Initial Environmental Examination

Project Number: 51418-001
September 2018

Proposed Loan for People's Republic of China: Air Quality Improvement in the Greater Beijing–Tianjin–Hebei Region—Shandong Clean Heating and Cooling Project (East Jinan Low-Emission Combined District Heating and Cooling Component)

Prepared by Jinan Heating Group for the Asian Development Bank

CURRENCY EQUIVALENTS

(as of 12 September 2018)

Currency Unit	–	Chinese Yuan (CNY)
CNY1.00	=	€ 0.1258
€1.00	=	CNY 7.9482

ABBREVIATIONS

ADB	Asian Development Bank
AP	Affected Person
AQI	Air Quality Index
CHP	Combined heat and power
EA	Executing Agency
EHS	Environment, Health and Safety
EIA	Environmental Impact Assessment
EMoP	Environmental Monitoring Plan
EMP	Environmental Management Plan
EMS	Environmental Monitoring Station
EPB	Environmental Protection Bureau
EPL	Environmental Protection Law
FSR	Feasibility Study Report
FGD	Flue-gas Desulfurization
GDP	Gross Domestic Product
GHG	Green House Gas
GIP	Good International Practice
GIIP	Good International Industrial Practice
GRM	Grievance Redress Mechanism
HSP	Heat source plant
IA	Implementing Agency
IEE	Initial Environmental Examination
IT	Interim Target
JHG	Jinan Heating Group
JTPC	Jinan Thermal Power Co,. Ltd
MAC	Maximum Acceptable Concentration
MEE	Ministry of Ecology and Environment
MEP	Ministry of Environmental Protection
MSDS	Material Safety Data Sheet
PAM	Project Administration Manual
PCR	Physical Cultural Resources
PPE	Personnel Protective Equipment
PPTA	Project Preparatory Technical Assistance

PRC	People's Republic of China
SCADA	Supervisory Control and Data Acquisition
SPG	Shandong Provincial Government
SPS	Safeguard Policy Statement, ADB
TA	Technical Assistance
WB	World Bank
WHO	World Health Organization
WWTP	Wastewater treatment plant

WEIGHTS AND MEASURES

BOD_5	Biochemical Oxygen Demand, five days
$CaCO_3$	Calcium Carbonate
cm	Centimeter
CO_2	Carbon Dioxide
COD	Chemical Oxygen Demand
dB(A)	A-weighted sound pressure level in decibels
DO	Dissolved Oxygen
kg	Kilogram
km	Kilometer
kWh	Kilowatt Hour
Leq	Equivalent Continuous Noise Level
m	Meter
m/s	Meters per Second
m^2	Square Meters
m^3	Cubic Meters
mg/l	Milligrams per Liter
mg/m^3	Milligrams per Cubic Meter
$\mu g/m^3$	Micrograms per Cubic Meter
NO_x	Nitrogen Oxides
^oC	Degrees Celsius
O_3	Ozone
pH	A measure of the acidity or alkalinity of a solution
PM	Particulate Matter
PM_{10}	Particulate Matter smaller than 10 micrometers
$PM_{2.5}$	Particulate Matter smaller than 2.5 micrometers
RT	Refrigerating Ton
SO_2	Sulfur Dioxide
t/h	Tons per Hour

TSP	Total Suspended Particulates

NOTES

(i) In this report, "$" refers to US dollars and "€" refers to Euro.

(ii) This document has been prepared following ADB's Safeguard Policy Statement 2009.

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EXECUTIVE SUMMARY

A. Introduction

1. This Initial Environmental Examination (IEE) report has been prepared for the proposed East Jinan Low-Emission Combined District Heating and Cooling Component of the Shandong Clean Heating and Cooling Project (the Project) in Shandong Province of the People's Republic of China (PRC). The proposed Project is the fourth in a multi-year multi-sectoral Asian Development Bank (ADB) support for air quality improvement in the greater Beijing–Tianjin–Hebei (BTH) region.

2. This component will utilize long-distance pipelines to transmit hot water recovered from the waste heat of Zhangqiu thermal power plant to provide district heating and cooling services to Maoling Area (3.2 km^2) in eastern Jinan City. The component will provide district heating to 3.15 million m^2 area and district heating to 2.2 million m^2 area. The component is innovative as the long-distance pipe network will be the first of its kind in the province to provide heating and cooling services. The network will use "large temperature gradient" transmission technology, to increase capacity and efficiency of the district heating system. The pipes will transport waste heat from Zhangqiu Thermal Power Plant, and cold water using a steam absorption refrigeration unit located within Zhangqiu Thermal Power Plant.[1] The component also utilizes ice-storage technology that uses off-peak electricity at night to provide refrigeration services during the day. These innovations will reduce peak load and improve efficiency by using district cooling and other sources of refrigeration (lithium bromide will be used as refrigeration for chillers which is not a GHG chemical, not ozone depleting substance and is not on ADB's Prohibited Investment Activities List) to replace distributed air conditioning systems. In turn this reduces the need to use expensive peaking power. In addition, the heating part of the component will reduce coal combustion for urban heating, contributing to better air quality in Jinan City.

B. Policy, Legal and Administrative Framework for Environmental Impact Assessment

3. Environmental impact assessment (EIA) procedures have been established in the PRC for over 20 years. Domestic EIA studies are required to be undertaken by relevant PRC environmental laws and regulations. National and local legal and institutional frameworks for EIA review and approval ensure that proposed projects are environmentally sound, designed to operate in line with applicable regulatory requirements, and are not likely to cause significant environment, health, social, or safety hazards.

4. ADB's Safeguard Policy Statement (SPS) 2009 has also been carefully considered. All applicable requirements of the SPS 2009 have been addressed in the IEE.

C. Implementation Arrangements

5. Shandong Provincial Government (SPG) will be the executing agency (EA) and responsible for overall guidance during project preparation and implementation. Jinan Heating Group (JHG), a state-owned company will be the implementing agency (IA) and responsible for implementing the component and administering and monitoring contractors and suppliers. A

[1] *Feasibility Study Report on the Implementing Plan for Utilization of Industrial Waste Heat for Heating Purposes in Jinan City,* May 2014. In May 2015, construction of a long-distance pipe network from the power plant to Western Jinan City was completed. An initiating cooling station is planned to be built at the Zhangqiu Power Plant, and transmission of cold water to the Western Jinan will also utilize the pipe network.

project management office (PMO) by the Jinan Municipal Bureau of Housing and Urban-rural Development will be responsible for day-to-day management of the Project.

D. Project scope

6. The component scope includes: (i) one South Energy Center with a cooling capacity of 1.8 million m^2 and one North Energy Center a cooling capacity of 0.4 million m^2. Both the two energy centers will be installed with heat and ice storage systems; (ii) 16.85 km of primary and 20.0 km of secondary network; (iii) four cooling towers in existing Dongxin Thermal Power Plant to cool the cooling water in south and north energy centers; and (iv) 35 heat exchange stations (HESs) (phase I) with a heating area of 3.15 million m^2. Once completed, the component will provide district heating to an area of 3.15 million m^2 and district cooling to an area of 2.2 million m^2.

E. Construction Schedule

7. The total construction period for the Project will be approximately 5 years from 2018 t0 2022.

F. Description of the Environment

1. Location and Topography

8. The component is located in Maoling Area (3.2 km^2), Lixia District, Jinan City of Shandong Province. Jinan City, with a total area of 10,356 km^2, is located in the northwest of the north shore of the Yellow River, bordering Hebei Province in north. It is located at east longitude 115°45'-117°36' and northern latitude 36°24 '- 38°00'. Dezhou City is in south and Binzhou City is in east of Jinan City.

9. Jinan City occupies a transition zone between the northern foothills of the Taishan Massif to the south-southeast and the Yellow River Valley to the north and northwest. Karst aquifers in limestone formations sloping down from the south to the north give rise to many artesian springs in the city center as well as in surrounding areas. Within the component area the topography is generally flat.

2. Meteorology and Climate

10. Jinan has a temperate continental climate with four distinct seasons. It is dry in the spring, hot and rainy in the summer, cool in the autumn, and dry and cold in the winter. The average annual temperature in Jinan is 16.6°C; the average summer average temperature is 26°C and the maximum recorded summer temperature was 42.7°C. The average temperature in the coldest months of winter is below 0°C, and the extreme lowest recorded temperature is -19.5°C. The annual average precipitation in Jinan from 1950-2011 was 685 mm and 65.9% of the precipitation occurs in June, July and August.

3. Water Resources

11. Annual average surface water resource of Jinan City is 1,158 million m^3, underground freshwater resources is 958 million m^3. The population of Jinan is 7.23 million and per capita water resource is only 292 m^3. Based on the standard of water quantity for municipal residential use in Shandong, daily average water consumption per capita is 85-120 l/d. Water resources in Jinan

can just meet the requirements

4. Ecological and Sensitive Resources

12. The component site is located in Maoling Area (3.2 km^2), which is urban area of Jinan. Surrounding land uses include mixed commercial and residential areas with little or no vegetation cover. There are no known rare or endangered flora or fauna, parks, nature reserves or areas with special national, regional or local ecological significance within or adjacent to the component site.

5. Socioeconomic Conditions

13. Jinan is the political, economic, cultural, scientific, educational, and financial center of Shandong province, and has been designated with sub-provincial administrative status since 1994.

14. In 2017, Jinan's GDP was CNY 720.196 billion, of which the primary sector (agriculture) accounted for 4.4% or CNY 31.740 billion; the secondary sector (industries) accounted for 35.7% or CNY 256.922 billion; and the tertiary (services) sector accounted for 59.9% or CNY 431.534 billion.

6. Physical Cultural Resources

15. Jinan is an accredited famous historic and cultural city for its long-standing history and culture. Historic sites include Chengziya Longshan Culture Site, Guo's Ancestral Temple of Han Dynasty at Xiaotangshan, Four Gates Pagoda of Sui Dynasty, Dragon and Tiger Pagoda of Tang Dynasty, Nine Tops Tower and Luozhuang Han Tomb.

16. The component activities are all within the Jinan highly developed urban area. There are no known physical cultural resources (PCRs) in the component site.

G. Anticipated Impacts and Mitigation Measures

17. Anticipated positive and negative environmental impacts of the proposed component were assessed based on the domestic Feasibility Study Report (FSR), domestic EIA report, a technical due diligence review of the component undertaken by ADB PPTA specialists; public consultations led by IA and assisted by ADB PPTA consultants; and site visits, surveys and consultations undertaken by ADB PPTA consultants.

18. Pre-construction, construction and operation phases were considered separately. The results of the assessment indicate that during the pre-construction phase environmental issues are very limited and are mostly associated with ensuring appropriate incorporation of mitigation measures into the project design.

19. Potential negative environmental impacts during construction phase are short-term and localized, and are associated with soil erosion, construction noise, fugitive dust, solid waste, waste water, disruption of traffic and community services, and risks to workers and community health and safety. These can be effectively mitigated through good construction and health and safety practices.

20. Potential negative impacts during operation phase are associated with solid waste,

wastewater, noise, and health and safety risks to workers and community. These can be effectively mitigated through good operation of the facility equipment and health and safety practices.

21. Potential positive operation phase impacts are significant and long-term and are associated with emissions reductions compared to equivalent heat and cool through traditional coal-fired sources and air conditioner. Once operational the component will: (i) result in annual energy savings equivalent to 59,069.28 tons of coal equivalent (tce), thereby providing a global public good by avoiding the annual emission of 214,516.21 tons of CO_2; (ii) improve local air quality through the estimated annual reduction of emissions of SO_2 by 280.99 tons, NOx by 345.43 tons, and PM by 51.32 tons; and (iii) eliminate the negative impacts of coal transportation through urban areas by truck or train.

H. Alternative Analysis

22. The district heating area in Jinan increased from 87.6 million m^2 in 2012 to 147 million m^2 in 2017. With rapid urban expansion, heat demand increases dramatically, leading to an urgent need to construct new heating infrastructure. Besides, after the Maoling Area is finished, there will be huge cooling requirements in the office and commercial buildings in this area. If the component is not implemented, heat from traditional coal-fired heat source plants (HSPs) and cool from traditional air conditioner system will be required to meet the increasing demand for district heating and cooling in Maoling Area. Separate air conditioner systems and existing polluting coal-fired boilers will continue to be used. Based on an overall analysis of alternatives, the component has selected the most appropriate heat and cool source, heating and refrigeration technique and pipeline type with installation method.

23. Implementation of the component will: (i) improve energy consumption structure; (ii) significantly reduce coal consumption; (iii) improve air quality; and (iv) reduce GHG emissions. It will also provide valuable experience in developing micro-energy grid to meet the increasing energy demand for heating. Its experience on mitigating some of the technology risks associated with micro-energy grid will be valuable as well.

I. Information Disclosure and Public Consultations

24. Domestic EIA Institute has undertaken one round of public consultation and two rounds of information disclosure in accordance with the Interim Guidelines on Public Consultation for EIA (2006) during domestic EIA process.

25. According to ADB SPS's requirements, the JHG held a public consultation meeting on 10 March 2018 during the preparation of the domestic EIA and IEE. A public project information notice was posted in the nearby communities for two weeks prior to the meeting. The meeting was held in the office of JHG and 36 nearby residents were invited to the meeting. During the meeting, information on the component construction content and status was presented by the JHG, while information on potential environmental impacts and proposed mitigation measures, GRM requirements of ADB and component benefits was presented by social consultant and environmental consultant. Then questions and subsequent discussions focused on environmental issues of the component and benefits of the component especially clean district heating and employment promotion. During the meeting, most of the participants believed that the component can provide a clean district heating service and provide more job opportunities to the nearby communities and 100% of participants supported the construction of component.

26. During the public consultant meeting, a total of 36 questionnaires and 36 completed questionnaires were received. The main contents of the questionnaire are potential impacts and mitigation measures. Most of the respondents work and live within a 5 km radius of the project; 58.3% of respondents knew about the component either from other person, newspapers or information signs, and 94.4% of respondents indicated that they were already familiar with the component benefits after the introduction of the project. 43.3% of the respondents were female. The top three environment issues respondents identified in their neighborhoods are air quality (63.9%), noise (41.7%) and surface water (16.7%). Dust and noise were identified as the top two issues during the construction phase. Air pollution and noise were identified as the top two issues during the operation phase. However, most participants also indicated that potential air, waste water, solid waste and noise impacts can be appropriately mitigated.

27. Overall support for the component is very strong; 83.3% of the respondents indicated that the component will improve local economic development; 88.9.0% indicated that the component will improve quality of life; and 91.7% of respondents indicated that they support the proposed component.

28. Meaningful consultation will continue throughout detailed design, construction, and operation phases, including information disclosure by the project proponent and posting of project information on community notice boards.

J. Grievance Redress Mechanism

29. A component-level grievance redress mechanism (GRM) has been established to receive and facilitate resolution of complaints during the construction and operation phases. The GRM includes procedures for receiving grievances, recording/documenting key information, and evaluating and responding to the complainants in a reasonable timeframe. Any concerns raised through the GRM will be addressed quickly and transparently, and without retribution to the affected persons.

K. Environmental Management Plan (EMP)

30. A comprehensive EMP has been developed to ensure: (i) implementation of identified mitigation and management measures to avoid, reduce, mitigate, and compensate for anticipated adverse environment impacts; (ii) implementation of monitoring and reporting against the performance indicators; and (iii) compliance with the PRC's relevant environmental laws, standards and regulations and the ADB's SPS 2009. The EMP includes an environment monitoring plan (EMoP) to monitor the environmental impacts of the component and assess the effectiveness of mitigation measures, and a capacity building and training program focused on health, safety and environment. Organizational responsibilities and budgets are clearly identified for implementation, monitoring and reporting. The EMP is presented in Appendix I.

L. Risks and Key Assurances

31. The IA has limited experience in ADB's projects. To support effective implementation of the project EMP, (i) a full-time Environment and Social Officer will be appointed in the PMO; (ii) a part-time loan implementation environmental consultant (LIEC) will be recruited to support the PMO; (iii) pre-construction readiness monitoring and defined roles and responsibilities of all relevant agencies have been included in the EMP; and (iv) staff will receive training on ADB's environment safeguard requirements and EMP implementation.

M. Conclusion

32. Through the environmental assessment process, it is concluded that the component has: (i) selected appropriate technologies to improve energy structure and reduce the emission of pollutants; (ii) identified potential negative environment impacts and established mitigation measures; (iii) received public support from the component beneficiaries and affected people; (iv) established project-level GRM procedures; and (v) prepared a comprehensive EMP including environmental management and supervision structure, environmental mitigation and monitoring plans, and capacity building and training.

33. Overall, any minimal adverse environmental impacts associated with the component can be prevented, reduced, or minimized through the appropriate application of mitigation measures. It is therefore recommended that: (i) the component is classified as environment category B; and (ii) the component will be supported by ADB, subject to the implementation of the commitments contained in the EMP and allocation of appropriate technical, financial and human resources by the borrower to ensure these commitments are effectively and expediently implemented.

I. INTRODUCTION

A. The Project

1. This IEE report is prepared for the proposed East Jinan Low-Emission Combined District Heating and Cooling Component of the Shandong Clean Heating and Cooling Project (the Project) in Shandong Province of the People's Republic of China (PRC). The proposed Project is the fourth in a multi-year multi-sectoral ADB support for air quality improvement in the greater BTH region.

2. This component will utilize long-distance pipelines to transmit hot water recovered from the waste heat of Zhangqiu Thermal Power Plant to provide district heating and cooling services to Maoling Area (3.2 km^2), in eastern Jinan City. The component will provide district heating to 3.15 million m^2 area and district heating to 2.2 million m^2 area. The component is innovative as the long-distance pipe network will be the first of its kind in the province to provide heating and cooling services. The network will use "large temperature gradient" transmission technology, to increase capacity and efficiency of the district heating system. The pipes will transport waste heat from Zhangqiu Thermal Power Plant, and cold water using a steam absorption refrigeration unit located within Zhangqiu Thermal Power Plant. The component also utilizes ice-storage technology that uses off-peak electricity at night to provide refrigeration services during the day. These innovations will reduce peak load and improve efficiency by using district cooling and other sources of refrigeration to replace distributed air conditioning systems. In turn this reduces the need to use expensive peaking power. In addition, the heating part of the component will reduce coal combustion for urban heating, contributing to better air quality in Jinan City.

