity reduced by 17% from 2010 levels (2010 baseline: 8.1 billion tons of CO₂ and CNY40,151 trillion GDP)</p> <p>Energy consumption per unit of GDP reduced by 16% from 2010 levels (2010 baseline: 3.25 billion tce and CNY40,151 trillion GDP)</p> <p>Share of nonfossil fuels in primary energy consumption reaches 11.4% by 2015 (2010 baseline: 8.3%)</p>	<p>Scaled-up financing for energy efficiency in energy-intensive provinces, such as Guangdong, Hebei, and Shandong</p> <p>Reduction in greenhouse gas emission intensity from fossil fuel power plants through innovative technologies such as IGCC power generation and carbon capture and storage</p> <p>Demonstration of new renewable-energy technologies combined with ultra-efficient gas-based technology for district heating</p>	<p>Achieve 18% reduction in energy intensity in Guangdong, Hebei, and Shandong provinces by 2015 compared with 2010</p> <p>Demonstrate carbon capture and storage in fossil fuel power plants, concentrated solar thermal, offshore wind, and grid-connected photovoltaic plant technologies for a total capacity of 200 MW by 2015</p> <p>Pilot test and demonstrate a smart grid to enlarge the share of renewables in the energy mix</p>	<p>Planned key activity areas</p> <ul style="list-style-type: none"> i. Energy efficiency improvement in industrial and district heating ii. Demonstration of new renewable energy technologies iii. Demonstration of low-carbon fossil fuel power plant technologies <p>Pipeline projects with estimated amounts (2015)</p> <ul style="list-style-type: none"> iv. Gansu Jinta Concentrated Solar Power Project (\$100 million) v. Chemical Industry Energy Efficiency and Emission Reduction Project (\$100 million) vi. Qingdao Smart Low-Carbon District Energy Project (\$130 million) <p>New renewable energy and energy efficiency technology projects</p> <p>Shaanxi Scaled-Up Financing for Accelerated Energy Efficiency</p> <p>Ongoing projects with approved amounts</p> <ul style="list-style-type: none"> vii. Hebei Energy Efficiency Improvement and Emission Reduction Project (\$100 million) viii. Guangdong Energy Efficiency and Environment Improvement Investment Program (\$100 million) ix. Shandong Energy Efficiency and Emission Reduction Project (\$100 million) x. Low-Carbon District Heating Project in Inner Mongolia Autonomous Region (IMAR) (\$150 million) 	<p>Planned key activity areas</p> <ul style="list-style-type: none"> i. Energy savings of over 600,000 tce per year and emission savings of more than 1.5 million tons of CO₂ per year achieved by 2015 from energy efficiency projects financed by ADB ii. Commissioning of 200 MW of new renewable energy technologies supported by 2015 iii. Carbon capture and storage successfully demonstrated in a commercial-scale project <p>Pipeline projects</p> <ul style="list-style-type: none"> i. 50 MW concentrated solar power plant with thermal storage, including a natural gas backup system, constructed in Gansu Province ii. Energy efficiency in the chemical industry improved and emissions reduced iii. Smart low-carbon district energy system demonstrated in Qingdao City <p>Ongoing projects</p> <ul style="list-style-type: none"> i. Industrial energy efficiency projects and energy service company projects implemented ii. Energy savings of over 300,000 tce/year achieved through projects in Guangdong and Shandong provinces

ADB = Asian Development Bank, CO₂ = carbon dioxide, GDP = gross domestic product, IGCC = integrated gasification combined cycle, MW = megawatt, tce = ton of coal equivalent.
Source: Asian Development Bank.