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ABBREVIATIONS

ADB – Asian Development Bank
CBM – Coal Bed Methane
CFB – Circulating Fluidized Bed
CHP – Combined Heat and Power Generation
CMM – Coal Mine Methane
CNY – Chinese Yuan
CO₂ – Carbon Dioxide
EA – Executing Agency
EMP – Environmental Management Plan
ESP – Electronic-Static Precipitators
FCDUC – Fuxin CBM/CMM Development and Utilization Company
FFUPO – Foreign Funds Utilization Project Office
HES – Heat Exchange Stations
LDRC – Liaoning Provincial Development and Reform Commission
LEIP – Liaoning Environmental Improvement Project (the Project)
LPG – Liaoning Provincial Government
M & E – Monitoring and Evaluation
MLG – Minimum Life Guarantee
MOU – Memorandum of Understanding
NCB – National Competitive Bidding
NDRC – National Development and Reform Commission
NOx – Nitrogen Oxides
PIA – Project Implementing Agency
PMO – Project Management Office
PPMS – Project Performance Management System
PRC – People’s Republic of China
RRP – Report and Recommendation of the President
RP – Resettlement Plan
SO₂ – Sulfur Dioxide
SOE – State-owned Enterprise
SPIA – Social and Poverty Impact Assessment
SPRSS – Summary Poverty Reduction and Social Strategy
TA – Technical Assistance
TSP – Total Suspended Particulates
WHO – World Health Organization

WEIGHTS, MEASURES, AND CONVERSIONS

GJ – GigaJoules (1 billion joules)
Km – Kilometer
m – Meter
MW – Megawatt (1 million watts)
Ton – 1,000 kg
1 MW – 3.6 GJ/hour = 1.42 ton (of steam)/hour

NOTES
In this report, “$” refers to U.S. dollars and “ton” refers to metric ton.
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I. INTRODUCTION

1. This 2010 Poverty and Social Economic Impact Monitoring and Evaluation Report (Report) discussed the actual poverty and social economic impacts during the implementation period of the Liaoning Environment Improvement Project (the Project), especially for a period from January to December 2010.

2. Based on Project Agreement, the Government of Liaoning Province (GLP) and each project implementing agency (PIA) shall ensure that the PIAs implement the pro-poor programs that provide gas and heating connection fee discounts and tariff discounts to the poor based on the cost savings from the efficiency improvement under the Project, and ensure that the project cities will establish the government-funded Heating Assistance Funds to assist the poor with income at or below the poverty levels in meeting their gas and heating needs. Based on the pro-poor characteristic of the Project, effective and adequate programs and measures to improve living standards and to enhance economic conditions for the poor have been integrated into the project design and monitoring framework. All the clauses for the poor listed in Project Agreement help ensure that the poor households benefit from the Project.

3. The Report covered the following contents: (i) actual heating assistance and subsidies for the poor; (ii) re-employment of affected boiler workers; (iii) retraining for affected boiler workers; (iv) jobs for the poor during both the construction and operation periods; (v) environmental impacts analysis; (vi) improvement of occupational safety of miners; (vii) enhancement of quality of life for the poor; and (viii) conclusions and recommendations.

II. BACKGROUND

A. Change of Scope of the Project

4. The long-term goal of the Project is to support environmental improvement in Liaoning Province. The main objectives of the Project are: (i) improvement in efficiency and reliability of gas and central heating supply and closure of small coal-fired boilers, and (ii) production and commercial utilization of CMM and CBM.

5. ADB agreed to provide $70 million of Loan for the Project in 2005. The Project originally consisted of seven subprojects which included four components: (i) Part A: coal bed methane (CBM) and coal mine methane (CMM) development and utilization in Fuxin; (ii) Part B: gas distribution improvement in Benxi and Fushun; (iii) Part C: improvement of city central heating supply in Anshan, Benxi, Liaoyang, and Yingkou; and (iv) Part D: institutional reform and governance improvement for all PIAs.

6. In 2007, ADB approved the following changes of scope of the Project: (i) the scope of Subproject A: Fuxin Coal Bed Methane/Coal Mine Methane (CBM/CMM) Development would be changed to include four mini CBM/CMM-fired power plants with total capacity of 22 MW; (ii) Subproject C2: Anshan City Central Heating Supply and Subproject B1: Fushun Gas Distribution Improvements would be cancelled; and (iii) two new subprojects -- Fuxin Central Heating Supply and Benxi Huaxing Central Heating Supply subprojects would be added. The ADB loan amount remains unchanged.

7. However, the scope of the Project has been changed again in 2010 due to unexpected
reasons. The scope changes have been approved by both Chinese Authorities and ADB in July 2010 and the total ADB loan amount has been reduced from $70 million into $56.7 million. The original scope of the Project and the changes of the scope are listed in Table 1.

Table 1: Original Scope and Changes of Scope

<table>
<thead>
<tr>
<th>Components at Appraisal</th>
<th>Changes of Scope</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Part A: CBM/CMM Development</strong></td>
<td></td>
</tr>
<tr>
<td>(i) Fuxin CBM/CMM Development</td>
<td>Dropped out from ADB financing in 2010, but keep as part of the Project</td>
</tr>
<tr>
<td><strong>Part B: Gas Distribution Improvement</strong></td>
<td></td>
</tr>
<tr>
<td>(i) Fushun Gas Distribution Improvement</td>
<td>Cancelled in 2007</td>
</tr>
<tr>
<td>(ii) Benxi Gas Distribution Improvement</td>
<td>No change.</td>
</tr>
<tr>
<td><strong>Part C: City Central Heating Supply</strong></td>
<td></td>
</tr>
<tr>
<td>(i) Anshan Central Heating Supply</td>
<td>Cancelled in 2007</td>
</tr>
<tr>
<td>(ii) Benxi Central Heating Supply</td>
<td>No change.</td>
</tr>
<tr>
<td>(iii) Liaoyang Central Heating Supply</td>
<td>No change.</td>
</tr>
<tr>
<td>(iv) Yingkou Central Heating Supply</td>
<td>No change.</td>
</tr>
<tr>
<td>(v) Benxi Huaxing Central Heating Supply</td>
<td>Newly added in 2007</td>
</tr>
<tr>
<td>(vi) Fuxin Central Heating Supply plus</td>
<td>Newly added in 2007</td>
</tr>
<tr>
<td>Fuxin Central Heating Supply Extension</td>
<td>Newly added in 2010</td>
</tr>
<tr>
<td><strong>Part D: Institutional Strengthening</strong></td>
<td>No change.</td>
</tr>
</tbody>
</table>

Source: 2006-2010 ADB MOUs

B. Main Changes of Social Benefits due to the Scope Change of the Project

8. Based on the original summary poverty reduction and social strategy (SPRSS), it was estimated that the Project would directly benefit an urban population of about 2.7 million in six cities. After the scope changes, the Project will directly benefit about 2.48 million urban people in the Project areas of Fuxin, Benxi, Liaoyang, and Yingkou cities, which number does not include the beneficiaries of cancelled subprojects in Anshan and Fushun. The Project will create 7,880 person-years employment opportunities during the construction phase and 2,145 full-time jobs during the operation of the Project, that are 8% and 11% higher than the estimation listed in the original SPRSS. Of these, 2,940 person-years of employment opportunities will be provided to the poor, women and minorities with salary earning of CNY28.26 million during the construction period. About 800 full-time operational employment opportunities with CNY8.58 million of wage payment per year is expected to be offered to the poor, women and minorities. In addition, the CBM/CMM development subproject will substantially improve the safety situation of the coal mines which will directly benefit 15,000 miners.

9. A total of 39,481 poor households will benefit from the government-funded gas and
heating assistance programs which provide discounts in gas and heating connection fees and tariffs. This is a significant decrease from the number of 90,870 households listed in the original SPRSS. The main reason is that 35,200 households were double-counted as beneficiaries as they benefit from both the discount of connection fee and tariff. Secondly, the number of poor people in the same area has been significantly reduced since the implementation of the country’s program aimed at revitalizing northeast regions. Likewise, the number of poor households benefited for Liaoyang Central Heating Supply Subproject has been reduced from 9,200 to 5,600, while from 8,970 to 3,000 for Benxi Central Heating Supply Project.

C. Description of Project Progress

10. The construction of the Project started in October 2005 and completed in March 2011. The detailed project implementation status for each component is described as follows:

Part A: CBM/CMM Development Component

11. The Fuxin CBM/CMM Development and Utilization Company (FCDUC, the PIA) confirmed that the revised subproject construction scope includes: (i) 22 vertical wells to extract CBM, (ii) improved CMM drainage stations with underground directional drilling and other equipment, including one new extraction station; (iii) CBM/CMM storage structures, including one 20,000 m³ and one 5,000 m³ above-ground methane gas storage tanks, transmission pipelines, pump stations, and distribution facilities; (iv) methane gas compression station and auxiliary facilities; and (v) 4 CMM-fired power generation plants with total capacity amounting to 22 MW.

12. This subproject has been completed through local funds, but still as part of ADB-financed Project. As a result, its social and environmental impact will still be an important part of the Project. In December 2010, the ADB mission members, the Liaoning PMO and the Consultant met the representatives of Fuxin CBM/CMM Development and Utilization Company and discussed the environment and social benefits of the CBM/CMM Development Project. Issues in terms of resettlement were also discussed, and the PIA has agreed to provide the updated resettlement report to the PMO in March 2011.

Part B: Gas Distribution Component

13. The construction of the Benxi Gas Distribution Improvement Subproject was completed in October 2008 with replacement of 43km of aging gas pipelines and construction of 5 km of new gas pipeline pipes, including a set of gas desulphurization facilities. The PIA, Benxi Gas General Company, conducted the corporate restructuring study in 2005 and changed itself into a limited liability company subsequently. A special report about this change was submitted to ADB in April 2007. Besides, the name of Benxi Panva Gas Co., Ltd. was changed into “Towngas Group, Benxi Ganghua Gas Company, Ltd.” in April 2008. The estimated project cost is CNY 47.66 million, including an ADB loan of $2.96 million.

Part C: City Central Heating Component

14. Benxi Central Heating Subproject, Liaoyang Central Heating Subproject, and Benxi Gas Distribution Improvement Subproject were completed in 2006, 2007 and 2008, respectively. Yingkou Central Heating Subproject, Fuxin Central Heating Subproject, and Benxi Huaxing
Central Heating Subproject were completed in 2009. As a result, approximately 20%-40% of heat efficiency increases for each subproject have been achieved upon completion of the heating subprojects.

15. **Benxi Central Heating Supply Subproject.** The Subproject was completed in 2006 with two 58 MW circulated fluidized-bed (CFB) hot water boilers, 2 sets of electronic-static precipitators (ESPs), 18 heat exchange stations, and 17 km heat supply pipelines installed. A total of 63 small boilers were demolished. Trial operation has started since 2006 to provide heating to area of 3.2 million m². The original estimated project cost was CNY 10.248 million, and the final project cost is over CNY 14.8 million, including an ADB loan of $5.86 million.

16. **Liaoyang Central Heating Supply Subproject.** The Subproject includes the Beicaoku Heating Plant and the Doushuangshu Heating Plant. This subproject includes (i) ten 58 MW chain-grate stoker hot water boilers and auxiliaries, of which two are financed by local funds; (ii) 63 HESs, of which 55 are financed by ADB; (iii) 48.5 km heat distribution pipelines; and (iv) civil works for two boiler houses. This Subproject was completed in 2008 with capacity of heating area of 8.2 million m². 174 small boilers were decommissioned. The originally proposed project cost was at CNY 339 million, and the updated project cost is at CNY 362 million, including an ADB loan of $13.96 million.

17. **Yingkou Central Heating Supply Subproject.** The Subproject includes (i) three 58 MW CFB boilers, of which two are financed by local funds and one by the ADB loan; (ii) two 12 MW steam turbine power generators, of which one is financed by local funds and the other by the ADB loan; (iii) two 29 MW peak shaving boilers; (iv) 12 HESs; and (v) 40 km heat distribution pipelines. The subproject was completed in 2009, 177 small obsolete boilers were demolished, and the total heating supply area has been increased from 1.5 million m² to 2.17 million m². The Subproject cost was originally estimated at CNY 361.85 million, and the updated project cost is CNY 287 million, including an ADB loan of $13.96 million. The PIA has changed its name to Yingkou Heating and Electrical Company without ownership and management changes.

18. **Benxi Huaxing Central Heating Supply Subproject.** The Subproject consists of (i) construction of three 58 MW hot water boilers and auxiliaries; (ii) construction/renovation of 20 km heat distribution network (diameters of 20 cm to 70 cm); (iii) construction/renovation of 16 heat exchange stations, 7 of which are to be newly constructed; and (iv) closure of 28 small boilers. The Subproject was completed in 2009. 28 small boilers located in 18 small boiler houses were decommissioned by the end of 2010. The total subproject cost is CNY 89 million, and is comprised of RMB 38.45 from ADB loan and RMB 51.55 million from a counterpart fund.

19. **Fuxin Central Heating Supply Subproject.** The Subproject includes 20.6 km pipelines, 14 new valve chambers, 12 upgraded valve chambers, and an automatic control system. The Subproject was completed in October 2009. Totally 24,500 households and several commercial users have benefited from this subproject. The heating service capacity has been increased from 2 million m² to 6 million m² upon completion of this subproject. The originally estimated project cost was CNY90.21 million, and the updated project cost is CNY 98 million, including an ADB loan of $5.8 million.

20. The PIA proposed two additional packages to utilize part of the remaining ADB loan of
approximate $7 million to finance additional central heating subproject, including 12 HESs, 6.6 km of main heating pipelines and 1.8 km of secondary heating pipelines, and associated automatic control systems. Total subproject cost is CNY89.6 million. Both Chinese Authorities and ADB agreed the adding of the two contracts in August 2010. As a result, the total ADB loan increases to $12.8 million. The bidding documents were developed by a local design institute, reviewed by the Consultant, and approved by both Chinese authorities and ADB in 2011. Bid opening, bid evaluation, bid awards, contract negotiating and contract signing for the two contracts were completed during the fourth quarter of 2010. Relevant equipment and materials were delivered on site in late 2010.

D. Methodology of Monitoring and Evaluation of Poverty Reduction and Social and Economic Impact

21. In order to have a better understanding of the social and economic impacts and poverty reduction under the Project, an integrated monitoring and evaluation system to obtain the basic profile of poor households benefited from the Project and the implementation of the assistance programs to the poor has been well established. The process of monitoring and evaluation of the poverty reduction and social and economic impacts for the Project includes (1) field trips to collect first-hand information; (2) secondary data collection; (3) regular data collections once a year; (4) data consolidation and analysis; (5) conclusions and recommendations. The method applied for the monitoring and evaluation on the social economic impacts and poverty reduction are described below:

(i) Field trips to collect first-hand information. The Consultant conducted several field trips to the cities of PIAs to collect first-hand data in terms of poverty reduction and environment monitoring data. The PIAs, heating supply offices and environment monitoring centers provided much of the quantitative and qualitative information. All the collected information has been used as the basis for identifying the potential project impacts, assessing their significance, and formulating complementary measures to enhance the positives and mitigate the negative impacts.

(ii) Secondary data collection. The Consultant collects all the social and economic information and other necessary data through statistical yearbooks and other data resources related to the Project.

(iii) Regular data collections. Data collection sheets were developed by the Consultant based on Design and Monitoring Framework (DMF) and SPRSS of the Project. Data collection sheets are distributed to the PIAs every year to collect regular data requested by the PPMS and SPRSS. The PPMS was established consistent with the DMF and specified in the RRP to reflect the direct impacts and changes of socioeconomic status of the Project. The indicators in the PPMS are monitored through the monitoring reports after the baseline was established. In accordance with the scope change of the Project and ADB comments on the poverty and social economic impact monitoring and evaluation report, the PPMS was revised and some indicators were deleted and some new indicators were added and updated. The main indicators including in the revised PPMS were listed below:
- Annual reduction of air emissions (CO$_2$, SO$_2$, NO$_x$, TSP);
- Annual reduction of coal consumption;
- Number of closed small inefficient and polluting coal-fired boilers;
- Installation of efficient heating supply plants (capacity, distribution pipeline network, etc.);
- Replacement of aging gas pipelines (length and diameter size);
- Number of new households using gas services;
- Number of poverty households that received heating supply subsides;
- Amount of heating supply subsides provided to assist poverty households;
- Number of vulnerable people (women, poor households, minorities, etc.) employed during the project construction and in operation of the project;
- Number of affected boiler workers being employed in newly built boilers;
- Training for affected boiler workers;
- Improvement of corporation governance of the PIAs;
- Heating tariff collection mechanisms and efficiency; and
- Financial management (financial ratios of the operating entity in 2008 and thereafter; debt-to-equity ratio not more than 70:30; debt service coverage factor at least 1.4 times; and return on net fixed assets at least 6%).

(iv) **Data consolidation and analysis.** Based on the first-hand and secondary information, the Consultant has analyzed the data provided and consolidated all the useful data into the social and economic impact and poverty reduction report.

(v) **Conclusion and Recommendation.** The Consultant has figured out the existing issues and provided the recommendations to address all the issues raised. Conclusions have been made.

22. The indicators specified in the updated DMF are presented in **Appendix 1.** Most of the analysis of this report is based on the PPMS. Some indicators related to financial management, corporation governance, etc. are analyzed in other reports so we will not discuss these issues in this report.
III. Monitoring and Evaluation of Poverty and Social Economic Impacts

A. Heating Assistance and Subsidy for the Poor

1. Background

23. Heating is a critical issue for people’s livelihoods in northern China like Liaoyang, Benxi, Fuxin, and Yingkou, where the winter temperature can drop as low as minus 20 degree Celsius. However, the affordability of the poor for heating services is a major concern. Take the year 2007 as an example. The average heating tariff in Benxi, Liaoyang, and Yingkou was about CNY22/m². The average heating bill for a poor household living in a 40 m² apartment unit is about CNY176 per month during the 5-month heating season. In a typical poor household of four people, for example, the income at the poverty line is CNY688 per household per month in Benxi, CNY760 in Liaoyang and CNY680 in Yingkou. Thus, the heating bill represents a large portion of the poor household’s monthly income (25.6% in Benxi, 23.2% in Liaoyang, and 25.9% in Yingkou), indicating that poor households can barely afford for the service of heat supply.

24. However, all the project cities have conducted moderate heating tariff increase in 2008 mainly due to the coal price increase from CNY330 per ton in 2007 to CNY500-600 per ton in 2008. For the Benxi Central Heating Subproject, the heating tariff for residential users was increased from CNY22 to CNY28 per square meters in 2009, but calculation by Benxi Price Bureau concluded that the actual average heating cost the heating company was CNY30.7 per square meters. It is indicated that the heating company is still not profitable even with heating tariff increase. For Fuxin Central Heating Subproject, the heating tariff for residential users was increased from CNY21.5 to CNY26.5 per square meters in 2009. For Liaoyang Central Heating Subproject, the heating tariff for residential users increased from CNY22 to CNY28 per square meters in 2009. The increasing of heating tariff exacerbated the payment situation for poverty households. According to the World Health Organization (WHO), a household is called heating poverty household if it cannot afford to keep sufficiently warm at reasonable cost during winter time. The most widely accepted definition of a heating poverty household is one which needs to spend more than 10% of its income on all fuel use and to heat its home to a sufficient standard of warmthness. This is generally defined as 21°C in the living room and 18°C in the other occupied rooms as recommended by the WHO.

25. Insufficient heating severely affects the quality of life and health of the poor. Causal links between poor housing and the incidence of heating poverty and poor health are not fully established. However, it is well accepted that poor housing conditions exacerbate existing illnesses such as asthma and reduce resistance to respiratory illnesses such as influenza, pneumonia and bronchitis. This risk of heart attack or stroke is also increased by cold conditions. For example, the evidence indicates that cardiovascular disease incidence in Shenyang is 12 times in Shanghai in winter months.

26. Poor housing conditions are also likely to contribute to other health and social problems such as poor mental and physical health and underachievement in education. One of the most important, and often cited, pieces of work in the heating poverty and health debate is the Acheson Report, “Independent Inquiry into Inequalities in Health”. This report recognized poor housing as a case of health inequality and recommended that actions should be taken to improve heating and insulation levels and address the issue of the heating supply for the poor.
27. Heating is a life necessity in Liaoning province where outdoor temperature could drop below minus 20 degree Celsius in winters. Thus, heating supply in winter has been part of the employers and/or government’s welfare support system for the past decades. In fact, the employers or the government were able to pay the heating bills for their employees before early-1990s when the restructuring and downsizing of State-owned Enterprises (SOEs) started. But since the early-1990, a large number of SOEs in Liaoning province were restructured or bankrupted, and were unable to pay the heating bills for their employees. The households have to pay their heating bills for themselves. To solve the heating affordability for the poor, all cities (including Benxi, Fuxin, Liaoyang and Yingkou) in Liaoning province have established some kinds of subsidy programs for the poor. For example, in 2005, seven cities experiencing poor fiscal conditions can obtain assistance with the help of the provincial government for the program funding. These include: (i) Yingkou, Dandong and Tieling each received CNY4 to 5 million; and (ii) Benxi, Fushun, Chaoyang and Fuxin each received CNY10 to 12 million. Other cities with better fiscal conditions provided the program funding from their own municipal budgets.

2 Heating Subsidy Programs

28. One of the important impacts or contributions of the Project is that the implementation of the Project promotes the improvement of the heating subsidy programs in the project areas. Under the promotion of the implementation of the Project, together with the help of other ADB projects such as TA 4402-PRC -- Heating Supply for Urban Poor in Liaoning Province, the measures for providing heating assistance to the poor in Liaoning Province and the project cities of Benxi, Fuxin, Liaoyang and Yingkou have been expedited.

29. Due to the pro-poor characteristic of the project, specific heating assistance programs to the poor were designed. According to the revised SPRSS, the main contents of assistance programs include:

- The PIA of the Benxi central heating supply has waved 90% of the heating tariff for around 3,000 poor households under the city poverty line in Benxi City. In total, it results in reduction of CNY4 million from the tariff collection per year for the poor households.

- The PIA of the Liaoyang central heating supply has waved 80% of the heating tariff discount for around 5,600 poor households under poverty line in Liaoyang City. In total it results in reduction of CNY 6.7 million from the tariff collection per year for the poor households in Liaoyang City.

- For the Yingkou central heating supply, the PIA has waved 80% of the heating tariff discount for around 4,000 poor households under poverty line in Yingkou City. In total, it results in reduction of CNY 5.5 million from the tariff collection per year for the poor households.

- The PIA of the Fuxin central heating supply plans to provide free connection for all new consumers and 90% tariff for 881 poor households or 2,236 persons (reduce 90% tariff at and below the house construction area of 60 m² per households and charge full above 60m² per household). It would result in an annual saving of CNY2.626 million for the poor households.

- For the Benxi Huaxing heating supply, the PIA plans to offer free for heating connection for all new consumers and 55% tariff reduction for 2,000 poor households or 7,000
persons. The total annual savings for the beneficiaries are estimated to be CNY3.00 million from tariff reduction.

- The PIA of the Fuxin CBM/CMM development plans to offer 50% discount for gas connection and 20% tariff discount for 15,000 poor households from 2007 to 2008. The estimated annual savings for the poor households include CNY12.75 million from the connection fee and CNY1.69 million from the tariff.

- The PIA of the Benxi gas improvement plans to offer 50% discount for gas connection and 20% tariff discount for 9,000 poor households from 2007 to 2009. The expected savings for the poor households are CNY7.65 million from the connection fee and CNY1.01 million from the tariff.

30. The design of the Project also requests the heating companies' market-oriented institutional reform. In the implementation of the subprojects, the local governments have gradually realized that it is the government’s responsibility to provide heating subsidies to the poor, more government-oriented heating assistance programs have been established in the project cities - Benxi, Liaoyang Yingkou and Fuxin. The detail heating assistance programs are presented in Appendix 2.

31. Based on the description above it is observed that a more suitable heating assistant system for the poor has been established with the implementation of the Project and more heating assistant funds have been gathered, and more poor households have been compensated. The total numbers of poor households received heating subsidies in each project city and the numbers of households received heating subsidies in the areas served by the PIAs are presented in Table 2.

Table 2: Numbers of Poor HHs Received Heating Subsidies in both Project Cities and the Areas Served by PIAs

<table>
<thead>
<tr>
<th>Number of Poor HHs Benefited</th>
<th>Target</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benxi City</td>
<td>24,790</td>
<td>25,950</td>
<td>18,054</td>
<td>18,357</td>
<td>26,831</td>
<td>113,982</td>
<td></td>
</tr>
<tr>
<td>Benxi Hengze PIA</td>
<td>3,000</td>
<td>12,949</td>
<td>15,830</td>
<td>12,970</td>
<td>13,310</td>
<td>12,458</td>
<td>67,517</td>
</tr>
<tr>
<td>Benxi Huaxing PIA</td>
<td>2,000</td>
<td>1,500</td>
<td>1,826</td>
<td>1,987</td>
<td>2,100</td>
<td>7,413</td>
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</tr>
<tr>
<td>Liaoyang City</td>
<td>5,600</td>
<td>3,955</td>
<td>4,568</td>
<td>4,964</td>
<td>5,600</td>
<td>19,087</td>
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<tr>
<td>Liaoyang PIA</td>
<td>15,139</td>
<td>15,843</td>
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<td>27,094</td>
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<tr>
<td>Yingkou City</td>
<td>3,852</td>
<td>3,913</td>
<td>17,655</td>
<td>22,773</td>
<td>19,157</td>
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<tr>
<td>Yingkou PIA</td>
<td>4,000</td>
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<td>12,358</td>
<td>15,837</td>
<td>15,325</td>
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<tr>
<td>Fuxin City</td>
<td>881</td>
<td>3,692</td>
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<td>5,031</td>
<td>5,218</td>
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<td>24,891</td>
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<td>Fuxin PIA</td>
<td>50,000</td>
<td>63,974</td>
<td>65,755</td>
<td>66,176</td>
<td>245,725</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total for all the Cities</td>
<td>43,781</td>
<td>95,706</td>
<td>119,383</td>
<td>123,410</td>
<td>139,258</td>
<td>521,538</td>
<td></td>
</tr>
<tr>
<td>Total for all the PIAs</td>
<td>19,614</td>
<td>29,155</td>
<td>36,753</td>
<td>41,316</td>
<td>41,701</td>
<td>168,539</td>
<td></td>
</tr>
<tr>
<td>Percentage</td>
<td>45%</td>
<td>30%</td>
<td>31%</td>
<td>33%</td>
<td>30%</td>
<td>32%</td>
<td></td>
</tr>
</tbody>
</table>

Source: provided by PIAs.

32. It can be seen from Table 2 that the 5 heating PIAs have successfully completed the heating assistance programs to the poor households. It can also be seen from Table 2 that the actual numbers of poor households received heating subsidies supported by the PIAs are more than the targets specified in the revised SPRSS. The percentages benefited by the PIAs account for over 30% of the total of the subproject cities since 2007. It should be also noted from Table 2 that the numbers of poor households received subsidies by the Benxi Hengze, Yingkou and Fuxin PIAs were significantly higher than the targets for the subprojects. The three PIAs expressed that the numbers of poor households received heating subsidies from the subprojects should be slightly higher than the targets, though the
accurate numbers of poor households received subsidies by the Benxi Hengze, Yingkou and Fuxin subprojects were not available. The amounts of subsides provided for each subproject city and in the area served by each PIA are presented in Table 3.

### Table 3: Amount of Subsides by Both Cities and the PIAs

<table>
<thead>
<tr>
<th>Number of Poor HHs Benefited</th>
<th>Target</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benxi City</td>
<td>26.74</td>
<td>32</td>
<td>29.88</td>
<td>32.08</td>
<td>30.4</td>
<td>151.1</td>
<td></td>
</tr>
<tr>
<td>Benxi Hengze PIA</td>
<td>4.00</td>
<td>13.39</td>
<td>16.8</td>
<td>15.1</td>
<td>14.64</td>
<td>15.47</td>
<td>75.4</td>
</tr>
<tr>
<td>Benxi Huaxing PIA</td>
<td>3.00</td>
<td>1.80</td>
<td>2.20</td>
<td>2.90</td>
<td>3.00</td>
<td>3.20</td>
<td>13.1</td>
</tr>
<tr>
<td>Liaoyang City</td>
<td>14.1</td>
<td>14.64</td>
<td>26</td>
<td>21.16</td>
<td>26.05</td>
<td>101.95</td>
<td></td>
</tr>
<tr>
<td>Liaoyang PIA</td>
<td>6.70</td>
<td>3.68</td>
<td>5.23</td>
<td>6.87</td>
<td>6.90</td>
<td>22.68</td>
<td></td>
</tr>
<tr>
<td>Liaoyang PIA</td>
<td>208</td>
<td>3.68</td>
<td>5.23</td>
<td>6.87</td>
<td>6.90</td>
<td>22.68</td>
<td></td>
</tr>
<tr>
<td>Yingkou City</td>
<td>5.5</td>
<td>12.25</td>
<td>16.22</td>
<td>13.95</td>
<td>53.79</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yingkou PIA</td>
<td>5.50</td>
<td>4.24</td>
<td>4.72</td>
<td>8.23</td>
<td>11.34</td>
<td>39.69</td>
<td></td>
</tr>
<tr>
<td>Fuxin City</td>
<td>2.63</td>
<td>2.55</td>
<td>3.33</td>
<td>4.47</td>
<td>4.64</td>
<td>19.63</td>
<td></td>
</tr>
<tr>
<td>Fuxin PIA</td>
<td>2.63</td>
<td>2.55</td>
<td>3.33</td>
<td>4.47</td>
<td>4.64</td>
<td>19.63</td>
<td></td>
</tr>
<tr>
<td>Total for all the Cities</td>
<td>46.34</td>
<td>52.51</td>
<td>89.68</td>
<td>99.84</td>
<td>109.61</td>
<td>397.98</td>
<td></td>
</tr>
<tr>
<td>Total for all the PIAs</td>
<td>21.98</td>
<td>30.73</td>
<td>35.93</td>
<td>41.32</td>
<td>40.54</td>
<td>170.5</td>
<td></td>
</tr>
<tr>
<td>Percentage</td>
<td>47%</td>
<td>59%</td>
<td>40%</td>
<td>41%</td>
<td>37%</td>
<td>43%</td>
<td></td>
</tr>
</tbody>
</table>

Source: provided by PIAs.

33. Similarly, Table 3 shows that the amounts of subsidies supported by the PIAs are significantly more than the planned. The amounts of subsidies supported by the PIAs and local government in 2010 accounts for 37%. It should be noted that some numbers in Table 2 and Table 3 are slightly different from the numbers provided in the previous monitoring and evaluation of social and economic and poverty reduction report, and the numbers given in this report have been confirmed by the relevant PIAs.
34. Figure 1 and Figure 2 show the comparison of poverty reduction of contributions provided by the PIAs and local governments. It can be seen from Figure 1 and Figure 2 that the Benxi Hengze PIA is the best provider to the poor.

3 Poor Households Benefited from Gas and Heating Subprojects

35. Based on the information provided by the PIAs, a total of 259,061 of households or 803,040 of urban population have been benefited from the heating subprojects in the 4 project cities of Benxi, Fuxin, Liaoyang and Yingkou. The total number of the poor households benefited by the heating subprojects is 41,701 in 2010, accounting for 16% of the total urban population benefited by the subprojects. The numbers of households and urban populations benefited by the heating subprojects are presented in Table 4.

Table 4: Numbers of Household and Urban Population Benefited by Heating Subprojects

<table>
<thead>
<tr>
<th>PIAs</th>
<th>Number of Households</th>
<th>Number of Urban Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benxi Hengze</td>
<td>15,379</td>
<td>47,675</td>
</tr>
<tr>
<td>Benxi Huaxing</td>
<td>17,000</td>
<td>52,700</td>
</tr>
<tr>
<td>Fuxin</td>
<td>93,837</td>
<td>290,895</td>
</tr>
<tr>
<td>Liaoyang</td>
<td>110,000</td>
<td>341,000</td>
</tr>
<tr>
<td>Yingkou</td>
<td>22,845</td>
<td>70,820</td>
</tr>
<tr>
<td>total</td>
<td>259,061</td>
<td>803,089</td>
</tr>
</tbody>
</table>

Source: provided by PIAs.

36. Figure 3 shows the comparison of the numbers of urban populations benefited by the 5 heating PIAs. The number of urban populations benefited by the PIAs of Liaoyang Central Heating Subproject and Fuxin Central Heating Subproject account for third quarter of the total.
37. Based on the information provided, the number of households benefited from the Benxi Gas Distribution Improvement Subproject is 189,128, of which the number for the poor households is 10,254, accounting for 5.2%. Similarly, the number of households benefited from the Fuxin CBM/CMM Development Subproject is estimated to be 405,000, of which the number for the poor is estimated to be 20,000, accounting for 5%.

38. As a result, a total urban population of about 2.64 million in the 7 project beneficiary areas of Fuxin, Benxi, Liaoyang, and Yingkou have benefited from the Project. Of the total beneficiaries, about 1.84 million urban residents benefit from the gas supply and 0.80 million from central heating supply. About 239,000 persons or about 9.1% of the total beneficiaries are the poor.

B. Re-employment of Affected Boiler Workers

39. According to the revised ‘Re-employment Plan for the Affected Employees’ of the PPTA for this Project, the heating supply subcomponents of the Project would involve the closure of 440 small coal-fired boilers in the three cities, including Benxi central heating subprojects by Benxi Hengze Heating Company and Benxi Huaxing Heating Company, the Liaoyang central heating subproject by the Liaoyang Real Estate Heating Company, and Yingkou central heating subproject by Yingkou General Heating Company. The closure of these boilers would affect an estimated of 1,959 boiler workers.

40. According to the information provided by the PIAs, as of the end of 2010, the number of small coal-fired boilers decommissioned and closed for the central heating supply subprojects reached 442, two more than the total small boilers planned to be closed, as shown in Table 5.

<table>
<thead>
<tr>
<th>Project IAs</th>
<th>Planned</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2004</td>
<td>2005</td>
</tr>
<tr>
<td>Benxi Hengze</td>
<td>63</td>
<td>29</td>
</tr>
</tbody>
</table>
41. It can be seen from Table 5 that all PIAs have finished the closure of small boilers upon completion of their respective subproject construction according to the project plan. It should be noted that no small boilers are requested to be closed or decommissioned for the Fuxin Heating Subproject.

42. Since 442 small and inefficient boilers were closed by the end of 2010, a total of 1,740 workers were affected. The re-employment action plan specified in the RRP states that the PIAs 'have agreed to re-employ all the affected employees in other units of their business or retain them for reassignments of other jobs with a common goal that the affected employees will not be financially worse off than they would have been without the Project.

43. According to the information provided by the PIAs, 1,740 of affected workers were well re-employed. The reemployment of the affected workers is given in Appendix 3.

- According to the information from Benxi General Heating Company, the affected 324 boiler workers were reemployed, among which 281 were reemployed as regular staff, which accounts for 86.7% for the affected workers.

- According to the information provided by Liaoyang Real Estate Heating Company, most of the affected workers are employees who worked as boiler workers in the company in heating season and looked for other work in non-heating season. The company assigned 380 workers to the newly built boilers while the other 564 affected employees were reemployed to other units, which includes civil work in 103 Geologic Survey Team and cleaning in Environmental and Sanitary Division of Baita District, etc.. The number of reemployed as regular workers accounts for 44.02%.

- According to the information provided by Yingkou General Heating Company, of the 419 affected workers, 101 are reemployed in the heating company. The number of reemployed as regular workers accounts for 80.1%.

- According to the information provided by Benxi Huaxing Heating Company, of the 53 affected workers, 21 are reemployed in the heating company. The number of reemployed as regular workers accounts for 40.0%.

44. According to the interviews made by the PIAs, the salaries for all of affected workers were not worse than that before the project implementation. Furthermore, it was reported that their salary for most of them were slightly higher than the minimum salary standard in each project city.
C. Retraining for Affected Boiler Workers

45. According to the information provided by the PIAs, the reemployed affected workers received some retraining before they started their new positions. A total of 2,215 person-times of retraining for the affected employees have been conducted since the construction and operation of the Project, of which 200 person-times for Benxi Central Heating Supply Subproject, 900 person-times for Liaoyang Central Heating Supply Subproject, 1,107 person-times for Yingkou Central Heating Supply Subproject, and 8 person-times for Benxi Huaxing Central Heating Supply Subproject. All of the training is on-the-job training. Most of the training contents are related to the heating supply sector, which include operation of large heating boilers, panel control, maintenance and repair, stoker, electrician, welder etc. The detailed training done is presented in Appendix 4.

46. For those affected workers who do not work in heating company, the opportunities for training are seldom and these kind of affected workers usually reemployed as temporary positions. Reemployment skills are badly needed for them.

D. Jobs for the Poor during both the Construction and Operation Periods

47. Based on the information provided, the Project has created about 8,000 person-years of employment opportunities during the construction period and approximate 2,200 full-time jobs during the operation period of the Project. Of these, nearly 3,000 person-years of employment opportunities have been filled by the poor, women and minorities, earning approximate CNY30.00 million in wage payments during the project construction period. An additional 800 full-time operational employment opportunities or CNY11.00 million of wage payment per year has gone to the poor, women and minorities. In addition, local procurement of the materials required for the Project also created additional jobs. By increasing gas and central heating supplies to local residents, industries, commercial users and public institutions, the Project has resulted in improvement of the socio-economic infrastructure for the project area.

E. Environmental Impacts Analysis

48. The use of residential heating technologies has been substantially influenced by the environmental quality in the Liaoning Province. In the 1980s and 1990s, urban heating systems in the Liaoning Province were dominated by small coal-fired boilers. These are typically 2 to 6 tons/hour boilers for individual building or a cluster of buildings within a small district in urban areas. These small boilers are usually owned by large SOEs that provide heating to their employees. There are also numerous heating service companies with distribution networks using large (greater than 10 tons/hour) central coal-fired boilers and/or a coal-fired combined heat and power (CHP) plant. In addition, a very small number of households use electricity and gas for heating. Poor households in a city may use domestic coal-fired stoves for heating.

49. As smaller coal-fired boilers and domestic stoves typically are not equipped with adequate emission control equipment or devices, they are the major sources of air pollution in urban areas in Liaoning Province. In an effort to improve ambient air quality in urban areas, the Government of Liaoning Province in 1999 promulgated an Ambient Air Quality Control Regulation and city governments (including Benxi, Liaoyang and Yingkou) have issued their respective regulations in the recent years to ban polluting heating technologies and promote cleaner heating technologies. As a result, the market shares of cleaner heating technologies, such as CHP plants and large efficient heating boilers, have been increasing and the number
of small heating boilers has been decreasing.

1 Air Quality Improvement of Subproject Cites

50. The implementation of ambient air quality control regulation and international environmental improvement projects such as this ADB project have steadily improved the ambient air quality of the project areas in Benxi, Fuxin, Liaoyang and Yingkou in recent years. The average concentrations of TSP, SO₂, NOₓ and CO during the heating seasons from 2004 to 2010 for Benxi, Liaoyang and Yingkou are presented in Table 6-8. The Comparison between the yearly average concentrations and the concentrations during the heating seasons are presented in Appendix 5.

| Table 6: Concentrations of TSP, SO₂, NOₓ and CO during the Heating Seasons in Benxi |
|---------------------------------|----------|----------|----------|----------|----------|----------|----------|
|                                | 2004     | 2005     | 2006     | 2007     | 2008     | 2009     | 2010     |
| TSP                             | 0.42     | 0.42     | 0.41     | 0.34     | 0.32     | 0.27     | 0.20     |
| SO₂                             | 0.08     | 0.08     | 0.15     | 0.10     | 0.10     | 0.09     | 0.09     |
| NOₓ                             | 0.03     | 0.03     | 0.04     | 0.04     | 0.04     | 0.04     | 0.04     |
| CO                              | 3.31     | 3.31     | 3.02     | 2.80     | 2.56     | 2.38     | 2.02     |

Source: provided by PIAs.

| Table 7: Concentrations of TSP, SO₂, NOₓ and CO during the Heating Seasons in Liaoyang |
|---------------------------------|----------|----------|----------|----------|----------|----------|----------|
|                                | 2004     | 2005     | 2006     | 2007     | 2008     | 2009     | 2010     |
| TSP                             | 0.239    | 0.144    | 0.11     | 0.1225   | 0.095    | 0.095    | 0.094    |
| SO₂                             | 0.103    | 0.113    | 0.076    | 0.0936   | 0.079    | 0.086    | 0.085    |
| NOₓ                             | 0.058    | 0.04     | 0.028    | 0.0608   | 0.043    | 0.045    | 0.044    |
| CO                              | 1.93     | --       | 1.82     | -        | -        | 1.4      | --       |

Source: provided by PIAs.

| Table 8: Concentrations of TSP, SO₂, NOₓ and CO during the Heating Seasons in Yingkou |
|---------------------------------|----------|----------|----------|----------|----------|----------|----------|
|                                | 2004     | 2005     | 2006     | 2007     | 2008     | 2009     | 2010     |
| TSP                             | 0.19     | 0.104    | 0.138    | 0.121    | 0.093    | 0.062    | 0.061    |
| SO₂                             | 0.05     | 0.068    | 0.122    | 0.094    | 0.072    | 0.061    | 0.059    |
| NOₓ                             | 0.032    | 0.029    | 0.05     | 0.061    | 0.029    | 0.024    | 0.023    |
| CO                              | 1.01     | 2        | 2.65     | 2.67     | -        | 1.617    | 1.614    |

Source: provided by PIAs.

51. Table 9 shows the completion dates for the heating subprojects. It can be observed from Figures 4, 5 and 6 that most of the concentrations of TSP, SO₂, NOₓ and CO₂ have been reduced since the time of the completion of the subprojects.

| Table 9: Completion Date by Subprojects |
|---------------------------------|-----------------|-----------------|
| City                            | Subproject       | Completion Date |
| Benxi                           | Benxi Hengze Central Heating | June 10, 2006 |
|                                 | Benxi Huaxing Central Heating | December 31, 2009 |
52. Figure 4, 5 and 6 show the trends of the changes of the concentrations of TSP, SO$_2$, NOx and CO for the subproject cities in Benxi, Liaoyang and Yingkou. It is difficult to estimate the accurate contributions of the Project to the reductions of the concentrations of TSP, SO$_2$, NOx and CO. However, it can be concluded that the Project has directly and indirectly contributed a lot to the reductions of the concentrations of TSP, SO$_2$, NOx and CO in the subproject cities.

![Figure 4: Variation Trends of Concentrations of TSP, SO$_2$, NOx during the Heating Seasons in Benxi](image)

![Figure 5: Variation Trends of Concentrations of TSP, SO$_2$, NOx during the Heating Seasons in Liaoyang](image)
Air Quality Improvement in the Subproject Cities

53. Because 442 small and inefficient boilers have been closed upon completion of the central heating subprojects, as a result, the air quality in the subproject cities have been significantly improved. The total days in the three project cities with air quality better than Grade II increase from 2006 to 2010. The number of days with air quality better than Grade II is shown in Table 10. The trend of the number of days with air quality better than Grade II is shown in Figure 7.

Table 10: Days with Air Quality Better Than Grade II

<table>
<thead>
<tr>
<th>Project Cities</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yingkou</td>
<td>353</td>
<td>343</td>
<td>344</td>
<td>352</td>
<td>359</td>
<td>362</td>
</tr>
<tr>
<td>Benxi</td>
<td>291</td>
<td>303</td>
<td>312</td>
<td>319</td>
<td>343</td>
<td>345</td>
</tr>
<tr>
<td>Fuxin</td>
<td>-</td>
<td>270</td>
<td>300</td>
<td>305</td>
<td>314</td>
<td>295</td>
</tr>
</tbody>
</table>

Source: provided by PIAs.
3 Reduction of Air Emissions

54. Environment in Liaoning has been significantly improved through the implementation of the Project, particularly for the air. The Project has achieved 68,891 tons of annual TSP emission reduction; 6,218 tons of annual SO2 emission reduction; 6,722 tons of annual NOx emission reduction; 1,202,891 tons of annual CO2 equivalent emission reduction. Particularly, the Project also achieved coal savings of 247,267 tons per year.

F. Improvement of Occupational Safety of Miners

55. The CBM/CMM development subcomponent and the strengthened coal mine safety programs committed by the PIA has directly improved the life safety for a number of mine workers at the project sites. Improved mine safety has prevented family members from becoming poor if a serious accident occurs.

G. Enhancement of Quality of Life for the Poor

56. Based on the information provided by PIAs, the increase of gas and heating supply for urban residents, especially for the poor, has significantly improve the overall quality of life, reduce the housework for women, decrease health problems, increase comfort and entertainment activities, and facilitate study longer in winter.
IV. CONCLUSIONS AND RECOMMENDATIONS

57. As discussed in the previous sections, the objective of the social and economic impacts and poverty reduction has been successfully achieved. Conclusions and recommendations of the social and economic impact and poverty reductions are summarized as follows.

A. Conclusions

58. The Project has directly benefited a total urban population of about 2.64 million in the 7 project beneficiary areas of Fuxin, Benxi, Liaoyang, and Yingkou. Of the total beneficiaries, about 1.84 million urban residents benefited from the gas supply and 0.80 million from central heating supply. About 239,000 persons or about 9.1% of the total beneficiaries are the poor.

59. Environment in Liaoning has been significantly improved through the implementation of the Project, particularly for the air. The Project has achieved 68,891 tons of annual TSP emission reduction; 6,218 tons of annual SO2 emission reduction; 6,722 tons of annual NOx emission reduction; 1,202,891 tons of annual CO2 equivalent emission reduction. Particularly, the Project also achieved coal savings of 247,267 tons per year.

60. The Project has created about 8,000 person-years of employment opportunities during the construction period and approximate 2,200 full-time jobs during the operation period of the Project. Of these, nearly 3,000 person-years of employment opportunities have been filled by the poor, women and minorities, earning approximate CNY30.00 million in wage payments during the project construction period. An additional 800 full-time operational employment opportunities or CNY11.00 million of wage payment per year has gone to the poor, women and minorities. In addition, local procurement of the materials required for the Project also created additional jobs.

61. A total of 41,701 poor households living under the city poverty lines classified for those with incomes under the minimum living guarantee (MLG) in the project cities has benefited from central heating supply connection and tariff discounts offered by the PIAs and local governments; while 10,254 poor households from gas supply connection and tariff discounts.

62. It is believed by the majority of the urban residents that the increase of gas and heating supply have improved the overall quality of life, reduced the housework for women, decreased health problems, increased comfort and entertainment activities, and facilitated study longer in winter.

63. Since 442 small and inefficient boilers have been closed and the increased use of gas and district heating supplies have reduced the use of coal, wood, and coal briquettes that cause environmental and health impacts, particularly for the poor. The Project has indirectly benefited the entire urban population residing in the 4 project cities.

64. By increasing gas and central heating supplies to local residents, industries, commercial users and public institutions, the Project has resulted in improvement of the socio-economic infrastructure for the project area.

B. Recommendations

65. The following recommendations have been identified based on the previous analysis and discussions.

66. Issue 1: The heating subsidy programs need to cover more near-poor households and
there is a lack of a long-term or legal mechanism to guarantee the sources of heating assistant funds.

67. **Recommendation:** A law or regulation needs to be established to ensure that some percentage of provincial and municipal fiscal revenue be collected as heating assistant funds. In addition, the coverage of the heating assistant programs can be expanded. The current program has covered the people under MLG and the marginal low-income households with income no higher than 1.2 times of the MLG line. It is recommended that more heating subsidies be expanded to households with income up to 1.5 times of the MLG level because it is obvious that these households also have difficult in paying their heating bills.

68. **Issue 2:** Affordability of the Poor in the heating supply reform. Considering energy conservation and emission reduction, the central government is promoting heating tariff mechanism reform in cities with heating supply. The current tariff system based on floor areas will be reformed to the new system based on heat meters.

69. **Recommendation:** It is suggested that the municipal governments of each subproject should prepare necessary funds for poor residents, which will be used to ensure they are able to pay for any increase in the tariff due to the reform.