3. The component scope includes: (i) one South Energy Center with a cooling capacity of 1.8 million m^2 and one North Energy Center a cooling capacity of 0.4 million m^2. Both the two energy centers will be installed with heat and ice storage systems; (ii) 16.85 km of primary and 20.0 km of secondary network; (iii) four open transverse flow cooling towers in existing Dongxin Thermal Power Plant; and (iv) 35 heat exchange stations (HESs) (phase I2) with a heating area of 3.15 million m^2. Once completed, the component will provide district heating to an area of 3.15 million m^2 and district cooling to an area of 2.2 million m^2.

4. The component will be implemented through five outputs:

(i) **Output 1**: One South Energy Center with a cooling capacity of 1.8 million m^2 and one North Energy Center a cooling capacity of 0.4 million m^2. Both the two energy centers will be installed with heat and ice storage system. North Energy Center will be built by the developer of Maoling Area.

(ii) **Output 2**: Four cooling towers in existing Dongxin Thermal Power Plant for cooling system.

(iii) **Output 3**: District heating and cooling pipeline network including 16.85 km of primary and 20.0 km of secondary network will be constructed. The pipeline network will used for cold water transfer in summer and hot water transfer in winter. The pipe networks will utilize two-pipe system. One is water supply pipe

[2] The phase II HESs will be built from 2023 and will be financed by counterpart fund.

and another is water return pipe;

(i) **Output 4**: 35 HESs (phase I) will be built for heat and cool supply with a heating area of 3.15 million m^2 and cooling area of 1.35 million m^2. The HESs will be built by the developers of the Maoling Area. The component will only involve procurement and installation of equipment.

(ii) **Output 5**: Strengthened capacity to install and maintain clean heating and cooling technologies. The component activities will employ women and include awareness raising about the benefits of clean energy targeted toward women who are often responsible for domestic upkeep.

5. The component scope includes: (i) one South Energy Center with a cooling capacity of 1.8 million m^2 and one North Energy Center a cooling capacity of 0.4 million m^2. Both the two energy centers will be installed with ice storage system; (ii) 16.85 km of primary and 20.0 km of secondary network; (iii) four open transverse flow cooling towers in existing Dongxin Thermal Power Plant; and (iv) 35 heat exchange stations with a heating area of 3.15 million m^2 and cooling area of 1.35 million m^2.

B. Introduction of Borrower

6. Shandong Provincial Government (SPG) will be the executing agency (EA) and responsible for overall guidance during project preparation and implementation. Jinan Thermal Power Co., Ltd. (JHG), a state-owned company will be the implementing agency (IA) and responsible for implementing project components and administering and monitoring contractors and suppliers. A project management office (PMO) led by the Jinan Municipal Public Utilities Bureau, involving Shandong Provincial Department of Housing and Urban-rural Development, Department of Finance, PDRC, Jinan Municipal DRC, Jinan Municipal Bureau of Finance will be responsible for day-to-day management of the project.

7. JHG was merged from four state-owned district heating companies in Jinan in 2007. Now JHG belongs to Jinan City Investment Group Co. Ltd and its main businesses are district heating and power, steam and hot water supply. JHG is responsible for district heating supply in eastern part in Jinan urban area, Jiyang County, Shanghe County and Zhangqiu District.

8. JHG has a registered capital of 600 million CNY and total assets of 9.416 billion CNY. JHG has 5 branch companies, 12 sub-companies and one pipeline network company. At the end of 2017, JHG has 2,134 employees and districting area of 1.1 billion m^2. JHG now has 5 heat source plants (HSPs), one thermal power plant, 20 coal fired boilers with a capacity of 1,900 t/h and a total heating pipe network length of 3,149 km.

C. Report Purpose

9. ADB's environmental safeguard requirements are specified in the SPS 2009. The component has been screened and classified as Environment Category B, requiring the preparation of an IEE (this report) including an EMP. The EMP is presented in **Appendix I**.

D. Approach to report Preparation

10. This report has been prepared based on a domestic Feasibility Study Report (FSR); domestic EIA report; a technical due diligence review of the FSR undertaken by ADB project

preparatory technical assistance (PPTA) consultants; public consultations with key stakeholders and affected persons attended by PPTA consultants; and site visits, surveys, consultations undertaken by ADB PPTA environmental consultants and ADB mission discussions with the IA and relevant government agencies.

E. Report Structure

11. This IEE report consists of an executive summary, nine chapters and one appendix. The report is structured as follows:

Executive Summary
Summarizes critical facts, significant findings, and recommended actions.

I Introduction
Introduces the proposed component, report purpose, approach to EIA preparation and EIA structure.

II Policy, Legal, and Administrative Framework
Discusses PRC's and ADB's environmental assessment legal and institutional frameworks, status of approval of the domestic EIA reports, and applicable environmental guidelines and standards.

III Description of the Project
Describes the project rationale, scope, components, location, key features, implementation arrangements, budget and time schedule.

IV Description of the Environment
Describes relevant physical, biological, and socioeconomic conditions within the component area.

V Anticipated Environmental Impacts and Mitigation Measures
Describes impacts predicted to occur as a result of the component and identifies the mitigation measures which will be implemented.

VI Analysis of Alternatives
Presents an analysis of alternatives undertaken to determine the best way of achieving the component objectives while minimizing environmental and social impacts.

VII Information Disclosure, Consultation, and Participation
Describes the process undertaken for engaging stakeholders and carrying out information disclosure and public consultation.

VIII Grievance Redress Mechanism
Describes the component grievance redress mechanism (GRM) for resolving complaints.

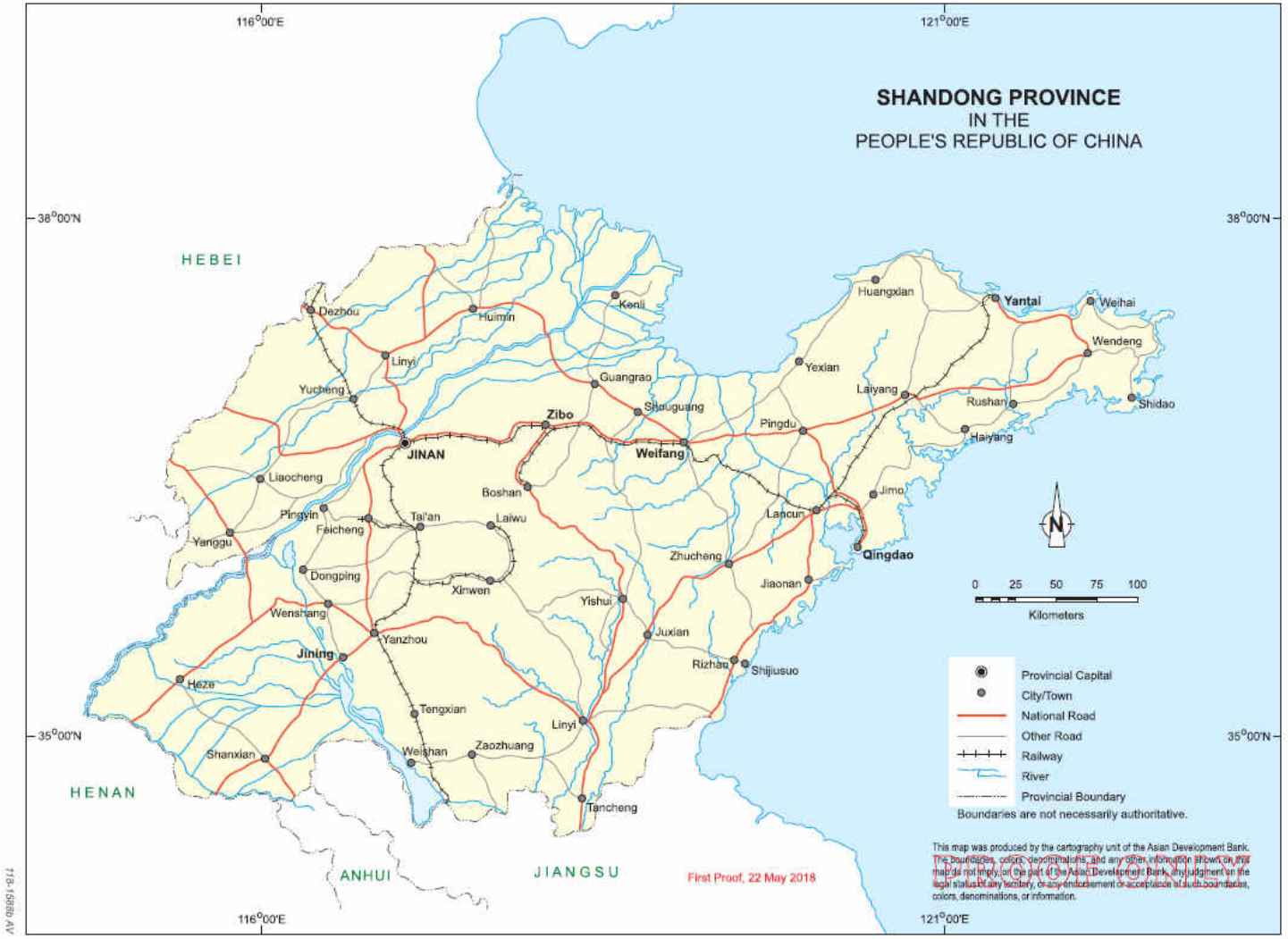
IX Conclusion and Recommendation
Presents conclusions drawn from the assessment and recommendations.

Appendix

12. Appendix I presents the EMP, including required construction and operation phase

environmental mitigation measures, EMoP, reporting requirements, and capacity building. Other appendices present supporting documentation and approvals, due diligence of existing and associated facilities, and coal and emission reduction factors and calculations.

Figure I-1: Jinan City, Shandong Province.



II. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

13. This IEE has been prepared in accordance with both the PRC's national and local environmental legal and institutional framework and environmental assessment requirements, and applicable ADB policies, requirements and procedures.

A. Applicable ADB Policies, Regulations and Requirements

14. The major applicable ADB policies, regulations, requirements and procedures for EIA are the *Safeguard Policy Statement* (SPS, 2009) and the *Environmental Safeguards – A Good Practice Sourcebook* (2012), which jointly provides the basis for this IEE. The SPS promotes good international practice as reflected in internationally recognized standards such as the World Bank Group's Environment, Health and Safety (EHS) Guidelines.

15. The SPS establishes an environmental review process to ensure that projects undertaken as part of programs funded through ADB loans are environmentally sound, are designed to operate in line with applicable regulatory requirements, and are not likely to cause significant environment, health, social, or safety hazards.

16. At an early stage in the project cycle, typically the project identification stage, ADB screens and categorizes proposed projects based on the significance of potential project impacts and risks. A project's environment category is determined by the category of its most environmentally sensitive component, including direct, indirect, induced, and cumulative impacts. Project screening and categorization are undertaken to:

(i) reflect the significance of the project's potential environmental impacts;

(ii) identify the type and level of environmental assessment and institutional resources required for the safeguard measures proportionate to the nature, scale, magnitude and sensitivity of the proposed project's potential impacts; and,

(iii) determine consultation and disclosure requirements.

17. ADB assigns a proposed project to one of the following categories:

(i) **Category A.** Proposed project is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented; impacts may affect an area larger than the sites or facilities subject to physical works. A full EIA including an EMP is required.

(ii) **Category B**. Proposed project's potential environmental impacts are less adverse and fewer in number than those of category A projects; impacts are site-specific, few if any of them are irreversible, and impacts can be readily addressed through mitigation measures. An IEE, including an EMP, is required.

(iii) **Category C**. Proposed project is likely to have minimal or no adverse environmental impacts. No EIA or IEE is required although environmental implications need to be reviewed.

(iv) **Category FI**. Proposed project involves the investment of ADB funds to, or through, a financial intermediary.

18. The component has been classified as environment category B and thus an IEE is required.

19. The SPS 2009 requires a number of additional considerations, including: (i) project risk and respective mitigation measures and project assurances; (ii) project-level grievance redress mechanism; (iii) definition of the project area of influence; (iv) physical cultural resources damage prevention analysis; (v) climate change mitigation; (vi) occupational and community health and safety requirements (including emergency preparedness and response); (vii) economic displacement that is not part of land acquisition; (viii) biodiversity conservation and natural resources management requirements; (ix) provision of sufficient justification if local standards are used; (x) assurance of adequate consultation and participation; and (xi) assurance that the EMP includes an implementation schedule and measurable performance indicators. These requirements, which may not be covered in the domestic EIA, have been considered, and all applicable environmental requirements in the SPS 2009 are covered in this IEE.

20. During the design, construction, and operation phases of a project, the SPS also requires the borrower to follow environmental standards consistent with good international practice (GIP), as reflected in internationally recognized standards such as the World Bank Group's *EHS Guidelines*.[3] The *EHS Guideline*s contain discharge effluent, air emissions, and other numerical guidelines and performance indicators as well as prevention and control approaches that are normally acceptable to ADB and are generally considered to be achievable at reasonable costs by existing technology. When host country regulations differ from these levels and measures, the borrower is to achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, the borrower is required to provide justification for any proposed alternatives.

B. PRC Environmental Legal Framework

21. The environmental protection and management system in the PRC consists of a well-defined hierarchy of regulatory, administrative and technical institutions. At the top level the People's Congress of the PRC has the authority to pass and revise national environmental laws; the Ministry of Ecology and Environment (MEE, former Ministry of Environmental Protection) under the State Council promulgates national environmental regulations; and the MEE either separately or jointly with the Administration of Quality Supervision, Inspection and Quarantine issues national environmental standards. Provincial and local governments can also issue provincial and local environmental regulations and guidelines in accordance with the national ones. In addition, national and local five-year environmental protection plans form an important part of the legal framework.

22. Key applicable PRC environmental laws are listed in **Table II-1** including associated regulations and decrees that support their implementation. Guidelines for EIA implementation are

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3 The guidelines applied for this component are Environmental, Health, and Safety General Guidelines, Environmental, Health, and Safety Guidelines for Construction and Decommissioning. These guidelines can be found at http://www.ifc.org/ehsguidelines

listed in **Table II-2**.

23. The most far-reaching law on pollution prevention and control is the Environmental Protection Law (EPL) (1989, amended 2014, effective 2015 and item 2 in **Table II-1**), which sets out key principles for the country's pollution control system, including the policy known as the "Three Simultaneities Policy" [4], the application of pollution levies, and requirements for EIA. The implementation of the "Three Simultaneities Policy" was further strengthened by decrees on its implementation (items 28 and 30) and the Construction Project Environmental Protection Management Regulation (item 19).

24. The amended EPL further defines enforcement and supervision responsibilities for all levels of environmental protection authorities, imposes stricter obligations and more severe penalties on enterprises and construction units regarding pollution prevention and control, and allows for environmental public interest litigation including through nongovernment organizations. The procedures and requirements for the technical review of EIA reports by authorities have been specified (**Table II-1** item 4), and environmental inspection and enforcement on design, installation, and operation of project-specific environmental protection and control measures are regulated under the "Three Simultaneities Policy" (**Table II-1** items 5, 15, 25, 26, and 28).

25. Public participation and environmental information disclosure provisions are among the most significant changes introduced in the amended EPL, further supported by the decrees on the preparation of EIA summaries for public disclosure (item 26), information disclosure on construction project EIAs by government (item 24), method for public participation in environmental protection (item 22), and technical guidelines for public participation in EIAs.

26. For grievance redress, a hotline number (12369) was established in March 2011 at each level of environmental protection authority throughout the country for receiving and resolving environmental complaints, in accordance with the Management Measures for Operation of the Environmental Complaint Hotline (MEP Decree 2010 No. 15 [item 29]).

27. The PRC also provides protection for community health and occupational health and safety through the Labor Law (1994) (item 13), the Occupational Disease Prevention and Control Law (2001) (item 5), PRC Safety Production Law (item 4), State Administrative Regulations of Safety Production (item 18) and environmental and hygiene standards for construction sites.

Table II-1: Applicable PRC Environmental Laws, Regulations, and Decrees

No.	Laws	Year Issued/Updated
1	National Environmental Impact Assessment Law	2016
2	Environmental Protection Law	2015
3	Atmospheric Pollution Prevention and Control Law	2015
4	Safety Production Law	2014
5	Occupational Disease Prevention and Control Law	2011

4 The "Three Simultaneities Policy" requires the design, construction, and operation of pollution control and treatment facilities to occur simultaneously with the project design, construction, and operation.

No.	Laws	Year Issued/Updated
6	Water and Soil Conservation Law	2011
7	Water Pollution Prevention and Control Law	2010
8	Urban and Rural Planning Law	2008
9	Solid Waste Pollution Prevention and Control Law	2005
10	Water Law	2002
11	Cultural Relics Protection Law	2002
12	Noise Pollution Prevention and Control Law	1999
13	Labor Law	1995
	Regulations	
14	Atmospheric Pollution Prevention and Control Action Plan (State Council Announcement No. 37)	2013
15	Policy on Integrated Techniques for Air Pollution Prevention and Control of Small Particulates (MEP Announcement No. 59)	2013
16	Planning Environmental Impact Assessment Regulation	2009
17	Cultural Relics Protection Law Implementation Regulation	2003
18	State Administrative Regulations of Safety Production	2003
19	Construction Project Environmental Protection Management Regulation	1998
20	Wild Plant Protection Regulation	1996
	Decrees and Announcements	
21	Directory for the Management of Construction Project EIA Categorization (MEP Decree 2017-44)	2017
22	Measures for Public Participation in Environmental Protection (MEP Decree 2015-35)	2015
23	Management Measures for Environmental Impact Post Assessment of Construction Projects (on trial) (MEP Decree 2015-37)	2015
24	Government Information Disclosure of Construction Project EIA (on trial) (MEP Announcement No. 103)	2013
25	Measures for Environmental Supervision (MEP Decree 2012-21)	2012
26	Requirement for Preparation of EIA Report Summary (MEP Announcement 2012-51)	2012
27	Strengthening of EIA Management for Prevention of Environmental Risk (MEP Announcement 2012-77)	2012
28	Opinion from the State Council on Important Tasks for Strengthening Environmental Protection (State Council Announcement 2011-35)	2011
29	Management Measures for Operation of the Environmental Complaint Hotline (MEP Decree 2010-15)	2010

No.	Laws	Year Issued/Updated
30	Management Procedures for the Supervision, Inspection and Environmental Acceptance of Construction Projects under the "Three Simultaneities" (on trial) (MEP Announcement 2009-150)	2009
31	Specifications on the Management of Urban Construction and Demolition Waste (Ministry of Construction Decree 2005-139)	2005
32	Management Measures for Inspection and Acceptance of Environmental Protection at Construction Project Completion (MEP Decree 2001-13)	2001

Source: ADB PPTA consultants.

C. PRC Environmental Impact Assessment Framework and Procedures

28. **EIA administrative framework.** The administrative framework for EIA in the PRC consists of national, provincial, and local (city and county) environmental protection authorities. The national authority is the MEE, which promulgates laws, regulations, administrative decrees, technical guidelines, and environmental quality and emission standards on EIA and pollution prevention and control. At the provincial level, there are environmental protection departments (EPDs), which act as gatekeepers for EIA and pollution prevention and control in the provinces. They are often delegated authority by the MEE to review and approve EIA reports for development planning and construction projects, except for those projects with national interest and those that cross provincial boundaries. The local (city or county level) environmental protection bureaus (EPB) enforce environmental laws and conduct environmental monitoring within city or county limits. Local EPBs can also be delegated the authority to approve EIA reports by the provincial EPDs. EPDs and EPBs are supported by environmental monitoring stations (EMS), which are subsidiaries of EPDs or EPBs and are qualified entities to carry out environmental monitoring.

29. The former MEP's "Guideline on Jurisdictional Division of Review and Approval of EIAs for Construction Projects" (2009) defines which construction project EIAs require former MEP review and approval, and which EIAs are delegated to the provincial EPDs.

30. The PRC has a qualification and registration system for EIA and only qualified and registered institutes and individuals are allowed to prepare EIAs. Under MEP Decree 2015-36, as of 1 November 2015 qualified institutes for conducting EIAs for construction projects in the PRC can no longer be a subsidiary of an environmental authority responsible for approving EIAs.

31. **EIA legal framework**. EIA is governed by the Environmental Impact Assessment Law (2016) (**Table II-1** item 1), covering EIAs for (i) plans (such as new development areas and new industrial parks) and strategic environmental assessments (SEA), and (ii) construction projects. This was followed by the promulgation of two regulations: the Construction Project Environmental Protection Management Regulation (1998) (item 19) and the Planning Environmental Impact Assessment Regulation (2009) (item 16), both of which require early screening and environmental categorization.

32. **EIA procedures.** EIA procedures have been established in the PRC for over 20 years. In 2008, former MEP issued "Management Guideline on EIA Categories of Construction Projects" (revised 2017). Under MEE decree, Directory for the Management of Construction Project Environmental Impact Assessment Categorization (MEP Decree 2017-44) (item 21) provides detailed EIA requirements for 50 sectors and 192 subsectors and classifies EIAs for construction projects into three categories with different reporting requirements based on the "significance" of

potential environmental impact due to the project and the environmental sensitivity[5] of the project site as described in the directory. The directory provides detailed EIA requirements for 50 sectors and 192 subsectors:

(i) **Category A:** projects with significant adverse environmental impacts, for which a full EIA report is required;

(ii) **Category B:** projects with adverse environmental impacts which are of a lesser degree and/or significance than those of Category A, for which a simplified tabular EIA report is required; and

(iii) **Category C:** projects unlikely to have adverse environmental impacts, for which an EIA registration form is required.

33. A full EIA report for category A and a simplified tabular EIA report for category B are similar to ADB's EIA and IEE reports, respectively. The registration form of an EIA is similar to an ADB Category C project.

34. **EIA follow-up actions.** In 2015, the MEP issued decree Management Measures for Environmental Impact Post Assessment of Construction Projects (MEP Decree 2015-37, item 23 of **Table II-1**). Under this decree, a trial program was implemented on 1 January 2016 requiring follow-up actions 3 to 5 years after commencement of project operation for large infrastructure and industrial projects or projects located in environmentally-sensitive areas. These actions include environmental monitoring and impact assessment to verify the effectiveness of environmental protection measures and to undertake any corrective actions that might be needed. The decree also specifies that the institute that did the original impact assessment for the project cannot undertake environmental impact post-assessment for the same project.

35. **EIA guidelines.** The MEE has issued a series of technical guidelines for preparing EIAs (**Table II-2**). These include impact assessment guidelines on general EIA implementation and principles, atmospheric environment and ambient air quality, noise, surface water, groundwater, ecology and regional biodiversity, biodiversity monitoring, quality management on environmental monitoring, and public participation.

Table II-2: Applicable PRC EIA guidelines

No.	Guideline	Date
1	HJ 192-2015 Technical Criterion for Ecosystem Status Evaluation	2015
2	HJ 130-2014 Technical Guidelines for Planning EIA - General Principles	2014
3	HJ 663-2013 Technical Regulation for Ambient Air Quality Assessment (on trial)	2013
4	HJ 2.1-2011 Technical Guidelines for EIA – General Program	2011

5 Environmentally-sensitive areas are defined in the Decree, and include (i) nature reserves and protected areas, scenic areas, world cultural and natural heritage sites, drinking water source protection zones; (ii) basic farmland and grassland, forest parks, geological parks, important wetland, natural woodland, critical habitats for endangered plant and animal species, important aquatic spawning/nursery/wintering/migration grounds, regions suffering from water resource shortage, serious soil erosion areas, desertification protection areas, eutrophic water bodies; and (iii) inhabited areas with major residential, health care, scientific research, and administration functions, cultural heritage protection sites, and protection areas with historical, cultural, scientific, and ethnic values.

No.	Guideline	Date
5	HJ 19-2011 Technical Guidelines for EIA – Ecological Impact	2011
6	HJ 616-2011 Guidelines for Technical Review of EIA on Construction Projects	2011
7	HJ 623-2011 Standard for the Assessment of Regional Biodiversity	2011
8	HJ 630-2011 Technical Guideline on Environmental Monitoring Quality Management	2011
9	Technical Guidelines for EIA - Public Participation (public comment version), (Jan. 2011)	2011
10	HJ 610-2011 Technical Guidelines for EIA – Groundwater Environment	2011
11	HJ 2.4-2009 Technical Guidelines for EIA – Acoustic Environment	2009
12	HJ 2.2-2018 Technical Guidelines for EIA – Atmospheric Environment	2018
13	HJ/T 393-2007 Technical Specifications for Urban Fugitive Dust Pollution	2007
14	JG/J 146-2004 Environmental and Hygiene Standards for Construction Sites	2004
15	HJ/T 2.3-1993 Technical Guidelines for EIA – Surface Water Environment	1993

Source: ADB PPTA consultants.

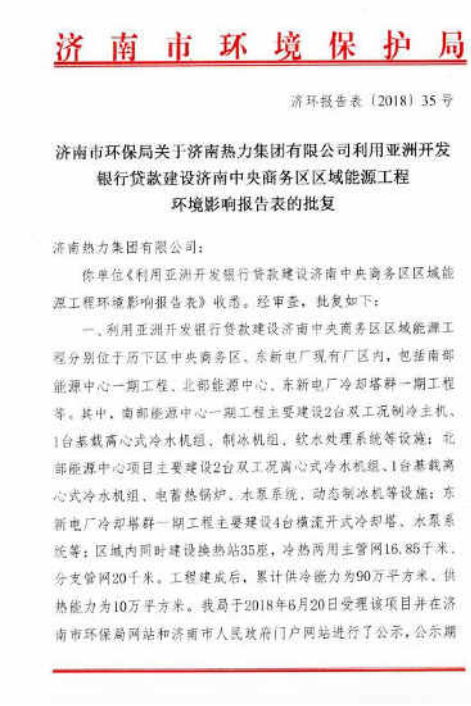
D. Project Domestic EIA Report

36. Under MEE Decree on Management Guideline on EIA Categories of Construction Projects (MEP Decree 2017-44), the component requires a tabular EIA report. The domestic EIA report covering all components of the project was prepared by Shandong Environmental Protection Research and Design Institute. The company is certified by the MEE to undertake category A, B, and C assessments.

The domestic EIA report was being disclosed on by Jinan EPB's website (the link is http://jnepb.jinan.gov.cn/art/2018/8/7/art_10432_2398279.html) at the time of this IEE preparation. The domestic EIA report was reviewed by Jinan EPB and formally approved by Jinan EPB on August 16, 2018. The EIA approval is presented in

37. **Figure II-1: Domestic EIA approval**

Figure II-1: Domestic EIA approval



济南市环境保护局

济环报告表〔2018〕35号

济南市环保局关于济南热力集团有限公司利用亚洲开发银行贷款建设济南中央商务区区域能源工程环境影响报告表的批复

济南热力集团有限公司：

你单位《利用亚洲开发银行贷款建设济南中央商务区区域能源工程环境影响报告表》收悉。经审查，批复如下：

一、利用亚洲开发银行贷款建设济南中央商务区区域能源工程分别位于历下区中央商务区、东新电厂现有厂区内，包括南部能源中心一期工程、北部能源中心、东新电厂冷却塔群一期工程等。其中，南部能源中心一期工程主要建设2台双工况制冷主机、1台基载离心式冷水机组、制冰机组、软水处理系统等设施；北部能源中心项目主要建设2台双工况离心式冷水机组、1台基载离心式冷水机组、电蓄热锅炉、水泵系统、动态制冰机等设施；东新电厂冷却塔群一期工程主要建设4台横流开式冷却塔、水泵系统等；区域内同时建设换热站35座，冷热两用主管网16.85千米、分支管网20千米。工程建成后，累计供冷能力为90万平方米、供热能力为10万平方米。我局于2018年6月20日受理该项目并在济南市环保局网站和济南市人民政府门户网站进行了公示，公示期

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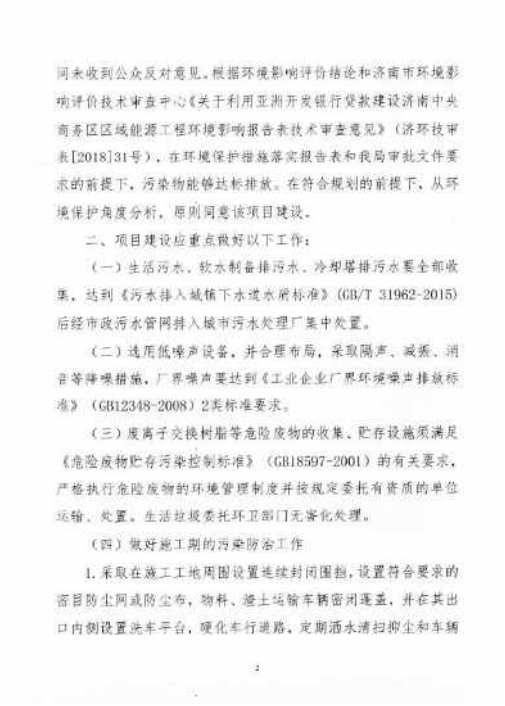


同未收到公众反对意见。根据环境影响评价结论和济南市环境影响评价技术审查中心《关于利用亚洲开发银行贷款建设济南中央商务区区域能源工程环境影响报告表技术审查意见》（济环技审表[2018]31号），在环境保护措施落实报告表和我局审批文件要求的前提下，污染物能够达标排放。在符合规划的前提下，从环境保护角度分析，原则同意该项目建设。

二、项目建设应重点做好以下工作：

（一）生活污水、软水制备排污水、冷却塔排污水要全部收集，达到《污水排入城镇下水道水质标准》（GB/T 31962-2015）后经市政污水管网排入城市污水处理厂集中处置。

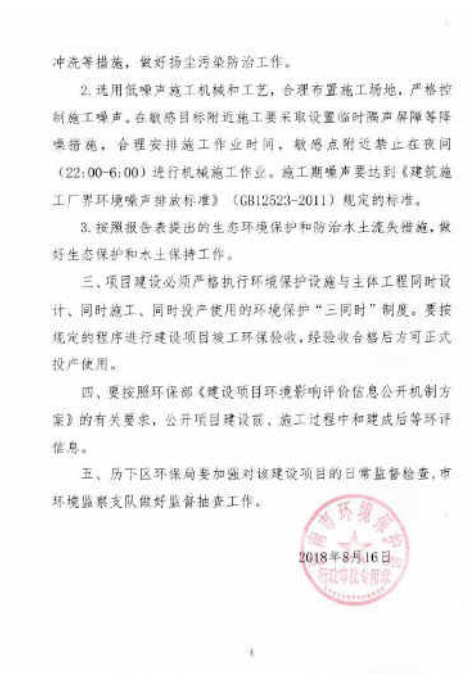
（二）选用低噪声设备，并合理布局，采取隔声、减振、消音等降噪措施，厂界噪声要达到《工业企业厂界环境噪声排放标准》（GB12348-2008）2类标准要求。

（三）废离子交换树脂等危险废物的收集、贮存设施须满足《危险废物贮存污染控制标准》（GB18597-2001）的有关要求，严格执行危险废物的环境管理制度并按规定委托有资质的单位运输、处置。生活垃圾委托环卫部门无害化处理。

（四）做好施工期的污染防治工作

1. 采取在施工工地周围设置连续封闭围挡，设置符合要求的密目防尘网或防尘布，物料、渣土运输车辆密闭遮盖，并在其出口内侧设置洗车平台，硬化车行道路，定期洒水清扫抑尘和车辆

Page 2



冲洗等措施，做好扬尘污染防治工作。

2. 选用低噪声施工机械和工艺，合理布置施工场地，严格控制施工噪声。在敏感目标附近施工要采取设置临时隔声屏障等降噪措施，合理安排施工作业时间，敏感点附近禁止在夜间（22:00-6:00）进行机械施工作业。施工期噪声要达到《建筑施工厂界环境噪声排放标准》（GB12523-2011）规定的标准。

3. 按照报告表提出的生态环境保护和防治水土流失措施，做好生态保护和水土保持工作。

三、项目建设必须严格执行环境保护设施与主体工程同时设计、同时施工、同时投产使用的环境保护“三同时”制度。要按规定的程序进行建设项目竣工环保验收，经验收合格后方可正式投产使用。

四、要按照环保部《建设项目环境影响评价信息公开机制方案》的有关要求，公开项目建设前、施工过程中和建成后等环评信息。

五、历下区环保局要加强对该建设项目的日常监督检查，市环境监察支队做好监督抽查工作。

2018年8月16日

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E. Relevant International Agreements

38. The PRC has signed a number of international agreements regarding environmental and biological protection. Those which have potential application to the component are listed in **Table II-3.**

Table II-3: Applicable international agreements

No.	Agreement	Year	Purpose
1	Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat	1975	Preventing the progressive encroachment on and loss of wetlands for now and the future
2	Convention Concerning the Protection of the World Cultural and Natural Heritage	1986	Conserving cultural and natural heritage sites.
3	Convention on Biological Diversity	1993	Conservation and sustainable use of biodiversity.
4	UN Framework Convention on Climate Change	1994	Stabilizing greenhouse gas (GHG) concentrations in the atmosphere at a level that will prevent anthropogenic induced climate change.
5	United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification	1996	Fighting against desertification and mitigating the effects of drought.
6	Kyoto Protocol	2002	Controlling emissions of anthropogenic GHGs in ways that reflect underlying national differences in GHG emissions, wealth, and capacity to make the reductions.
7	Stockholm Convention on Persistent Organic Pollutants	2004	Safeguarding human health and the environment from persistent organic pollutants (POPs), ascertaining sound management of stockpiles and wastes that contain POPs, and taking measures to reduce or eradicate releases from intentional production and use of POPs.
8	Paris climate agreement	2015	Dealing with greenhouse gas emissions mitigation, adaptation and finance starting in the year 2020.
9	Minamata Convention on Mercury	2017	A global treaty to protect human health and the environment from the adverse effects of mercury.

Source: ADB PPTA consultants.

F. Applicable PRC Environmental Quality Standards

39. **PRC environmental standards**. Standards issued by the MEE generally consist of environmental quality (ambient) standards applicable to the receiving environment and emission

standards applicable to the pollution source. The former includes standards for ambient air quality, noise and vibration, surface water, groundwater, soil, etc. The latter includes standards for integrated wastewater discharge, construction and community noise, odor and air pollutants, etc. (**Table II-4**).

Table II-4: Applicable PRC environmental standards

No.	Standard	Code/Date
1	Ambient Air Quality Standards	GB 3095-2012
2	Quality Standards for Ground Water	GB/T 14848-2017
3	Environmental Quality Standards for Surface Water	GB 3838-2002
4	Environmental Quality Standards for Noise	GB 3096-2008
5	Environmental Quality Standards for Soil	GB 15618-1995
6	Noise Standards for Construction Site Boundary	GB 12523-2011
7	Noise Standards for Industrial Enterprises at Site Boundary	GB 12348-2008
8	Emission standards for Odor Pollutants	GB 14554-93
9	Air Pollutant Integrated Emission Standards	GB 16297-1996
10	Integrated Wastewater Discharge Standards	GB 8978-1996
11	Emission Standard for Community Noise	GB 22337-2008
12	Standard of Environmental Vibration in Urban Area	GB 10070-88
13	Technical Specifications for Regionalizing Environmental Noise Function	GB/T 15190-2014
14	Standard for Flood Control	GB 50210-94
15	Limits and Measurement Methods for Crankcase Pollutants from Heavy-duty Vehicles Equipped with Pressure Ignition Engines	GB 11340-2005
16	Emission Limits and Measurement Methods for Exhaust Pollutants from Vehicle Compression-Ignition and Gas Fueled Ignition Engines	GB 17691-2005
17	Limits and Measurement Methods for Exhaust Pollutants from Vehicles Equipped with Ignition Engines	GB 18285 -2005
18	Limits and Measurement Methods for Emissions from Light Duty Vehicles	GB 18352-2005

Source: ADB PPTA Consultant and domestic EIA report.

40. As noted above, ADB's SPS requires borrowers to follow environmental standards consistent with good international practice as reflected in internationally recognized standards such as the World Bank Group's EHS Guidelines. When host country regulations differ from these levels and measures, the borrower is to achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, the borrower/client is required to provide justification for any proposed alternatives. Both PRC standards and EHS

guidelines are used in this assessment as described below.

1. Ambient Air Quality Standards

41. Ambient air quality limits are intended to indicate safe exposure levels for the majority of the population, including the very young and the elderly, throughout an individual's lifetime. Limits are given for one or more specific averaging periods, typically one-hour average, 24-hour average, and/or annual average. The PRC's recently updated *Ambient Air Quality Standards (*GB3095-2012) has two classes of limit values; Class 1 standards apply to special areas such as natural reserves and environmentally sensitive areas, and Class 2 standards apply to all other areas, including urban and industrial areas. The PRC standards for Class 2 areas are applicable for the project.[6]

42. The World Health Organization (WHO) Air Quality Guidelines are recognized as international standards and are adopted by the World Bank Group's EHS Guidelines. In addition to guideline values, interim targets (IT) are given for each pollutant by the WHO as incremental targets in a progressive reduction of air pollution. The WHO guidelines and corresponding PRC standards are presented in **Table II-5**.

43. From a review of **Table II-5**, it can be observed that:

- For TSP, there are PRC standards but no corresponding WHO guidelines.
- For PM_{10}, PRC Class 2 annual average and 24-hour average standards meet WHO IT-1 guidelines (there are no 1-hour average standards or guidelines for either PRC or WHO).
- For $PM_{2.5}$, PRC Class 2 annual and 24-hour standards meet WHO IT-1 guidelines (there are no 1-hour standards or guidelines for either PRC or WHO).
- For SO_2, WHO only has a 24-hour average guideline (0.125 mg/m^3), which is slightly lower than the PRC standard (0.150 mg/m^3). However, SO_2 levels are low in the component area, and the component will only contribute low levels of SO_2, so the very minor difference is inconsequential.
- For NO_2 ,the PRC standard is equivalent to the WHO annual average guidelines, there is no WHO 24-hour average guideline; and the 1-hour average PRC standard is equivalent to the WHO guideline.
- For O_3, the PRC class I 1-hour average standard is equivalent to the WHO 1-hour average guideline and PRC 1-hour average class II standard is equivalent to the WHO IT-1 1-hour average guideline.
- For CO, there are PRC standards but no corresponding WHO guidelines.

6 On 29 February 2012, the China State Council passed the roadmap for ambient air quality standards with the aim of improving the living environment and protecting human health. The Ambient Air Quality Standards (GB 3095-2012) prescribes the first-ever limits for $PM_{2.5}$. It also modified the previous area classifications by combining Class III (special industrial areas) with Class II (residential, mixed use areas).

Table II-5: PRC Ambient Air Quality Standards and WHO ambient air quality guidelines, μg/m^3

Air Quality parameter	Averaging period	PRC Ambient Air Quality Standard		WHO/EHS Guidelines	
		Class I	Class II	Interim Targets	Air quality guideline
TSP	annual	80	200	NA	NA
	24-hour	120	300	NA	NA
PM_{10}	annual	40	70	30-70	20
	24-hour	50	150	75-150	50
$PM_{2.5}$	annual	15	35	15-35	10
	24-hour	35	75	37.5-75	25
SO_2	annual	20	60	NA	NA
	24-hour	50	150	50-125	20
	1-hour	150	500	NA	NA
NO_2	annual	40	40	NA	40
	24-hour	80	80	NA	NA
	1-hour	200	200	NA	200
O_3	8-hour	100	160	160	100
	1-hour	160	200	NA	NA
CO	24-hour	4,000	4,000	NA	NA
	8-hour	NA	NA	NA	NA
	1-hour	10,000	10,000	NA	NA

Note: NA= not applicable.
Source: WHO Air Quality Guidelines (2006) in IFC EHS Guidelines (2007), and PRC GB 3095-2012.

44. Overall the PRC standards show a high degree of equivalency to the WHO guidelines or IT-1 values and are adopted for use in this IEE report.

2. Fugitive Particulate Matter Emission

45. Fugitive emission of particulate matter such as dust from operation sites is regulated under Shandong Province's Integrated particulate matter emission standard for stationary sources in Shandong Province (DB 37/1996-2011), which sets 120 mg/m^3 as the maximum allowable emission concentration and $\leqslant$1.0 mg/m^3 as the concentration limit at the boundary of construction sites, with no specification on the particular matter's particle diameter. There is no equivalent

standard recommended in the *EHS Guidelines,* and the PRC standard is adopted for use in this IEE report.

3. Surface Water

46. PRC's *Surface Water Ambient Quality Standard* (GB3838-2002) defines five water quality categories for different environmental functions. For example, Category I is the best, such as water at sources of rivers and National Nature Reserves. Category V is the worst quality, suitable only for agricultural and scenic water uses. Based on information collection and site visit, the surface water bodies near the component site are Xiaoqing River and Daming Lake. Category IV water quality standard (see **Table II-6**) is applicable for Daming Lake which is used as landscape water and Category V water quality standard (see **Table II-6**) is applicable for Xiaoqing River which is used as agricultural water. There are no applicable EHS guidelines or target for water quality in this context, and the PRC standard is adopted for use in this IEE report.

Table II-6: Applicable surface water standard. Unit: mg/l, pH excluded

No.	Parameter	Water Quality Category				
		I	II	III	IV	V
1	pH	6-9	6-9	6-9	6-9	6-9
2	Dissolved Oxygen	90% saturation or ≥7.5	≥6	≥5	≥3	≥2
3	COD_{Mn}	≤2	≤4	≤6	≤10	≤15
4	COD_{Cr}	≤15	≤15	≤20	≤30	≤40
5	BOD_5	≤3	≤3	≤4	≤6	≤10
6	NH_3-N	≤0.15	≤0.5	≤1.0	≤1.5	≤2.0
7	TP	≤0.02	≤0.1	≤0.2	≤0.3	≤0.4
	For lakes and reservoirs	≤0.01	≤0.025	≤0.05	≤0.1	≤0.2
8	TN (N for lakes and reservoirs)	≤0.2	≤0.5	≤1.0	≤1.5	≤2.0
9	Copper	≤0.01	≤1.0	≤1.0	≤1.0	≤1.0
10	Zinc	≤0.05	≤1.0	≤1.0	≤2.0	≤2.0
11	Fluoride	≤1.0	≤1.0	≤1.0	≤1.5	≤1.5
12	Selenium	≤0.01	≤0.01	≤0.01	≤0.02	≤0.02
13	Arsenic	≤0.05	≤0.05	≤0.05	≤0.1	≤0.1
14	Total Mercury	≤0.00005	≤0.00005	≤0.0001	≤0.001	≤0.001
15	Cadmium	≤0.001	≤0.005	≤0.005	≤0.005	≤0.01

No.	Parameter	Water Quality Category				
		I	II	III	IV	V
16	Hexavalent Chromium	≤0.01	≤0.05	≤0.05	≤0.05	≤0.1
17	Lead	≤0.01	≤0.01	≤0.05	≤0.05	≤0.1
18	Cyanide	≤0.005	≤0.05	≤0.2	≤0.2	≤0.2
19	Volatile Phenol	≤0.002	≤0.002	≤0.005	≤0.01	≤0.1
20	Sulfide	≤0.05	≤0.1	≤0.2	≤0.5	≤1.0
21	Petroleum	≤0.05	≤0.05	≤0.05	≤0.5	≤1.0
22	Anionic surfactant	≤0.2	≤0.2	≤0.2	≤0.3	≤0.3
23	Coliforms	≤200	≤2000	≤10000	≤40000	≤40000

Source: PRC GB3838-2002.
Note: COD_{Mn} = permanganate index; CODcr = chemical oxygen demand; BOD_5 = 5 days biochemical oxygen demand; NH_3-N= ammonia nitrogen; TP = Total Phosphorus; TN = Total Nitrogen.

4. Groundwater

47. PRC's *Groundwater Water Ambient Quality Standard* (GB/T14848-2017) also defines a number of water quality categories for different environmental functions. As shallow groundwater bodies near the Maoling Area are the springs including Batou, Heihu, Wulong and Zhenzhu in Jian which are primarily used for landscape, the Category III standard is applicable (**Table II-7**). There is no equivalent standard recommended in the *EHS Guidelines,* and the PRC standard is adopted for use in this IEE report.

Table II-7: Applicable groundwater standard

No.	Parameter	Unit	Category III Standard
1	pH	-	6.5-8.5
2	COD_{Mn}	mg/l	3.0
3	Sulfate	mg/l	250
4	Chloride	mg/l	250
5	Volatile Phenols	mg/l	0.002
6	Total hardness ($CaCO_3$)	mg/l	450
7	Nitrate NO_{3-}	mg/l	20
8	Nitrite NO_{2-}	mg/l	1.0
9	NH_3-N	mg/l	0.5

No.	Parameter	Unit	Category III Standard
10	Molybdenum	mg/l	0.2
1	Cyanide	mg/l	0.05
12	Cadmium	mg/l	0.005
13	Chromium VI	mg/l	0.05
14	Arsenic	mg/l	0.01
15	Zinc	mg/l	1.0
16	Fluoride	mg/l	1.0
17	Lead	mg/l	0.01
18	Iron	mg/l	0.3
19	Manganese	mg/l	0.1
20	Copper	mg/l	1.0
21	Selenium	mg/l	0.01
22	Benzene	mg/l	0.01
23	Methylbenzene	mg/l	0.7
24	Total coliforms	/L	3.0
25	Colony forming unit	/L	100
26	Mercury	mg/l	0.001
27	Total dissolved solid	mg/l	1000

Source: PRC GB/T14848-2017.
Note: COD_{Mn} = permanganate index; CODcr = chemical oxygen demand; BOD_5 = 5 days biochemical oxygen demand; NO_3- = Nitrate; NO_2- = Nitrite; NH_3-N= ammonia nitrogen; TP = Total Phosphorus; TN = total nitrogen.

5. Wastewater Discharge

48. **Table II-8** presents the relevant PRC wastewater discharge standards. The *EHS Guidelines* indicate that wastewater discharged to public or private wastewater treatment systems should: meet the pretreatment and monitoring requirements of the sewer treatment system into which it discharges; not interfere, directly or indirectly, with the operation and maintenance of the collection and treatment systems, or pose a risk to worker health and safety, or adversely impact characteristics of residuals from wastewater treatment operations; and be discharged into municipal or centralized wastewater treatment systems that have adequate capacity to meet local regulatory requirements for treatment of wastewater generated from the project.

49. **The** component will discharge wastewater to the municipal sewer systems for treatment

at nearby wastewater treatment plant (WWTP) of Jinan. This WWTP treated domestic wastewater and is about 5.2 km away from the site. The wastewater discharges will be required to meet Class B maximum acceptable concentrations (MACs) in *Wastewater Quality Standards for Discharge to Municipal Sewers* (GB/T 31962-2015), and the WWTP discharges are required to meet Class 1A of *Discharge Standard of Pollutants for Municipal Wastewater Treatment Plants* (GB 18918-2002).

Table II-8: PRC *Wastewater Quality Standards for Discharge to Municipal Sewers*

No.	Pollutant	Maximum acceptable concentration (MAC) mg/L (except pH and chromacity)
		Class B
1	pH	6.5-9.5
2	SS	400
3	COD	500
4	Ammonia nitrogen	45
5	TDS	2000
6	Chromacity	70
7	BOD	350
8	Total phosphorus	8

Source: PRC GB/T 31962-2015.

6. Noise

50. **Table II-9** presents the relevant PRC *Urban Noise Standards* compared with relevant international guidelines from the WHO (as presented in the *EHS Guidelines*). The classes within the standards are not directly comparable, but the PRC Category I standards are equivalent to WHO Class I standards, Category II standards are less stringent than WHO Class I standards and Category II and III standards are stringent than WHO Class II standards. Because Category II standard is applicable to the component area and Category I standard is applicable to the nearby sensitive receptors, Category II for component area and Category I for sensitive receptors are utilized in this IEE report.

Table II-9: PRC *Environmental Quality Standards for Noise* (GB3096-2008) and relevant international guidelines

PRC Standards Leq dB(A)			International Standards One Hour Leq dB(A)		Comparison
Category	**Day** 06-22h	**Night** 22-06h	**Day** 07-22h	**Night** 22-07h	
0: Areas needing extreme quiet, such as special health zones	50	40	WHO Class I: residential, institutional, educational: 55 WHO Class II: industrial, commercial: 70	WHO Class I: Residential, institutional, educational: 45 WHO Class II: Industrial, Commercial: 70	Classes are not directly comparable, but PRC Class II standards exceed WHO Class II standards. PRC standards are utilized in this report.
I: Mainly residential; and cultural and educational institutions	55	45			
II: Mixed residential, commercial and industrial areas	60	50			
III: Industrial areas	65	55			
IV: Area on both sides of urban trunk roads	70	55			

Source: WHO Noise Quality Guidelines (1999) in IFC EHS Guidelines (2007), and PRC GB3096-2008.

51. **Table II-10** presents the relevant PRC and international standards (US EPA, there no such WHO or *EHS Guidelines* standards) for on-site construction noise. The PRC standards are more stringent than international guidelines and are utilized in this IEE report. At sensitive receptors, the component will apply World Bank EHS Guidelines. The PRC's Emission Standard of Environmental Noise for Boundary of Construction Site (GB12523–2011) regulates construction noise, limiting construction noise levels at the construction site boundary to 70 dB(A) in the day time (06:00–22:00 hours) and 55 dB(A) at night (22:00–06:00 hours).

Table II-10: PRC *Noise Emission Standard for Construction Site Boundary* (GB12523-2011) and relevant international guidelines

Day Leq dB(A)	Night Leq dB(A)	International Standards Leq dB(A)	Comparison
70	55	US EPA: 85 (day, 8-hour exposure)	IFC EHS Guideline: Occupational Health and Safety: 85 (Equivalent level LAeq,8h) 110 (Maximum LAmax, fast)

Source: US EPA, IFC Occupational Health and Safety standard and PRC GB 12523-2011.

During operation noise at site boundaries should comply with Class II of the PRC I*ndustrial Enterprise Boundary Noise Emission Standard* (GB12348-2008) (**Table II-11: PRC *Noise Emission Standard for Construction Site Boundary* (GB12348-2008) and relevant international guidelines**

Standard Type	Standard Value Leq dB(A)	
	Day	Night
Class 2	60	50

Source: PRC GB 12348-2008.

52.). At sensitive receptors, the component should comply with World Bank EHS Guidelines

(**Table II-9).**

Table II-11: PRC *Noise Emission Standard for Construction Site Boundary* (GB12348-2008) and relevant international guidelines

Standard Type	Standard Value Leq dB(A)	
	Day	Night
Class 2	60	50

Source: PRC GB 12348-2008.

III. PROJECT DESCRIPTION

A. The Project

53. This component will utilize long-distance pipelines to transmit hot water recovered from the waste heat of Zhangqiu Thermal Power Plant to provide district heating and cooling services to Maoling Area (3.2 km^2), in eastern Jinan City, which is under construction now. The component will provide district heating to 3.15 million m^2 area and district heating to 2.2 million m^2 area. The component is innovative as the long-distance pipe network will be the first of its kind in the province to provide heating and cooling services. The network will use "large temperature gradient" transmission technology, to increase capacity and efficiency of the district heating system. The pipes will transport waste heat from a thermal power plant, and cold water using a steam absorption refrigeration unit located within that plant. The component also utilizes ice-storage technology that uses off-peak electricity at night to provide refrigeration services during the day. These innovations will reduce peak load and improve efficiency by using district cooling and other sources of refrigeration to replace distributed air conditioning systems. In turn this reduces the need to use expensive peaking power. In addition, the heating part of the component will reduce coal combustion for urban heating, contributing to better air quality in Jinan City.

54. The component will be implemented through five outputs:

(i) **Output 1**: One South Energy Center with a cooling capacity of 1.8 million m^2 and one North Energy Center a cooling capacity of 0.4 million m^2. Both the two energy centers will be installed with heat and ice storage systems for peak adjustment. The North Energy Center will be built by developer of Maoling Area following the PRC requirements.

(ii) **Output 2**: Four cooling towers in existing Dongxin Thermal Power Plant for cooling system.

(iii) **Output 3**: District heating and cooling pipeline network including 16.85 km of primary and 20.0 km of secondary network will be constructed. The pipeline network will used for cold water transfer in summer and hot water transfer in winter. The pipe networks will utilize two-pipe system. One is water supply pipe and another is return water pipe.

(iv) **Output 4**: 35 HESs (phase I) will be built by the developers of Maoling Area following the PRC requirements for heat and cool supply with a heating area of 3.15 million m^2 and cooling area of 1.35 million m^2. The component will only involve procurement and installation of equipment. The HESs will be built by the developer of the Maoling Area following the PRC requirements.

(v) **Output 5**: Strengthened capacity to install and maintain clean heating and cooling technologies.

55. The component scope includes: (i) one South Energy Center with a cooling capacity of 1.8 million m^2 and one North Energy Center, which will be built by the developer of Maoling Area with a cooling capacity of 0.4 million m^2. Both the two energy centers will be installed with heat and ice storage systems; (ii) 16.85 km of primary and 20.0 km of secondary network; (iii) four open transverse flow cooling towers in existing Dongxin Thermal Power Plant and one primary

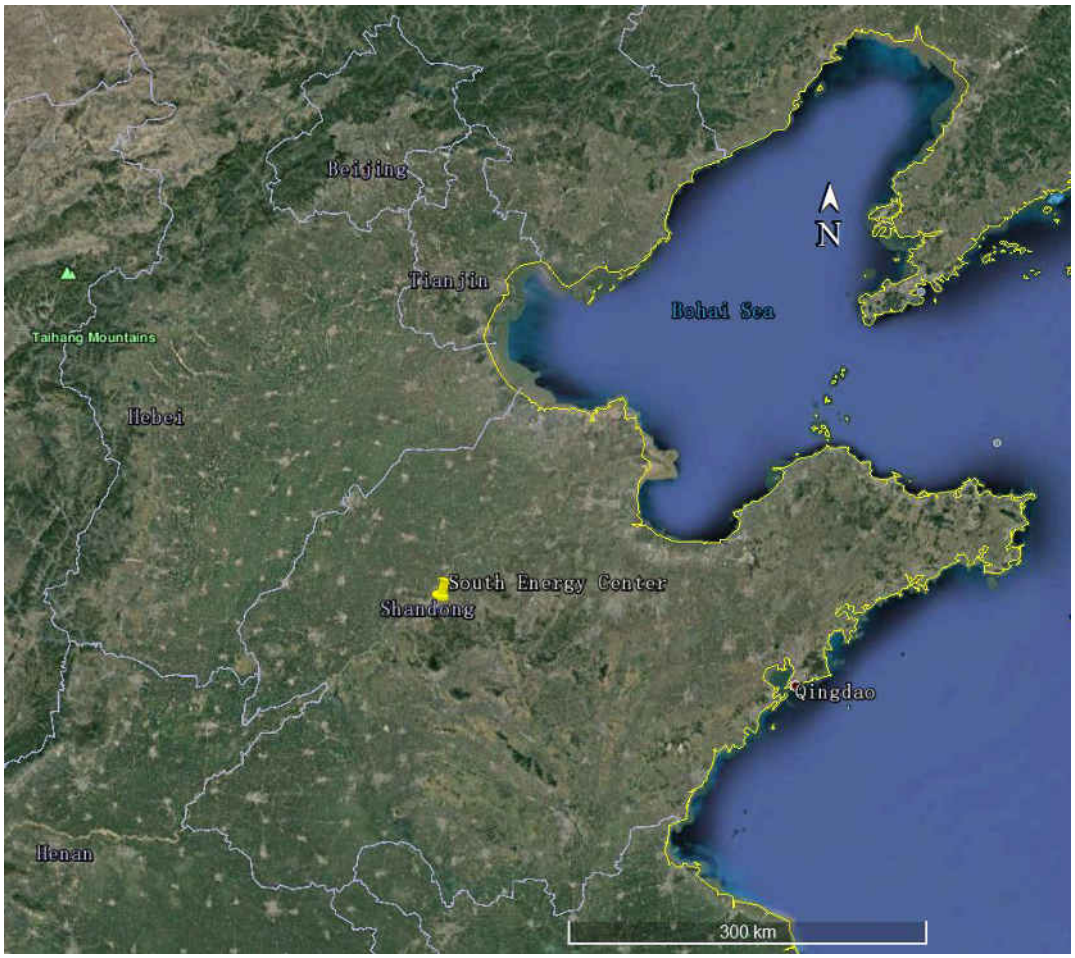
cooling station in existing Zhangqiu Thermal Power Plant; and (iv) 35 HESs (phase I), which will be built by the developers of Maoling Area with a heating area of 3.15 million m^2 and cooling area of 1.35 million m^2.

56. The component impact will be improved air quality and reduced greenhouse gas emissions in Jinan City. The outcome will be improved energy efficiency, a cleaner environment in Jinan City and a reduction in cases of respiratory and heart diseases.

B. Project Location

57. The component will be implemented at Lixia District of Jinan City which is located on the central and western areas of Shandong Province (**Figure III-1**). Jinan is capital city of Shandong Province and is comprised of seven urban districts and three rural county-level cities.

Figure III-1: Component location in Shandong Province

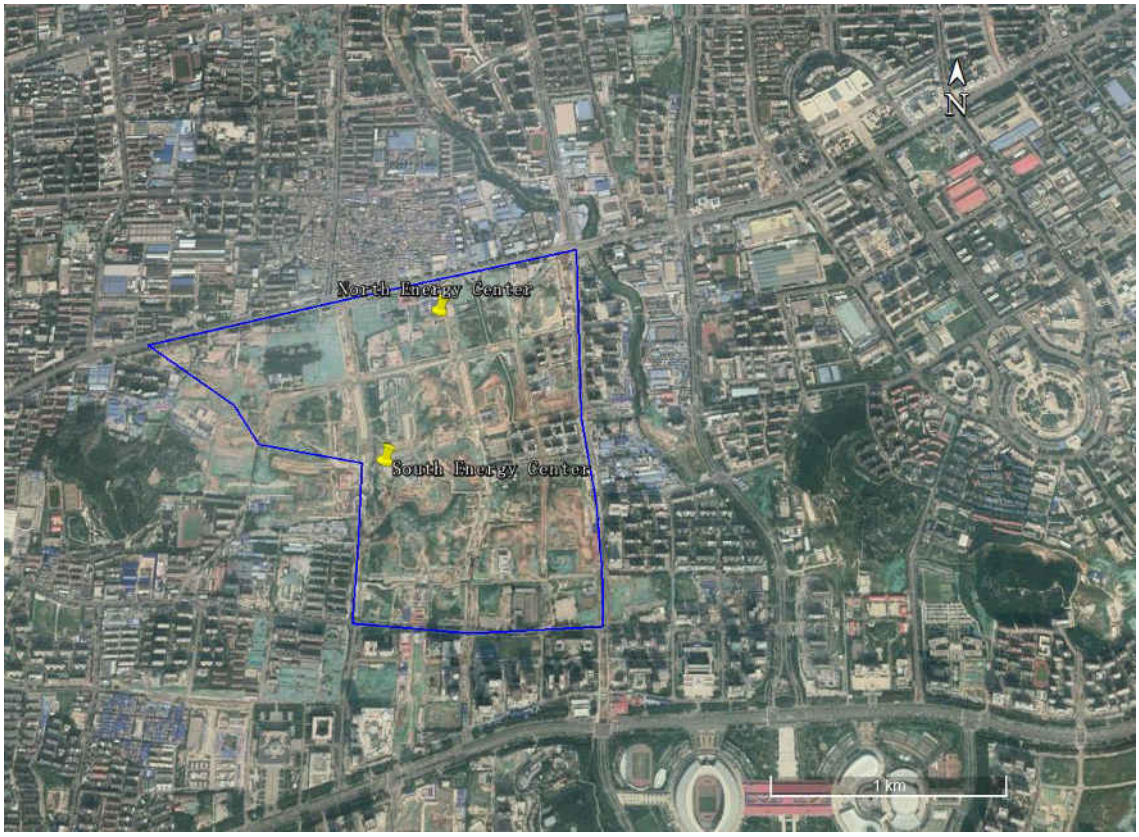


Source: Google earth, 2018

The component is located in Maoling Area (3.2 km^2), Lixia District of Jinan City (

58. **Figure III-2**).

Figure III-2: Component location



Source: Google earth, 2018.

C. Project Rational

59. Jinan, the capital city of Shandong Province, is situated in the northeastern part of PRC. The winter temperature drops to as low as –19 degree Celsius (°C), and sub-zero temperatures typically last for 4 months a year; under this climate heating service is an essential requirement for sustaining people's livelihoods. Heat demand in Jinan is increasing substantially due to rapid ongoing urban expansion. Current district heating coverage in Jinan is approximately 147 million m^2, compared to 87.6 million m^2 in 2012.

60. The existing heating system in Jinan is a large scale district heating system driven by coal-fired HSPs or CHP plants. However, the expansion of the existing coal-based district heating system to meet the increasing demand is not an option as Jinan has been experiencing significant pollution problems in the winter heating seasons including hazy skies and high levels of particulates.

61. Shandong Province is one of the most important regional economies in the PRC. Its provincial capital, Jinan, is a key economic, political, and transportation center in northern PRC. In 2017, Shandong's economy was ranked the third, contributing 8.79% of the country's total gross domestic product (GDP).

62. In 2017, Shandong's economy grew at 8.46%, among the highest growth rates in the PRC. However, the province's economic growth is energy intensive, highly polluting, and

overwhelmingly dependent on coal, especially for heavy industry and winter space heating. Heavy industry accounts for 68% of the province's industrial output, which is led by chemical production, agro-processing, machinery manufacturing, textiles, and smelting. Its power generation is almost exclusively coal-based.[7] Shandong Province alone consumes 10% of the PRC's total energy consumption. 79.3% of Shandong's primary energy mix is from coal, which makes it the PRC's largest consumer of coal. The province's coal consumption has steadily increased between 2011 and 2015, whereas the entire country has reduced its consumption between 2013 and 2015.[8]

63. As a result, the province is a substantial contributor of air pollution in the Greater BTH region. Jinan City is one of the cities with severe air pollution in the Greater BTH region. In 2017, Jinan ranked 65 among 74 major cities in the PRC, and first in Shandong Province for poorest air quality. Raw coal combustion produces lots of particulate matter and carbon dioxide. The average annual concentration of PM_{10} was measured at 130 micrograms per cubic meter (μg/m³) and particulate matter less than 2.5 microns in diameter ($PM_{2.5}$) was measured at 63 μg/m^3. These concentrations were nearly double the national air quality category II standards (70 μg/m³ and 35μg/m³) and more than six times the level recommended by the World Health Organization (20 μg/m³ and 10 μg/m³).[9] Annual concentration levels of other pollutants such as sulfur dioxide (SO_2) at 25 μg/m³ which is compliance with national air quality standard (60 μg/m³), and nitrogen dioxide (NO_2) is 46 μg/m³ which is worse than national air quality standard (40 μg/m³). Exposure to high levels of particulate matter and other air pollutants are associated with health risks such as cardiovascular and respiratory disease.

64. Restructuring the country's energy mix to combat air pollution is at the forefront on the government's agenda for transforming the PRC's economic growth model from an export-driven economy to a consumption-led, low-carbon one. The PRC's 13th Five-Year Plan (2016-2020) coins this goal as transforming the PRC into an "ecological civilization", guided by principles of environment, innovation, sustainability, and inclusive growth. To this end, the Plan includes targets for air quality and $PM_{2.5}$ levels in large cities and for the reduction of energy and carbon intensity. The 13th Five-year Plan builds on the Comprehensive Action Plan for Air Pollution Prevention and Control 2013–2017 (CAAP), which set the strictest air quality measures and targets to date on SO_2, NOx, $PM_{2.5}$, and volatile organic compounds nationally, and for the BTH region. More recently, MEE introduced the Work Program for Air Pollution Control (2017) in the BTH Region and its Surrounding Areas. The program aims to implement strict pollution control measures in 28 cities, of which 7 are located in Shandong province. The program emphasizes the importance to reduce winter raw coal burning for heating supply in urban, semi-urban and rural areas of the BTH region.

65. Coal-based heating is the major cause of rising level of outdoor and indoor air pollution during the winter. According to *Particulate matter (PM) source analysis result in Jinan in 2017* by Jinan EPB, 24.6% of $PM_{2.5}$ and 17.4% of PM_{10} are from coal combustion. According to *Jinan Action Plan (2017-2020) for Clean District Heating Pilot Cities in Northern China*, boilers with a capacity less than 35 t/h are prohibited in Jinan City from 2018. Thus, other alternatives to meet the growing heat demand are urgently required.

66. Development of cleaner, innovative heating and cooling systems are stymied by their high upfront capital costs. Heating and cooling storage systems, on the other hand, have much lower

[7] HKTDC Research. Shandong: Market Profile. Accessed March 22, 2018.
[8] Yiqing Zhang, Chuangeng Liu, Ke Li, Yong Zhou. 2018 Strategy on China's regional coal consumption control: A case study of Shandong province, *Energy Policy*. 112. pp. 316–327.
[9] Jinan EPB, 2017. The 2017 Bulletin on the Jinan Municipal Air Quality. Jinan.

investment costs compared to these without heating and cooling storage systems since the power prices are different in peak hours and valley hours.[10]

67. Instead of a conventional large scale heating system and air conditioner system, the component aims to provide district heating and cooling by waste heat, electric boilers, chillers and heat and cool storage systems. The component is more flexible allowing (i) the use of different clean and renewable energy sources; and (ii) heat and cool storage in non-peak hours so that the systems can provide enough heating and cooling in peak hours.

68. Compared to equivalent heating and cooling produced through traditional coal-fired sources and air conditioner, once operational, the component will: (i) result in annual energy savings equivalent to 59,069.28 tons of coal equivalent (tce), thereby providing a global public good by avoiding the annual emission of 214,516.21 tons of CO_2; (ii) improve local air quality through the estimated annual reduction of emissions of SO_2 by 280.99 tons, NOx by 345.43 tons, and PM by 51.32 tons; and (iii) eliminate the negative impacts of coal transportation through urban areas by truck or train.

D. Project Scope

69. The components are summarized in **Table III-1**.

Table III-1: Project Components and Key Features

No.	Component	Characteristics and Special Features
1	Energy Centers	South Energy Center will have a peak cooling capacity of 31,200 Refrigerating Ton (RT) (109,730kW) and heating capacity of 24 MW with a floor area of 5,603 m^2 and a building area of 13,440 m^2. South Energy Center will have four floors. One floor is above ground with a building area of 255.7 m^2 and height is 3.6m. Three floors are underground with a total building area of 13,184.3 m^2. The heights of three ground floors are 5.4m, 6.0m and 8.1m respectively. First ground floor will be used for office, meeting room, control room and power equipment room, second ground floor will be used for main equipment room and third ground floor will be used for ice storage tank and supporting equipment. Dual-condition chillers, electric boilers, ice storage system, heat storage system and heat exchangers will be installed in South Energy Center.
		North Energy Center will have a peak cooling capacity of 7,700 (RT) (27,080 kW) and heating capacity of 6 MW. North Energy Center will be located at No.1-11 plot of the Maoling Area with a floor area of 3,000 m^2. North Energy Center will have one floor below the ground. Dual-condition chillers, electric boilers, ice storage system, heat storage system and heat exchangers will be installed in North Energy Center.
2	Cooling Towers	Four cooling towers will be built in existing Dongxin Thermal Power plant to cool the cooling water in south and north energy

[10] International Energy Agency and Tsinghua University. 2017. *District Energy Systems in China: Options for Optimization and Diversification.* Paris.

No.	Component	Characteristics and Special Features
		centers. Municipal water will be used and water flow of each cooling tower will be 2,000 m^3/h. Total floor area of the four cooling towers will be 5,000 m^2. Wastewater will discharged to the existing sewer system.
3	Heat exchange stations	HESs which can provide both heat and cooling will be built in commercial areas. Heat exchange stations which can provide only heat will be built in residential areas. Total 35 HESs (phase I) will be built by the developers of Maoling Area while 14 HESs for heating are above ground and 21 HESs for heating and cooling are below ground. Only procurement of equipment and equipment installation will be included in the component. Total heat supply area will be 3.15 million m^2 and cool supply area will be 1.35 million m^2.
4	Pipeline network	District heating and cooling pipeline network including 16.85 km of primary and 20.0 km of secondary network will be constructed for both heating and cooling supply. The pipeline network will used for cold water transfer in summer and hot water transfer in winter. The pipe networks will utilize two-pipe system. One is water supply pipe and another is water return pipe. Pipe diameters of primary pipeline network will be from DN 200 to DN 1,400 and secondary pipeline network will be from DN 150 to DN 1,000.
5	Water treatment system	Softened water treatment system will be installed to produce make up water of boilers, cooling towers and heating and cooling system at the two energy stations.. The softened water treatment process use municipal water. Treatment process is ion exchange resin and treatment capacity is 120 m^3/h.
6	Water supply system	Domestic water and production water will be both from municipal water system.
7	Water drainage system	Production and domestic wastewater will be discharged to the municipal sewage pipeline network
8	Power distribution equipment	HESs and cooling towers will be located at existing or newly facilities and will utilize local power transformers. Two new 10 kV power distribution rooms will be installed at two Energy Centers separately.

70. Key parameters of the component are summarized in **Table III-1**.

Table III-2: Project Key Parameters

No.	Parameter	Unit	No.
1	Heating supply area	Million m^2	6.22
2	Cooling supply area	Million m^2	2.0
3	Operation days of heat supply	Days	150
4	Operation days of cool supply	Days	120
5	Annual power consumption (from grid)	GWh	42.7

No.	Parameter	Unit	No.
6	Annual standard coal savings	tons	59,069.28

E. Implementation Arrangements

71. SPG will be the EA and responsible for overall guidance during project preparation and implementation. Jinan Thermal Power Co,. Ltd and JHG, two state-owned companies will be IA and responsible for implementing project components and administering and monitoring contractors and suppliers. JHG is the IA of the component. A PMO led by the Jinan Municipal Bureau of Housing and Urban-rural Development will be responsible for day-to-day management of the project.

F. Key Project Features

72. Key features of the component are listed below:

1. Energy Efficiency and Environmental Improvement

73. The component will use waste heat from Zhangqiu Thermal Power Plant for heat supply. Waste heat is the cleanest source for heat supply. Except a small amount of electricity needed to transport the heat from normally power plants to customers, there is no emission at all. One primary energy station was already built in Zhangqiu TPP by JHG to use the waste heat from Zhangqiu Thermal Power Plant to generate hot water following the PRC applicable environmental regulations. Hot water is transferred to Maoling Area through one 43.8 km pipeline to provide district heating in east Jinan urban area. The pipeline was built by JHG in 2014.

74. The component will build district cooling system, in which large-scare chillers replace independent air conditioners in separate buildings. In doing so, it can improve cooling efficiency, energy efficiency, and using rate of building space and reduce water wasted in cooling towers and noise pollution. Besides, the combination of district cooling technique and cooling storage technique reduces the installed capacity of cooling devices, as well as the initial investment. Chillers use electricity to produce ice at off-peak time during night and provide cooling by ice melting with no additives needed at peak time during the day, which shifts peak load, narrows differences between the peak time and valley time in the grid, and enables users using peak-valley tariff to save operation cost. Furthermore, cold source is easy to optimize control and maintenance management, which is helpful to improve operation efficiency, save energy, and cut labor cost in management.

75. Overall, the component is expected to improve the energy efficiency and environmental performance compared to equivalent heat and cool through traditional coal-fired sources and air conditioner. Once operational the component will: (i) result in annual energy savings equivalent to 59,069.28 tce, thereby providing a global public good by avoiding the annual emission of 214,516.21 tons of CO_2; (ii) improve local air quality through the estimated annual reduction of emissions of SO_2 by 280.99 tons, NOx by 345.43 tons, and PM by 51.32 tons; and (iii) eliminate the negative impacts of coal transportation through urban areas by truck or train.

2. Electrode boilers

76. Electrode boiler is an energy transformation device, which transforms electricity to heat

and then pass heat to medium. Electrode boilers work by passing current through the medium (water), between two electrodes, thereby creating heat. They have several key advantages over fossil fuel fired boilers: they have extremely quick response times; they are flexible for cyclical or intermittent operations; they are clean firing and produce no combustion emissions and do not require stacks; they are greater than 99% efficient; and, they are smaller in volume and footprint than fossil fired boilers.

77. The component adopts 10KV high voltage electrode boilers as heat resource in two energy centers. The boilers in two energy centers use electricity at valley time (from 11 pm to 7 am when the electricity price is low) during night to produce hot water (about 90°C. Part of produced heat is stored and part is delivered. Electrode boiler only works at valley time at night, providing heat with heat stored in hot water storage tank.

78. The component will construct one 24 MW electrode boiler in south energy center and one 6 MW peak adjustment high-efficiency zero emission electrode boiler in north energy center. The total installed capacity of electrode boilers is 30MW, operating for 8 hours a day (23:00 to 7:00 of next morning), consuming 23.4 GWh electricity in one heating season to heating 0.7 million m³ area. **Table III-3** presents the key design features for the electrode boilers.

Table III-3: Key design features of electrode boilers

No.	Item	Feature
1	Name	High voltage electrode hot water boiler
2	Capacity	24 MW/ 6 MW
3	Diameter of boiler body	2700 mm/ 1500 mm
4	Voltage	10 kV
5	Area standing	15m^2 / 8 m^2(for the boiler body)
6	Weight	12 tons/ 6 tons

3. Lithium bromide absorption chiller

79. A chiller is a machine that removes heat from a liquid via a vapor-compression or absorption refrigeration cycle. This liquid can then be circulated through a heat exchanger to cool equipment, or another process stream (such as air or process water). As a necessary by product, refrigeration creates waste heat that must be exhausted to ambience, or for greater efficiency, recovered for heating purposes.

80. Chilled water is used to cool and dehumidify air in mid- to large-size commercial, industrial, and institutional facilities. Water chillers can be water-cooled, air-cooled, or evaporatively cooled. Water-cooled systems can provide efficiency and environmental impact advantages over air-cooled systems.

81. Lithium bromide absorption chiller is driven by heat and consumes little electricity, making full use of low-quality heat. Its advantages are as follows: (i)In the equipment, no part, other than canned-motor pump, needs to move. So, it's quiet in operation. (ii) With lithium bromide being medium, the chiller operates in vacuum, not toxic, not smelly, and no explosion. The adjustment spectrum is wide. Based on changes in demand, the cooling energy provided by the chiller can be adjusted from 10% to 100% continuously. And when adjusting in low demand, heat efficiency basically maintains the same. But it also has disadvantages. For example, lithium bromide solution is highly corrosive in the air, so it's extremely important to make sure that its inside is in vacuum when operating. Even just a very small amount of air can cause badly damage to the

chiller. Thus, the equipment should be perfectly sealed, which puts a high requirement to the operation and maintenance of the chiller. Besides, in operation, the chiller needs a lot of high quality cooling water, which is a high load for discharge. When the cooling demand is high, the lithium bromide solution is required to be high concentration, which may produce crystal. To prevent crystallization, more electricity is required. Lithium bromide solution will not be lost during normal working conditions because the solution is stored in vacuum environment. Therefore, it is retained in the system and does not need top-up. To reduce the potential leakage of lithium bromide, daily air tightness check of chillers is necessary. In case of leakage, the lithium bromide solution will be collected and stored following the PRC standards, then transported and treated by a certificated company.

Figure III-3: District Cooling and Heating System Using Industrial Waste Heat

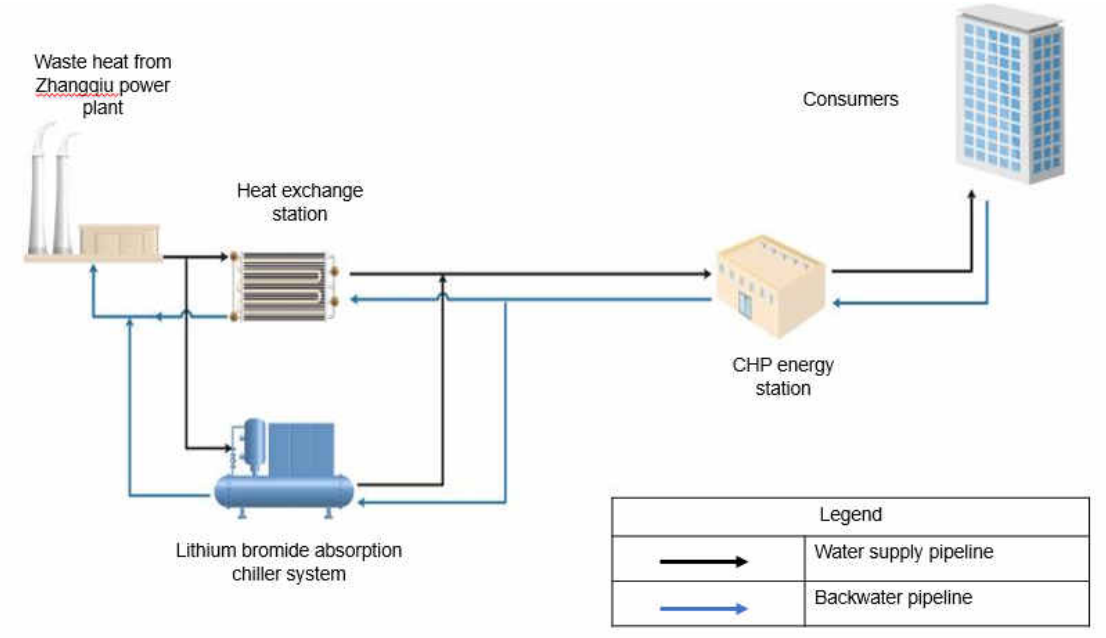
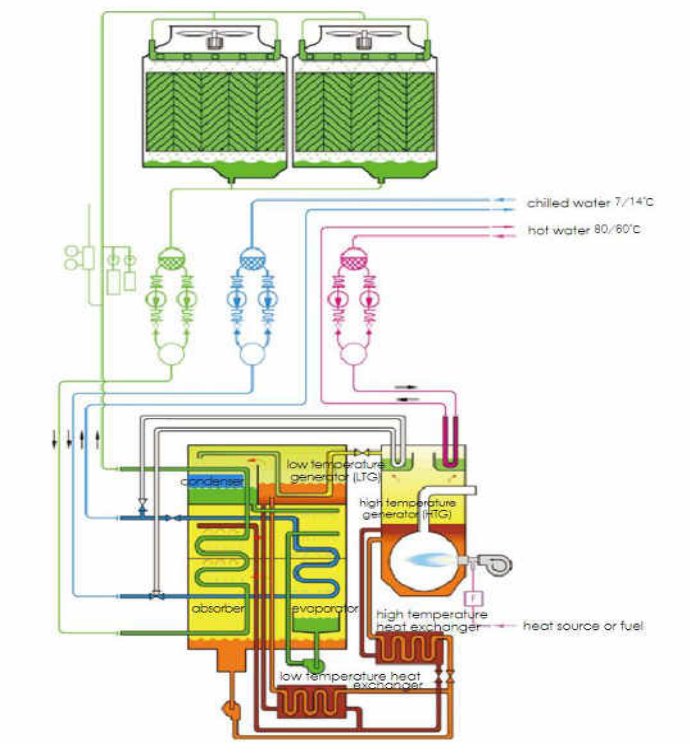


Figure III-4: Working Principle of Lithium Bromide Absorption Chiller



4. Electrical air conditioning

82. Air conditioning (AC) system contains refrigerant to absorb heat. Ethylene glycol will be used as refrigeration which is not a GHG chemical, not an ozone depleting substance and is not on the PIAL. The main refrigeration system consists of compressor, condenser, evaporator and expansion valve. In operation, circulating refrigerant vapor enters the compressor where its pressure and temperature are increased. When refrigerant vapor pressure is larger than the pressure inside of the condenser, the high-pressure vapor is condensed. In the condenser, hot and condensed refrigerant vapor is cooled by air flow or normal temperature water and condensed into liquid. The condensed, pressurized and usually hot liquid refrigerant is routed through an expansion valve, where it undergoes a rapid reduction in temperature and pressure. The cold refrigerant is then routed through the evaporator where it absorbs heat and is evaporated. Thus, the circulating refrigerant removes heat and refrigerant vapor is routed back into the compressor. The circulation consists of 4 processes, including compression, refrigeration, expansion and evaporation. In the circulation, the compressor performs a function of condensing and transporting refrigerant and consumes energy.

83. There are many types of compressor, including piston compressor, rotary-screw compressor, and centrifugal compressor etc. In a piston compressor, compression cylinder is the working part, which uses pistons driven by a crankshaft to compress, exhaust stream, expand and absorb. The piston compressor is mature in manufacture and simple in construction and can be built at a low cost. It can be used under various pressures and cooling demands and can be easily maintained; thus, it's widely used. However, it cannot rotate at a high speed; it's bulky and heavy; it does not exhaust steam continuously, which may cause fluctuation in air flows; and it vibrates when operating. Rotary-screw compressor is a type of gas compressor that uses a rotary-type positive-displacement mechanism to absorb, compress and exhaust air. It only contains

rotating, not reciprocation. It's well balanced with less vibration, which allows raising rotary speed. It's simple and compact in structure, and light. In the case of low evaporation temperature and high compression ratio, single-stage compressor remains working and performing well. It's not sensitive to moisture of refrigerant. Its refrigeration amount can be adjusted from 10% to 100% continuously, and when demand is higher than 40%, it is more efficient. On the other hand, rotary-screw compressor produces lots of noises in operation and requires many associate equipment to separate, refrigerate, filter, and pressurize lubricant oil. Centrifugal compressor transforms mechanical energy to air pressure in the centrifugal impeller and the diffuser. It has high rotate speed with large amount venting output, stable air flows and none fluctuation in air flows. It has a better seal system and less leakage. Centrifugal compressor has less vulnerable parts than other types of compressors that result to less maintenance work. It has a better economic performance when cooling load larger than 1500kW. Based on the information above, centrifugal compressor is selected by the component.

5. Ice storage air conditioner (AC)

84. The system adds ice storage devices on the basis of electricity-driven chillers. It uses electricity at off-peak time during the night and stores the cooling energy in the form of ice. During peak hours in daytime (especially in electricity consumption peak time), ice is melted to provide cooling energy to meet the demand of centralized AC.

85. Ice storage system includes two kinds: static system and dynamic system. Static ice storage system sinks heat exchanging coils in the ice storage tank to produce ice on the outside surface of the coils; during the process, water remains static in ice storage tank, not influenced by water flows, and can perform well. Dynamic ice storage system presents high efficiency in heat transportation, ice production, the COP in main machines, fast respond to demand, and high adaptability. But it cannot control the amount of ice being melted and the melting speed. The component will use dynamic ice storage system.

86. Currently, ice storage devices can be divided into ice coil system, freezing system, and ice ball system. Their introductions are as follows:

(i) Ice coil system: the system put metal coils into ice storage tank to produce ice on the outside surface of coils. In using, the return water in AC melts ice to provide cooling energy.

(ii) Freezing system: the system puts plastic coils or metal coils into ice storage tank and provides low-temperature secondary refrigerant (ethylene glycol) produced by water chilling unit. In doing so, water in the ice storage tank is frozen to be ice. In using, glycol solution from AC consumer end, which is usually at a higher temperature, is routed through coils to melt ice outside of coils to provide cooling energy.

(iii) Ice ball system: the system is also called container cold storage. It uses plastic balls as containers, which is filled with water and put into ice storage tank. Water in plastic balls exchanges heat with glycol solution to be turned into ice. In using, glycol solution from AC consumer end, which is usually at a higher temperature, is routed into plastic balls, melts ice and produces cooling energy.

87. Ice storage AC uses electricity at off-peak time to shift power load, improving operation security of the grid and power generation efficiency of power plants. It can also cut operational

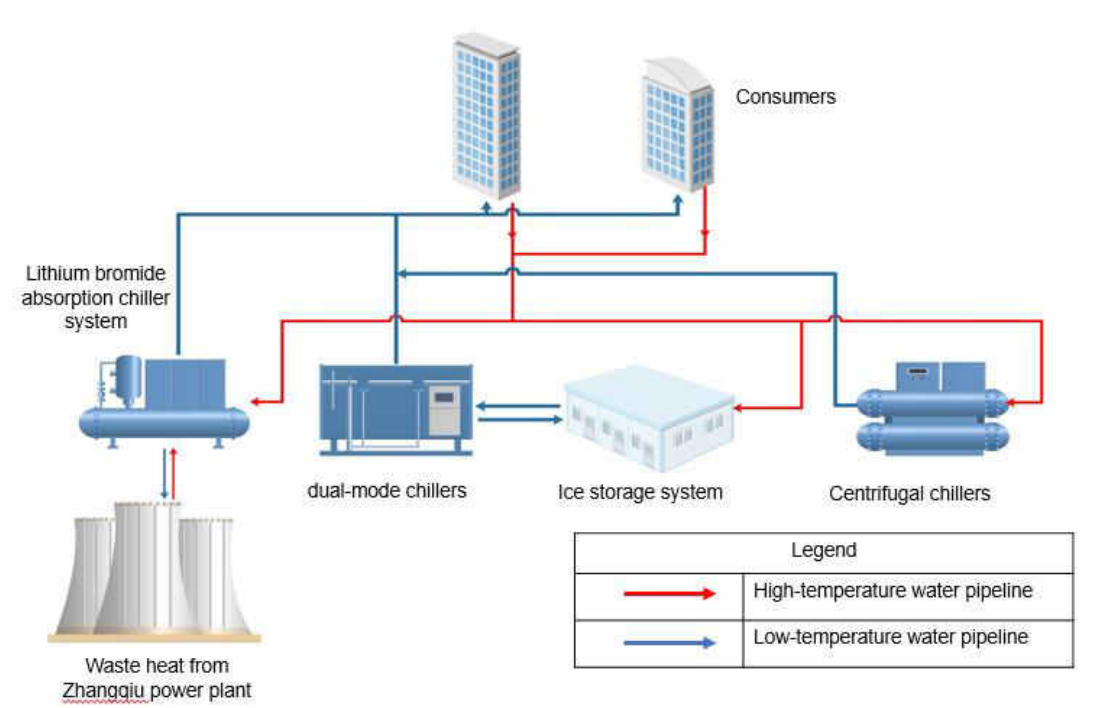
expenses of power plants in areas with peak-valley tariffs. It can respond to contingencies. Because in power cut, it uses self-contained power set off water pumps to melt ice and provide cooling energy. In doing so, AC system is more reliable. The system has a long lifetime and can be easily maintained.

88. Considering the cooling demand, demand curve, changes in building user's manner and occupancy rate, power demand in Shandong Province, and the implementation of time of use (TOU) tariff and other related factors, this project adopts dynamic ice storage AC as cooling approach with electric chiller as backup. When the cooling demand is low, electric chiller is more flexible and economical, thus is a better choice. Electric chiller in the project is a dual-mode chiller where double evaporator chillers are used to improve the energy efficiency when the system in cooling supply mode only. It can directly produce cooling energy and also produce ice to store cooling energy and provide cooling energy while needed. The system includes centrifugal chillers with variable speed drive which operate at night when cooling demands from commercial buildings are low. A separate secondary cycling pump is used to match the low cooling load and reduce the energy consumption in case the main secondary cycling pump fails to respond to the low load. Meanwhile, the centrifugal chiller operation can guarantee the dual-mode chiller making ice for storage at night.

The dual-mode chillers connect with ice storage system in series, with dual mode chillers at upstream and ice melting boards at downstream of the dual-mode chillers. This reduces energy consumption of centrifugal chillers during peak times by lowering the supply water temperature, thereby increasing temperature difference between supply and return water, and reducing the amount of cycling water and energy consumption for pumping the water. The system is shown in

89. **Figure III-5**.

Figure III-5: District Cooling System



90. Based on the load curve, the proposed district cooling system may operate under the following operating schemes:

(i) Scheme 1: The centrifugal chiller provides cooling energy, with dual-mode chillers to produce and store ice. The centrifugal chiller operates during the night, when cooling demand is very low.

(ii) Scheme 2: Ice in ice storage tank is melted to provide cooling energy. When cooling demand is not high (it happens in the early stage of the project operation when most residents have not moved in and the occupancy of offices and commercial facilities are not is low), ice stored at night can meet the peak demand during daytime.

(iii) Scheme 3: The centrifugal chiller operates and the ice in ice storage tank is melted to provide cooling energy together. When demand grows to a certain scale, ice melting only cannot meet the demand, the centrifugal chillers must operate during daytime.

(iv) Scheme 4: The centrifugal chiller and dual-mode chillers are connected in parallel to provide cooling energy. When demand is larger than the capacity of the centrifugal chiller and the ice storage tank are faulty, the centrifugal chiller and dual-mode chillers are operated in parallel to meet the demand.

(v) Scheme 5: When demand grows to a scale, the centrifugal electrical chiller, dual-mode chillers and the ice in ice storage tank are required to work together to provide cooling. This represents the peak capability of the district cooling system in providing cooling energy.

G. Component Design Details

1. Layout

91. The location of the 35 HESs and two energy centers and layout of the pipelines are presented in

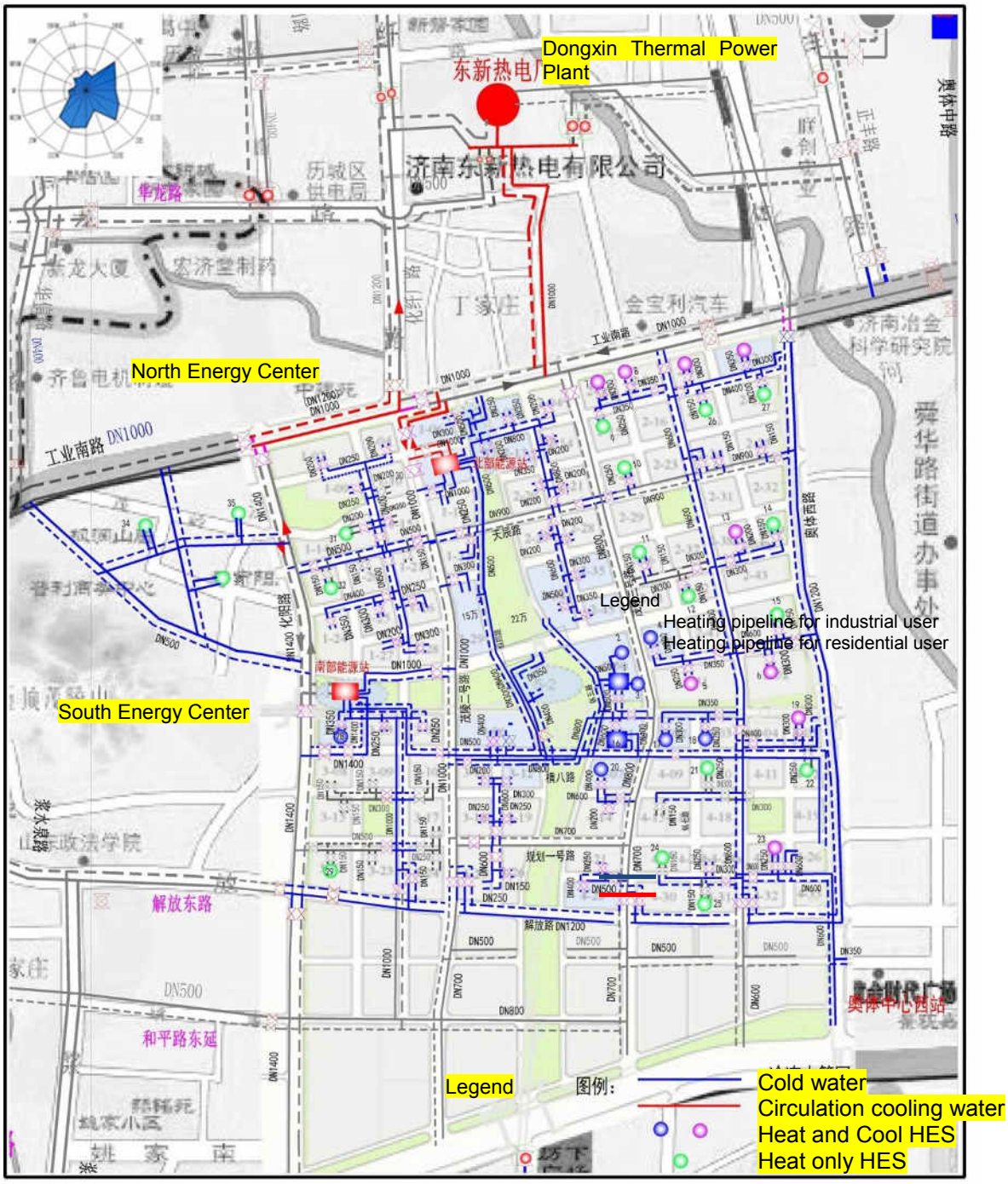
92. **Figure III-2**. Layout of the component is presented in **Figure III-6**.

93. The component will provide district heating to 6.22 million m^2. The heat load of the component is presented in **Table III-4**.

94. The component will provide district cooling to 2.22 million m^2. The cool load of the component is presented in **Table III-5** and

95. **Figure III-1010**.

Figure III-6: Component Layout.



Source: FSR Report, 2018.

Figure III-7: Layout of equipment floor of south energy center (secondary ground floor).

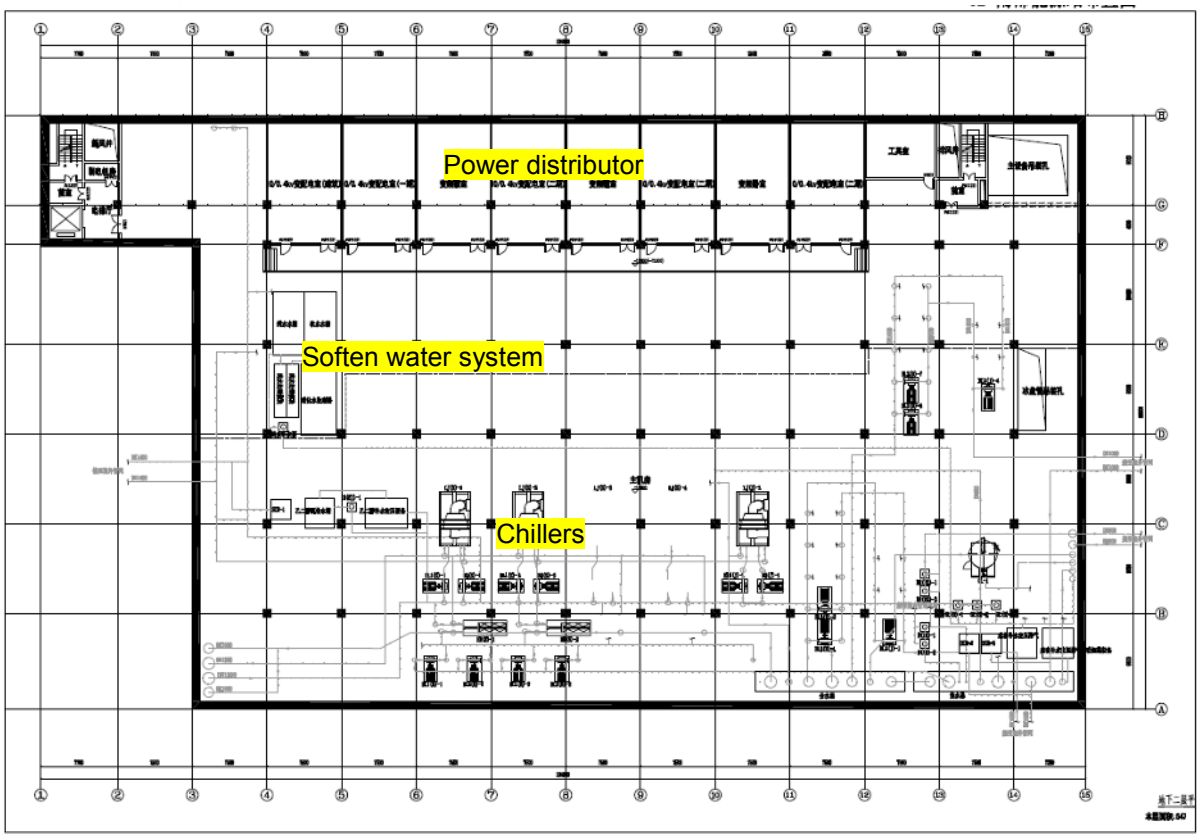


Figure III-8: Layout of north energy center.

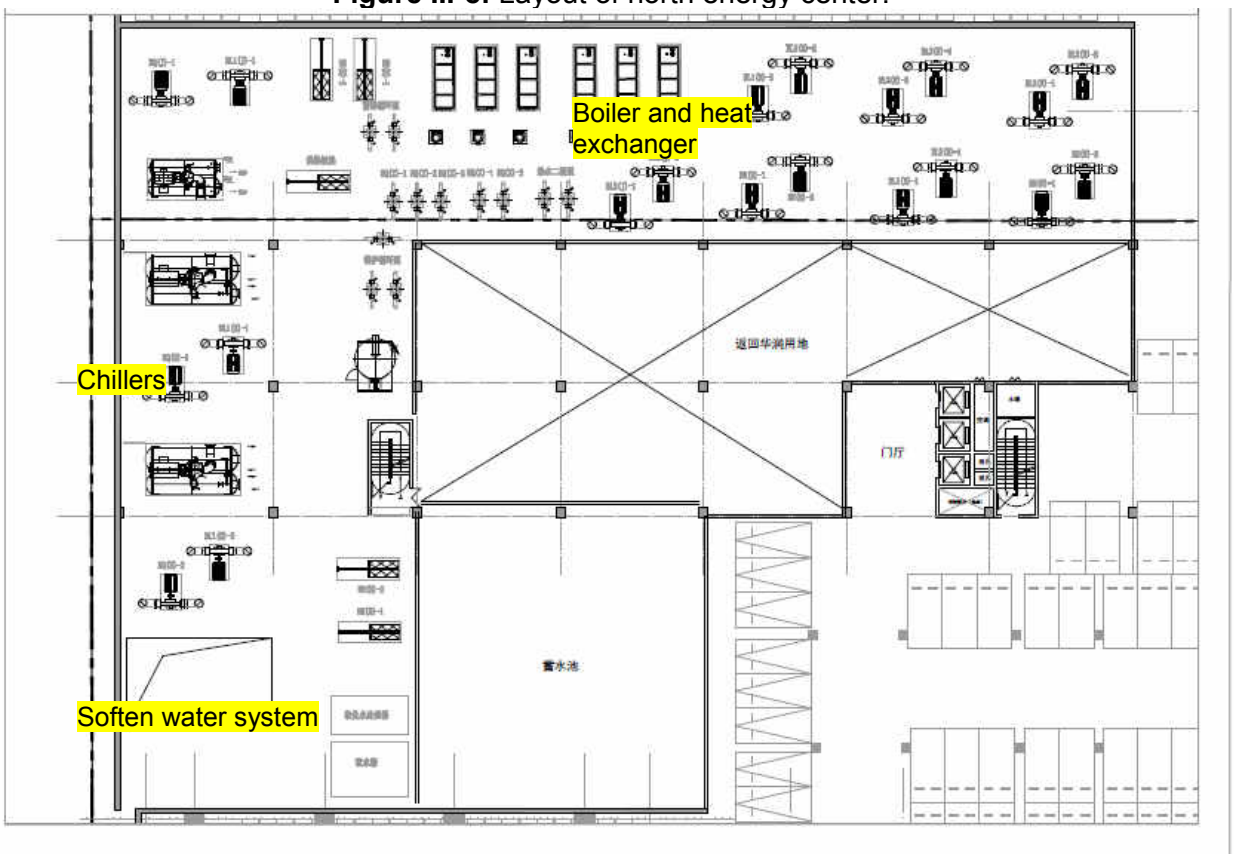


Figure III-9: Layout of Dongxin TPP

Table III-4: Heat load

No.	Building type	Heating area (million m^2)	Heating load index (W/m^2)	Heat load (MW)
1	Office	3.26	50	163
2	Commercial retail	0.705	50	35.25
3	Apartment	0.87	35	30.45
4	Residential area	1.31	35	56.35
5	Cultural facility	0.1	50	5
6	Municipal service facility	0.8	50	4
7	Total	6.225		294.05

Source: FSR report, 2018.

Table III-5: Cooling load

Plot No.	Land use	Building area (m^2)	Cool load		Installed capacity	
			kW	RT	kW	RT
1-06	Business	102,966	11,326	3,220	6,343	1,803
1-11	Business	108,750	11,963	3,401	6,699	1,905
1-29	Business	147,879	16,267	4,625	9,109	2,590
2-02	Business	78,030	8,583	2,441	4,807	1,367
2-13	Business	80,000	8,800	2,502	4,928	1,401
2-34	Business	217,557	23,931	6,804	13,402	3,810
2-35	Business	79,200	8,712	2,477	4,879	1,387
2-45	Business	67,146	7,386	2,100	4,136	1,176
2-46	Commercial	70,718	10,608	3,016	7,425	2,111
2-50	Business	320,674	35,374	10,030	19,754	5,617
3-02	Commercial	66,574	9,986	2,839	6,990	1,988
3-06	Business	175,079	19,259	5,476	10,785	3,066
3-12	Business	96,450	10,610	3,017	5,941	1,689
4-01	Business	173,798	19,118	5,436	10,706	3,044
4-02	Commercial	67,777	10,167	2,891	7,117	2,023
4-07	Business	111,330	12,246	3,482	6,858	1,950
4-28	Business	101,285	11,141	3,168	6,239	1,774
5-1	Commercial	13,000	2,306	656	1,614	459
5-2	Commercial	115,000	20,401	5,801	14,281	4,060
5-3	Commercial	16,000	2,838	807	1,987	565
	Total	2,209,213	260,922	74,189	154,000	43,785

Source: FSR report, 2018.

Figure III-10: Cooling load

96. Detailed pipeline network information is presented in **Table III-6** and **Table III-7**.

Table III-6: Primary Pipeline network information

No.	Location	Pipe diameter (millimeter)	Length of pipelines (m)
1	No. 1 Guihua Road	DN 200-800	2,893
2	No. 2 Guihua Road	DN 600	500
3	Six subway stations	DN 250-600	1,315
4	West Aoti road	DN 1000	2,173
5	Dingjiazhuang	DN 1000	720
6	South Gongye Road	DN 1000	400
7	Feiyue Road	DN 1000	6,450

8	North Gongye Road	DN 1000	2,400
	Total		16,851

Source: FSR Report, 2018.

Table III-7: Secondary Pipeline Information Statistics data

Location	Pipeline trend	Pipe diameter (millimeter)	Length of pipelines (m)
Between No.2 Guihua Road and West Aoti Road	Hengyi Road	DN 400	468
		DN 200	216
	Hengwu Road	DN 300	204
		DN 250	60
		DN 200	36
	Hengliu Road	DN 600	252
		DN 300	42
		DN 250	60
	Hengba Road	DN 500	306
		DN 400	336
	Hengjiu Road	DN 300	240
	No. 1 Guihua Road	DN 300	106
	East Jiefang Road	DN 600	305
	Zongjiu Road	DN 600	264
	West Aoti road	DN 500	378
Between No.2 Guihua Road and No.3 Maoling Road	Hengyi Road	DN 400	109
		DN 300	220
	Hengwu Road	DN 250	41
		DN 300	53
		DN 200	288
		DN 350	150
	Hengliu Road	DN 300	120
		DN 250	42

Between No.2 Maoling Road and No.3 Maolingi Road	Hengqi Road	DN 400	84
		DN 300	360
	Hengba Road	DN 500	336
		DN 600	56
	Hengjiu Road	DN 200	288
		DN 150	52
	Hengshiyi Road	DN 300	73
		DN 200	204
		DN 150	43
	Hengyi Road	DN 1000	124
		DN 800	348
		DN 400	60
	Henger Road	DN 1000	130
		DN 250	108
	Hengsi Road	DN 500	66
	Hengba Road	DN 600	276
		DN 350	138
		DN 300	79
		DN 800	480
		DN 500	816
		DN 400	73
	Hengjiu Road	DN 600	120
		DN 400	52
	Hengshiyi Road	DN 200	58
		DN 300	186
		DN 600	138
	Zongsi Road	DN 400	290.4
		DN 350	216

Between No.2 Maoling Road and Huayang Road	No.1 New Road	DN 300	660
		DN 600	252
		DN 400	276
	Zongwu Road	DN 800	157.2
		DN 400	270
		DN 300	516
	Zongliu Road	DN 250	188.4
		DN 800	306
		DN 600	308.4
		DN 500	86.4
		DN 400	249.6
	Hengyi Road	DN 300	144
		DN 200	139.2
	Hengsi Road	DN 400	342
		DN 1000	342
	Hengqi Road	DN 300	249.6
		DN 1000	228
		DN 250	240
	Hengba Road	DN 1400	174
		DN 500	159.6
	Hengjiu Road	DN 300	180
	Hengshi Road	DN 500	103.2
		DN 300	62.4
	Zonger Road	DN 1400	165.6
	Zongsan Road	DN 1000	690
		DN 500	624
		DN 400	324
		DN 300	344.4

		DN 300	810
	No. 2 Road	DN 250	288
		DN 200	168
West of Huayang Road		DN 300	420
		DN 250	168
	No. 3 Road	DN 250	96
		DN 200	174
	Total		20,008.4

Source: FSR Report, 2018.

97. Location of the cooling towers in Dongxin Thermal Power Plant is presented in **Figure III-11**.

Figure III-11: Location of cooling towers in Dongxin Thermal Power Plant

Source: Google earth, 2018.

98. The locations of the 35 HESs are presented in

99. **Figure III-2**. Detailed information of HESs is presented in **Table III-8**.

Table III-8: Detailed information of 35 HESs

No.	Location	Type	Area (thousand m^2)
1	A1 plot	Heat and cool	200
2	A1 plot	Heat and cool	50
3	A1 plot	Heat and cool	50
4	A2 plot	Heat and cool	100
5	A3 plot	Heat and cool	50
6	A4 plot	Heat and cool	50
7	A5 plot	Heat and cool	50
8	A6 plot	Heat and cool	50
9	B1 plot	Heat only	50
10	B1 plot	Heat	10
11	B4 plot	Heat	10
12	B7 plot	Heat	5
13	B9 plot	Heat	5
14	B10 plot	Heat	10
15	B13 plot	Heat	10
16	4-01 plot	Heat and cool	20
17	4-02 plot	Heat and cool	10
18	4-03 plot	Heat and cool	5
19	4-04 plot	Heat and cool	10
20	4-08 plot	Heat and cool	10
21	4-10 plot	Heat	10
22	4-12 plot	Heat	10
23	4-25 plot	Heat	10
24	4-23 plot	Heat	10
25	4-31 plot	Heat	5

26	2-17 plot	Heat	10
27	2-18 plot	Heat	10
28	3-02 plot	Heat and cool	10
29	3-22 plot	Heat	10
30	1-10 plot	Heat	10
31	1-14 plot	Heat	10
32	1-19 plot	Heat	10
33	5-1 plot	Heat	10
34	5-2 plot	Heat	10
35	5-3 plot	Heat	10
	Total		3,150

Note: Heating HES will be located at residential area. Heating and cooling HES will be located at commercial area. These areas are under construction.
Source: FSR and domestic EIA Report, 2018 and site visit.

2. Main equipment

100. Main equipment of South Energy Center is presented in **Table III-9**.

Table III-9: Main equipment of South Energy Center

No.	Item	Capacity	Power Rate (kW)	Numbers
1	Dual-condition centrifugal chiller	1,750 RT	1,350	8
2	Base load centrifugal chiller	1,200 RT	942	4
3	Dual-condition plate heat exchanger	2,000 RT	NA	8
4	Plate heat exchanger for ice melting	1,600 RT	NA	4
5	Plate heat exchanger for ice storage	1,600 RT	NA	4
6	Ice making unit	Each is 494 RTH	4	24
7	Electrode boiler	24 MW	16,000	1
8	Water treatment equipment	NA	NA	1

Main equipment of North Energy Center is presented in

101. **Table III-10**.

Table III-10: Main equipment of North Energy Center

No.	Item	Capacity	Power Rate (kW)	Numbers
1	Dual-condition centrifugal chiller	1,750 RT	1,350	2
2	Base load centrifugal chiller	1,200 RT	942	1
3	Dual-condition plate heat exchanger	2,100 RT	NA	2
4	Plate heat exchanger for ice melting	1,800 RT	NA	1
5	Plate heat exchanger for ice storage	1,800 RT	NA	1
6	Ice making unit	Each is 570 RTH	4	6
7	Electrode boiler	6 MW	4,000	1
8	Water treatment equipment	NA	NA	1

102. When the cooling system is under operation, a lot of condensation heat will be generated. Cooling towers will be built to remove the condensation heat. Main equipment of cooling towers is presented in **Table III-11**.

Table III-11: Main equipment of cooling towers

No.	Item	Capacity	Power Rate (kW)	Numbers
1	Super silence cooling towers	Flow: 2,000 m^3/h	75	4
2	Cooling water pump	Flow: 1,890 m^3/h	110	4
3	Circulation pump	Flow: 2,000 m^3/h	280	4
4	Water treatment equipment	NA	NA	1

Source: FSR and domestic EIA Report, 2018.

3. Ice storage system

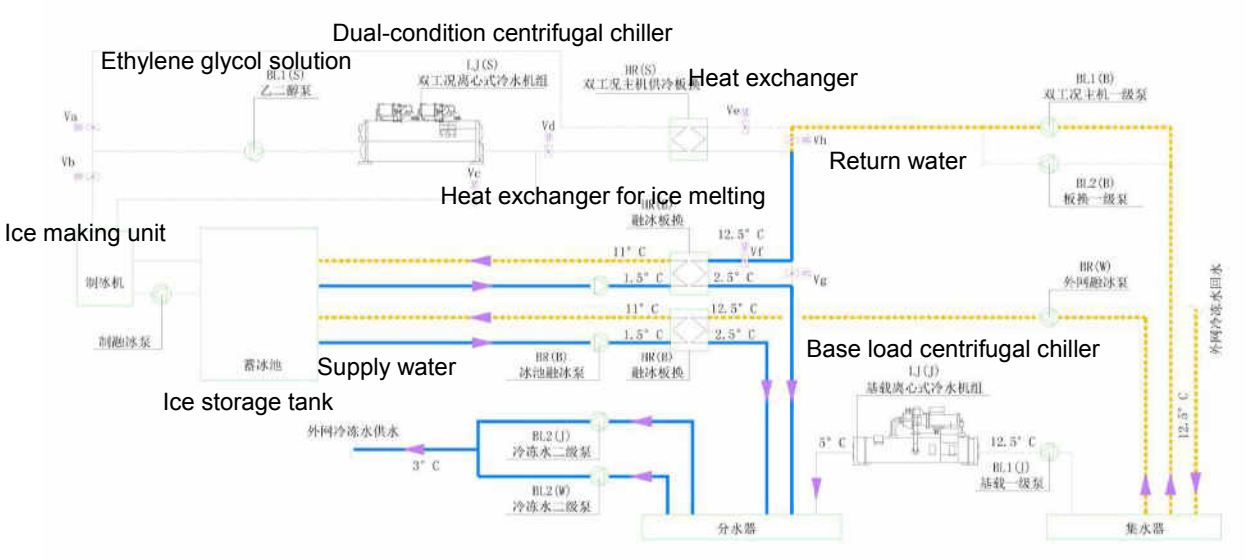
To save operation cost, the component will build ice storage system. The power prices in different time periods in Jinan are presented in

103. **Table III-12** .Flow chart of ice storage system is presented in **Figure III-12**. Ethylene glycol solution (20% percentage) is used for ice making. The temperature of the supply water is 3°C and the return water is 12°C.

Table III-12: Power prices in different time periods

No.	Time Period	Power Price (CNY/kWh)
1	11 pm to 7 am	0.36875
2	10:30 am to 11:30 am and 7 pm to 9 pm	1.25375
3	8:30 am to 11:30 am and 4 pm to 9 pm	1.10625
4	7 am to 8:30 am, 11:30 am to 4 pm and 9 pm to 11 pm	0.7375

Figure III-12: Flow chart of ice storage system



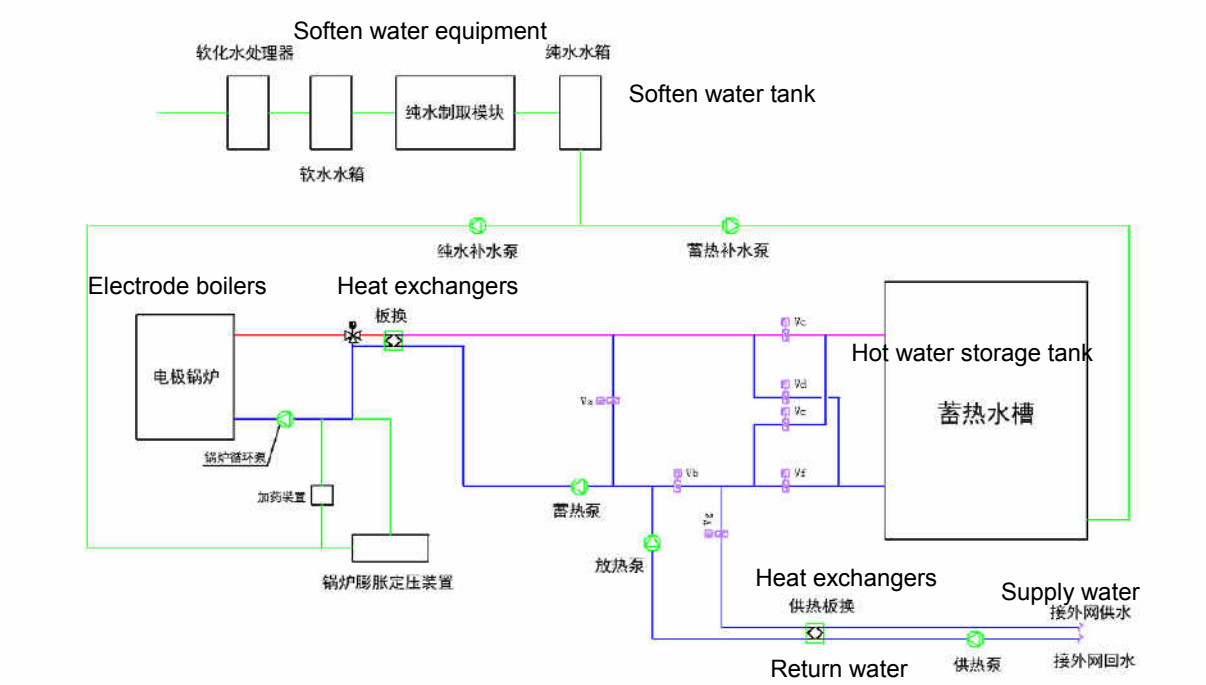
Source: Domestic FSR, 2018.

4. Heat Storage system

104. The component will utilize heat storage system for peak adjustment to save operation cost. The process is presented in

105. **Figure III-133.** The electrode boilers will be under operation in non-peak hours to generate hot water (around 90°C), and then the hot water will be stored in tanks. In peak hours, the stored hot water will be used for heat supply.

Figure III-13: Flow chart of heat storage system



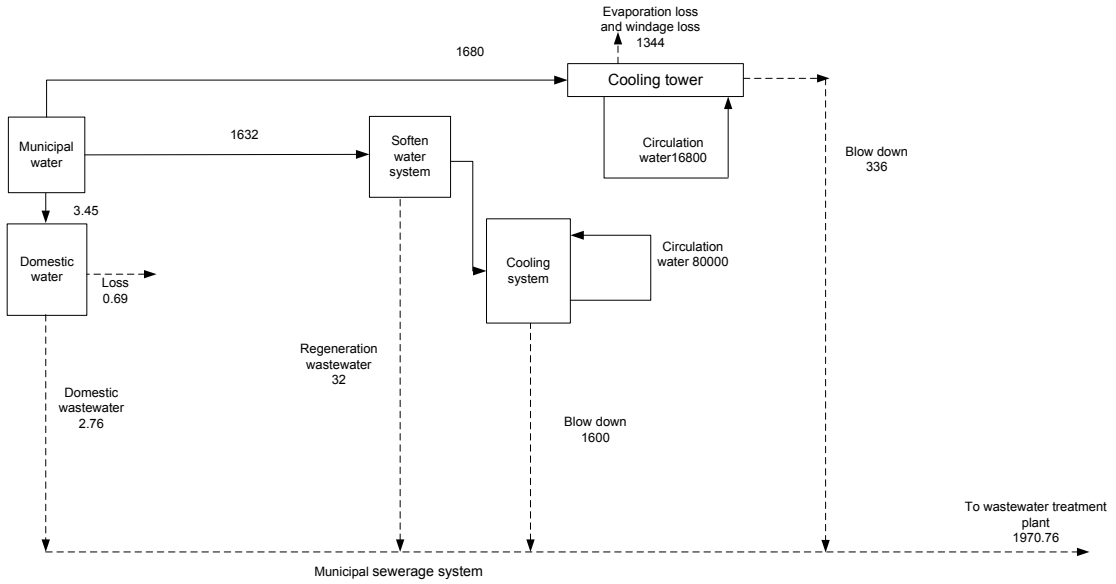
Source: Domestic FSR, 2018.

5. Water balance

106. The water balances in cooling season and heating season are presented in

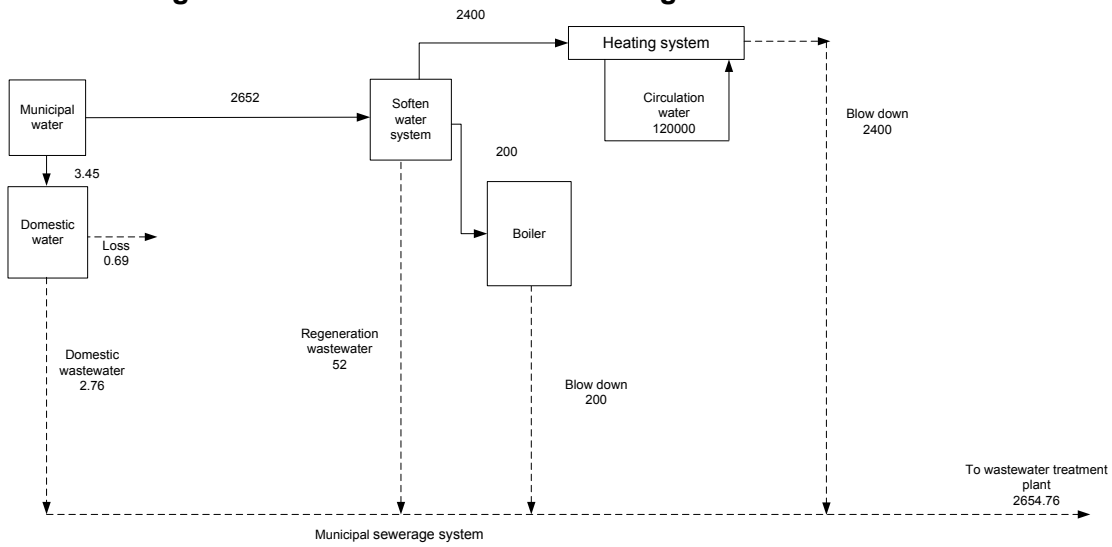
107. **Figure III-14** and **Figure III-15.**

Figure III-14: Water Balance in cooling season Unit: m^3/d



Source: Domestic EIA, 2018.

Figure III-15: Water Balance in heating season Unit: m^3/d



Source: Domestic EIA, 2018.

6. Wastewater generation and discharge

The wastewater generated during operation includes domestic wastewater, blow down of cooling towers, blow down of boilers, wastewater from district heating and cooling system and re-generation wastewater of soften water system. Based on operation data from similar projects, parameters of wastewater are presented in

108. **Table III-13** and **Table III-14**.

Table III-13: Wastewater analysis data in heating season

No.	Item	Flow (m^3/d)	COD (mg/L)	Ammonia nitrogen (mg/L)	Petroleum (mg/L)
1	Boiler blow down	200	30	15	--
2	Wastewater from soften water treatment workshop	52	150	15	--
3	Heating system blow down	2400	135	13	--
4	Domestic wastewater	2.76	200	25	20
	Total	2654.76	127.2	13.2	0.02
	Standard	NA	NA	≤500	≤20

Source: Domestic EIA, 2018.

Table III-14: Wastewater analysis data in cooling season

No.	Item	Flow (m^3/d)	COD (mg/L)	Ammonia nitrogen (mg/L)	Petroleum (mg/L)
1	Cooling tower blow down	336	30	15	--
2	Wastewater from soften water treatment workshop	32	150	15	--
3	Heating system blow down	1600	135	13	--
4	Domestic wastewater	2.76	200	25	20
	Total	1970.76	87.0	9.9	0.02
	Standard	NA	NA	≤500	≤20

Source: Domestic EIA, 2018.

109. Domestic wastewater and production wastewater will be discharged to the municipal sewerage system will be treated at the nearby WWTP. All discharge concentration of SS, COD, BOD_5 and ammonia nitrogen will be in compliance with of *Wastewater Quality Standards for Discharge to Municipal Sewers* (GB/T 31962-2015) for wastewater discharged to a municipal sewerage system.

7. Solid waste generation

110. The component will have 69 staff during operation period. Estimated domestic waste generated by the component is 3.726 tons per year.[11]

111. The component will use ion exchange resin to produce softer water which is used in boilers and cooling system as make-up water. Then the component will generate ion exchange waste resin from water softener during operation period. Based on domestic EIA, the component will change all the resin every four years and 3 tons waste resin will be generated. The waste resin is considered as hazardous waste and be collected, stored, transported and treated by a certified

[11] Based on a waste production factor of 0.2 kg/worker/day and 270 working days.

company following the PRC laws and regulations.

112. Ethylene glycol will be used as refrigerant by the component. Ethylene glycol is recognized as a general chemical based on the PRC regulations. It will be treated following the PRC requirements. Other chemicals used will also be transported, stored and disposed following the PRC requirements.

8. Environmental protection measures

113. Environmental protection measures of the component are summarized in

114. **Table III-15**.

Table III-15: Environmental protection measures

Category	Item	Measures
Wastewater	Heating and cooling system blow down	To sewage
	Boiler blow down	To sewage
	Wastewater from soften water treatment workshop	To sewage
	Cooling tower blow down	To sewage
	Domestic wastewater	To sewage
Solid waste	Waste resin	Treated by certified company
	Domestic waste	Collected and treated by local sanitary department

Source: Domestic EIA, 2018.

9. Fire protection

115. The HESs and energy centers will be in compliance with relevant PRC fire protection regulations and requirements, including the Code for Design of Buildings (GB50016-2014), and Regulation on Electric Apparatus Design for Explosion and Fire Risk Environment (GB50058-92). All risk areas will have alarm systems and automatic fire suppression systems.

116. An emergency risk and response plan will be established in accordance with the “National Environmental Emergency Plan” (24 January 2006) and other relevant PRC laws, regulations and standards. In addition, construction and operation phase EHS plans will be developed by specialists in occupational health and safety to ensure protection of workers and the surrounding community.

10. Heating and Ventilation

117. The HESs and energy centers will be equipped with cast-iron radiators for space heating. The design room temperature of the HESs and energy centers 18°C; pump rooms is 10°C. The North Energy Center and the HESs will be constructed by the developers of the Maoling Area.

Only South Energy Center is included in the component.

118. The two energy centers will be mechanically ventilated by fans. The HESs will be naturally ventilated. Noise levels of control room and electric rooms should be less than 60 dB.

11. Temporary Worker's Camps

112. Because the civil work of two energy centers and 35 HESs will be built by the developers and the component will only install equipment for them, no workers' camp is needed. For construction of the North Energy Center and 35 HESs, the developers will provide workers' camp to the workers. The workers' camp of South Energy Center will be equipped with adequate temporary sanitary facilities. Toilets will be equipped with septic tanks in accordance with the PRC standards. Domestic wastewater will be treated in the septic tanks to meet relevant national standards and discharged to the existing municipal sewer system.

119. For cooling tower installation, the workers will use existing toilets, office and dormitory in Dongxin Thermal Power Plant, no workers' camp is needed.

120. No workers' camp is needed for pipeline construction as it is done in phases and a very limited number of workers will be needed for each phase of pipe installation.

IV. DESCRIPTION OF THE ENVIRONMENT

A. Location

121. The component will be implemented at Maoling Area, Lixia District, Jinan City of Shandong Province. Jinan is located in the north-western part of Shandong province at 36°40′ northern latitude and 116°57′ east of Greenwich, about 400 kilometers south of the national capital of Beijing. It borders Liaocheng to the southwest, Dezhou to the northwest, Binzhou to the northeast, Zibo to the east, Laiwu to the southeast, and Tai'an to the south. The city occupies a transition zone between the northern foothills of the Taishan Massif to the south of the city and the valley of the Yellow River to the north. Karst aquifers in limestone formations sloping down from the south to the north give rise to many artesian springs in the city center as well as in surrounding areas.

Figure IV-1: Component site location

Source: https://en.wikipedia.org/wiki/China

B. Shandong Province Overview

Shandong is a coastal province of the PRC and is part of the East China region (

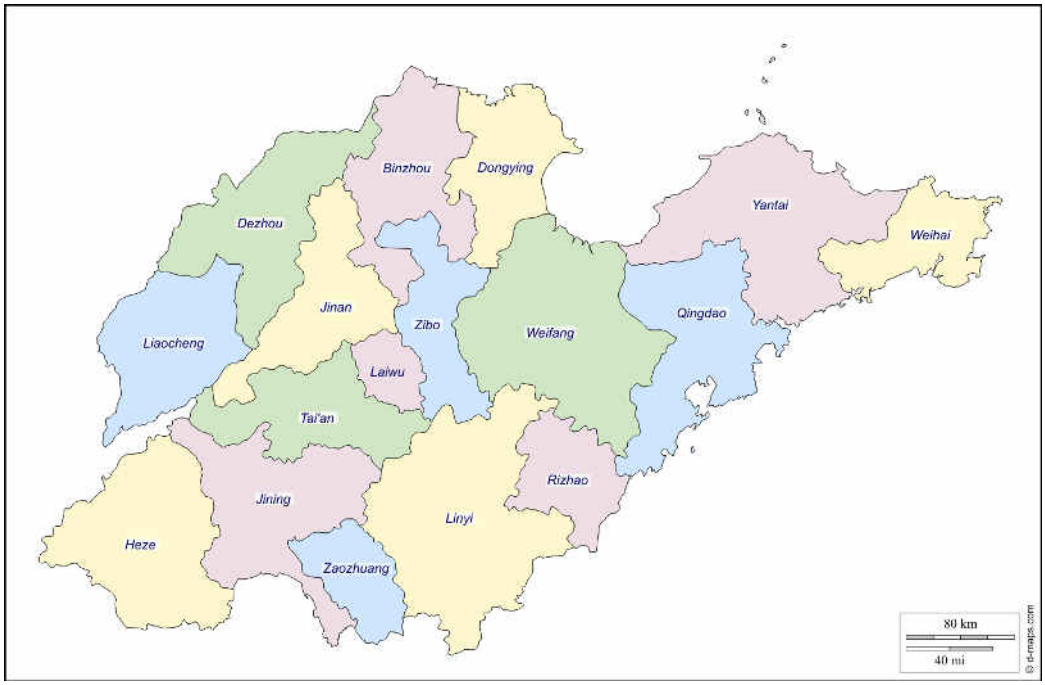
122. **Figure IV-2**). Neighboring provinces are Anhui, Hebei, Henan and Jiangsu.

Figure IV-2: Shandong Province in China

Source: https://en.wikipedia.org/wiki/Shandong

123. Shandong is divided into seventeen prefecture-level divisions including two sub-provincial cities. The seventeen prefecture-level divisions of Shandong are subdivided into 137 county-level divisions (51 districts, 28 county-level cities, and 58 counties). Those are in turn divided into 1941 township-level divisions (1223 towns, 293 townships, two ethnic townships, and 423 sub-districts).

Figure IV-3: Map of Shandong Province administrative divisions



Source: http://d-maps.com

124. In 2016, the population of the province was 99.47 million. The land area is 157,100 km^2 and the length of coastline is 3,100 km. The province has 17 municipalities and 140 counties (including county level cities and districts). Shandong has a temperate climate, with hot, rainy summers and dry, cold winters. Mean annual temperature is 10.5-13.5°C; the average temperature in July is 24-27°C, while the temperature in January is -4-1°C. