SECTOR ASSESSMENT SUMMARY: ENERGY –DISTRICT HEATING SUBSECTOR

1. Sector Performance, Problems and Opportunities

1. **Overview.** The People's Republic of China (PRC) is the second-largest district heating market in the world after the Russian Federation. In the PRC, Beijing and Tianjin cities as well as 16 provinces[1] have adopted centralized heating systems. A centralized heating or district heating system offers substantial benefits in installation and operational efficiency, and in lowering the environmental impact. However, inefficient and polluting household stoves and small coal-fired boilers are still widely used in many cities and counties. District heating in the PRC has expanded rapidly between 2003 and 2010, when the total area covered increased from 1.9 billion square meters (m^2) to 4.4 billion m^2 at an average annual growth rate of 12%. In Shanxi, the centralized heating area increased from 71 million m^2 in 2003 to 287 million m^2 in 2010, or an average annual growth rate of 21%, almost double the national average.[2] However, district heating still cover only 30% of the total heating area in the PRC, while the penetration rate in European countries ranges from 55% to 60%.

2. The Government of the PRC plans to eliminate small and inefficient coal-based, heat-only boilers, and to increase the share of energy-efficient combined heat and power (CHP) plants in the overall heat supply from 36% in 2010 to 43% by 2015. In Shanxi, CHP plants provide 63% of the heat consumed, followed by coal-fired boilers at 35%, and gas-fired boilers and other heat sources at less than 2%. CHP plants are the least-cost and least-polluting heat source for district heating if they are located within a suitable distance from the urban area. Small boilers, with their lower capital costs, have been widely used to supply incremental extensions of urban areas.

3. **Coal-mine methane and coal-bed methane.** Unconventional gas such as coal-mine methane (CMM) and coal-bed methane (CBM) has considerable environmental advantages over coal. Compared with coal combustion, gas combustion emits only half the carbon dioxide and only a fraction of the harmful emissions of sulfur oxides and nitrogen oxides. Shanxi has abundant CMM–CBM resources,[3] estimated at approximately 10 trillion cubic meters (m^3), about one-third of the total amount available in the PRC. The CMM–CBM development in Shanxi has made good progress, since 2003. In 2010, the province produced 1.5 billion m^3 of CBM, (98% of the PRC total) and consumed 1.2 billion m^3 or 80%. During the same year, its CMM extraction and production reached 2.8 billion m^3 (37% of the PRC total), of which it used 0.95 billion m^3 or 34%. The Shanxi provincial government is actively promoting unconventional gas integration development in Shanxi, and intends to make Shanxi the largest clean-energy development base in the PRC. CMM–CBM gas is widely used by residential, transport, commercial, and industrial users in the cities of Jincheng,[4] Yangquan, and Changzhi. Based on

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[1] The provinces are Anhui, Gansu, Hebei, Heilongjiang, Henan, Hubei, Inner Mongolia, Jiangsu, Jilin, Liaoning, Ninxia, Qinghai, Shaanxi, Shandong, Shanxi, and Xinjiang.

[2] Shanxi's urban population has increased from 8.6 million in 2000 to around 17.2 million in 2010, and is expected to grow to as much as 19.4 million by 2015.

[3] Methane is a nontoxic combustible greenhouse gas, about 21 times more potent than carbon dioxide (CO_2). Methane produced by coal is referred to as CMM when it is released through mine shafts in connection with underground coal-mining operations, and as CBM when it is released through wells that are drilled from the surface into underground coal seams.

[4] The Asian Development Bank (ADB) supported a CMM project in Jincheng that ushered in robust development of CMM–CBM in the PRC [*ADB. 2004. Report and Recommendation of the President to the Board of Directors: Proposed Loan to the People's Republic of China for Coal Mine Methane Development Project*. Manila (Loan 2146-PRC)].

the Shanxi provincial government's unconventional gas development target, total gas supply will reach 15 billion cubic meters (m^3) in 2015 and 36 billion m^3 in 2020. Future market-driven gas demand (e.g., for space cooling of buildings) will be met based on the potential gas resources that can be developed.

4. The key issues of district heating are summarized below:

(i) **Remaining inefficiencies.** Energy-efficient district heating systems are an important element in reducing emissions and improving public health. Large cities have already adopted district heating. However, inefficient household stoves and small boilers, which are a source of air pollution, are still widely used for space heating in small cities and counties. Large gains in energy efficiency and emission reduction can be attained by (a) eliminating small and inefficient inner-city boilers and replacing them with cleaner district heating and emission control equipment;[5] (b) improving insulation in the transmission and distribution systems; and (c) installing demand-control mechanisms—i.e., variable flow drive and computer monitoring and control system, building-specific heat metering, horizontal distribution with a two-pipe system, and thermostatic valves in radiators.[6]

(ii) **Slow progress in the transition to consumption-based tariffs and billing.** The transition to consumption-based tariffs and billing is important for demand-side energy conservation. Heating tariffs and billing based on a flat rate per m^2 per heating season are still widely applied in the PRC. Most buildings constructed before 2008 do not have household-specific energy efficiency devices such as heat meters, room temperature regulators, and heating system controllers. Although central and provincial regulations on consumption-based tariffs and billing are in place, actual implementation has been slow. Accelerating installation of energy efficiency devices in pre-2008 buildings is critical to conserving energy on the demand side.

(iii) **Tariff increases seldom match fuel price increases.** When fuel costs rise, heating companies have to submit a proposal for a tariff increase to the local government. Since the local government is obliged to maintain the tariff at an affordable level for consumers, it tends to disapprove the tariff increase. Thus, increases in the heating tariff rarely match the increases in fuel costs, which results in operating losses for the heating companies.

(iv) **Need to improve business practices of heating companies.** Many state-owned heating companies have low tariff collection rates due to their old-fashioned business practices, and thus serious revenue shortfalls. Generally, privately owned heating companies attain higher tariff collection rates because of better customer orientation. Promotion of good business practices at state-owned heating companies is vital.

(v) **Need to monitor implementation of heating reforms.** Although the central government has announced many policies for energy conservation and heating

[5] Small, heat-only boilers operate at 50%–60% efficiency compared with about 80%–90% for new large boilers.
[6] About 15%–20% of heat can be saved by converting area-based heating tariffs to consumption-based heating tariffs along with the installation of radiator control valves.

reforms, they often lack in specifics, which allows widely differing interpretations by local government units and makes it difficult to implement and monitor.

(vi) **Need to support financing.** Rapid urbanization and the urgent need to rehabilitate aging heating networks require huge investments in district heating. However, due to prevailing low tariff, poor collection rate and higher perceived risks, the private sector has been reluctant to invest. Also, the provision of heating entails large initial investments but relatively low rates of return. Thus, district heating require public investment in the short term and acceleration of ongoing tariff reforms to improve the risk profile of district heating sector for private investment.

2. Government's Sector Strategy

5. Recognizing the environmental challenges and climate change impacts of the PRC's growing energy use, the government made unprecedented efforts to improve the energy efficiency of its economy by setting specific targets in the Eleventh Five-Year Plan, 2006–2010. To reinforce these efforts, the Energy Conservation Law was revised in 2007 to more clearly define responsibilities and accountabilities and lay the foundation for many new programs. The PRC has since launched a set of energy conservation policies, regulations, and programs that cover all aspects of the economy. As part of the PRC's contribution to mitigating global greenhouse gas emissions, the government committed to reducing the carbon intensity of its gross domestic product (GDP) by 40%–45% by 2020, from baseline 2005. The Twelfth Five-Year Plan, 2011–2015 has set the targets of reducing carbon intensity by 17%, the energy intensity of GDP by a further 16%, and emissions of sulfur dioxide by 8% and of nitrogen oxides by 10% by 2015.[7]

6. The PRC made initial progress in its heating reform, notably in consolidating small boilers into larger, centralized heating systems, and in adopting a variety of models for retrofitting energy-efficient heating to older buildings. It also gained widespread experience in the application of various metering technologies, and provincial and municipal governments issued guidelines for heat metering. By the end of 2009, 400 million m^2 of heating area in the northern PRC had been equipped with metering facilities, of which 150 million m^2 used consumption-based billing.

7. The Shanxi provincial government, too, has issued policies to promote energy efficiency and reduce emissions, and has established financial incentives that make it easier to eliminate inefficient small coal-fired boilers and replace them with efficient pulverized-coal boilers. Providing reliable district heating in Shanxi is the responsibility of municipal and county governments. Most district heating in Shanxi is provided by especially established, state-owned enterprises. These generally control generation, distribution, and tariff collection. Municipal and county governments are responsible for urban planning, establishing heating tariffs, providing financial support to the urban poor to pay heating bills, encouraging private sector participation in the heating sector, and establishing supply contracts with district heating companies.

8. Shanxi has made some progress in promoting consumption-based tariffs. As an important step, most cities have defined the areas for retrofitting and prepared for consumption-based billing. A two-part tariff scheme for heating—a base cost per square meter serviced and a

[7] Carbon intensity is the amount of greenhouse gas emitted per unit of GDP, whereas. energy intensity is the amount of energy consumed per unit of GDP.

variable cost component based on gigajoules of heat metered—was developed in Datong, Jincheng, Luliang, Shuozhou, Taiyuan, and Xinzhou. This tariff scheme is still at an experimental stage and piloted in very limited places due to various technical and institutional constraints. Recent statistics provided by the implementing agencies have shown that the installation rate of household meters has increased (e.g., in Linyi county, from 0% before 2006 to 5% in 2007, 10% in 2008, 23% in 2009, and 37% in 2010; in Xinjiang county, from 7% in 2008, to 10% in 2009, and 15% in 2010; in Luliang, the rate was 30% in 2010).

9. The Shanxi provincial government encourages the private sector to participate in developing urban infrastructure and public utilities, including district heating, and enacted regulations in 2006, amended later in 2008, to promote concession of public utilities by private companies. However, the response has not been encouraging, mainly because the low tariff levels do not allow heating companies to realize attractive returns.

3. ADB Sector Experience and Assistance Program

10. The project is closely aligned with Strategy 2020 of the Asian Development Bank (ADB), which defines climate change mitigation through improvement of energy efficiency and reduction of greenhouse gas emissions as a core area of operation.[8] The country partnership strategy, 2011–2015 for the PRC[9] focuses on promoting resource efficiency and environmental sustainability as one of the four pillars of ADB's assistance to the country. Improving the energy intensity through more efficient use of energy and reducing the carbon intensity by shifting the energy mix from fossil fuels (i.e., mainly coal) to less carbon-intensive energy sources are named as key interventions in this regard. Given the PRC's status as the biggest emitter of greenhouse gases, supporting it in achieving its carbon intensity reduction commitments also contributes toward the global public good of mitigating global warming.

11. Previous ADB district heating projects in the PRC have provided many lessons. The country assistance program evaluation[10] for the PRC indicated that projects focused on energy efficiency improvements, renewable energy, and environmental concerns appropriately add value and contribute to PRC priorities. Earlier district heating projects with many subprojects experienced delays due to (i) late approval of the feasibility reports, (ii) multiple project components that required elaborate onlending formalities and approvals in the PRC, and (iii) uneven managerial capacity in some implementing agencies. In the case of the ADB-supported CMM project (footnote 4), lessons include the need for (i) critical assessment of available methane gas supply and quality to avoid design changes and repeat of the approval process, (ii) thorough evaluation of the least-cost option for the pipeline routes and location of gas-receiving facilities, and (iii) close coordination with government agencies with oversight functions in public utilities. These issues and lesson were taken into account when preparing this project[11] by (i) ensuring that feasibility studies were approved, (ii) consulting closely with local government units to ensure that the implementing agencies fully understand their procedural requirements, (iii) obtaining assistance from technology experts to mitigate technical and operational risks in specific technical areas; and (iv) supporting capacity building in implementing agencies.

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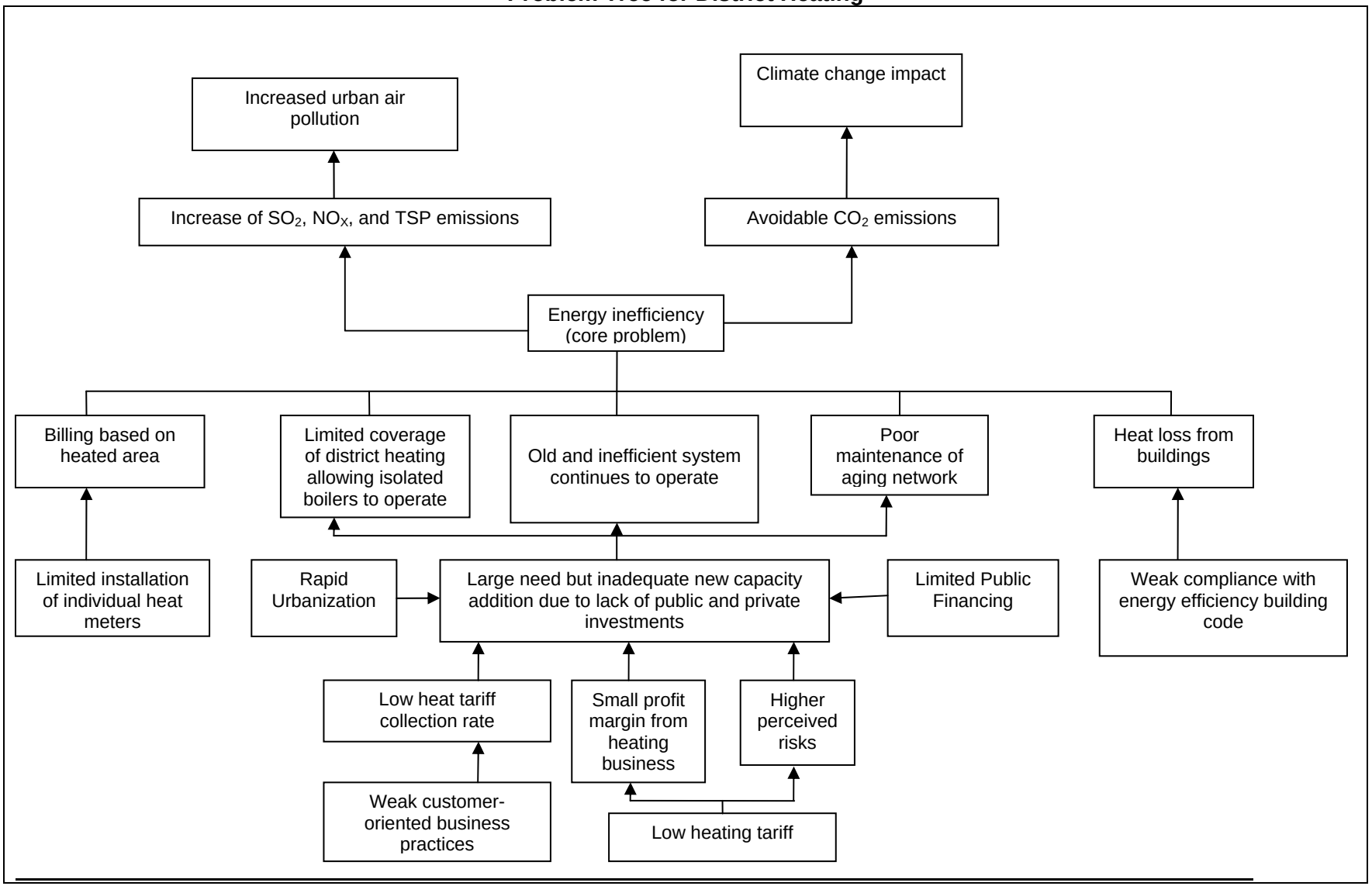
[8] ADB. 2008. *Strategy 2020: The Long-Term Strategic Framework of the Asian Development Bank, 2008–2020.* Manila.

[9] ADB. 2012. *Country Partnership Strategy: People's Republic of China, 2011–2015.* Manila.

[10] ADB. 2007. *Country Assistance Program Evaluation for the People's Republic of China*. Manila (April, para. 157).

[11] The project was prepared with the support of ADB. 2010. *Technical Assistance to the People's Republic of China for Preparing the Shanxi Energy Efficiency and Environment Improvement Project*. Manila (TA 7736-PRC).

Problem Tree for District Heating



CO_2 = carbon dioxide, NO_x = nitrogen oxides, SO_2 = sulfur dioxide, TSP = total suspended particles
Source: Asian Development Bank estimates.

Sector Results Framework (Energy, 2011–2015)

Country Sector Outcomes		Country Sector Outputs		ADB Sector Operations	
Sector Outcomes with ADB Contribution	**Indicators with Targets and Baselines**	**Outputs with ADB Contribution**	**Indicators with Incremental Targets**	**Planned and Ongoing ADB Interventions**	**Main Outputs Expected from ADB Interventions**
Greater efficiency in energy sector	16% reduction in energy intensity by 2015 (baseline year: 2010)	Scaled-up financing for energy efficiency in energy-intensive provinces such as Guangdong, Hebei, and Shandong	Achieve 17% reduction in energy intensity in Hebei, Guangdong, and Shandong provinces by 2015 (baseline year: 2010)	**Planned key activity areas** Energy efficiency improvement in industrial and district heating Demonstrating new renewable energy technologies Low-carbon technologies in fossil fuel power plants	**Planned key activity areas** Achieve energy savings of over 600,000 tce/y and emission savings of over 1.5 mt/y from energy efficiency projects financed by ADB by 2015 Support commissioning of 200 MW of new renewable energy technologies by 2015
Reduced GHG emissions	17% reduction in carbon intensity by 2015 (baseline year: 2010)	Reduced GHG emission intensity from fossil fuel power plants through innovative technologies such as IGCC and CCS	Demonstrate the IGCC and CCS technologies in fossil fuel power plants Demonstrate concentrated solar power, offshore wind, and grid-connected PV plants for a total capacity of 200 MW by 2015	**Pipeline projects with estimated amounts** Hebei Energy Efficiency Improvement and Emission Reduction Project ($100 million) Two projects in Heilongjiang and Shanxi for district heating ($250 million) **New renewable energy technology projects**	Successfully demonstrating CCS in a commercial-scale project **Pipeline projects** Mobilize over $600 million of financing for energy efficiency projects in Guangdong, Hebei, and Shandong provinces by 2015 Improve the efficiency of district heating and the area covered by district heating in Heilongjiang and Shanxi provinces
Increased investments in renewable energy	Increase in the share of renewable energy in the primary energy mix to 11.4% by 2015 (2010 baseline; 8%)	Demonstrate new renewable energy technologies such as concentrated solar power, grid-connected PV, and offshore wind Piloting and demonstrating a functioning cap-and-trade-based emissions trading market	Pilot-test and demonstrate a smart grid to enable larger share of renewable energy in the mix Pilot-test and demonstrate a functioning carbon market in key province or city	**Scaled-up energy efficiency investment program** **Ongoing projects with approved amounts** IMAR phases 1 and 2 ($270 million) Guangdong Energy Efficiency Project ($100 million) Shandong Energy Efficiency Project ($100 million) Tianjin IGCC ($135 million)	**Ongoing projects** More efficient district heating systems in Inner Mongolia Successful demonstration of commercial-scale IGCC technology

ADB = Asian Development Bank, CCS = carbon capture and storage, GHG = greenhouse gas, IGCC = integrated gasification combined cycle, IMAR = Inner Mongolia Autonomous Region, mt/y = million tons per year, MW = megawatt, PV = photovoltaic, tce/y = ton of coal equivalent per year.
Source: Asian Development Bank cost estimates.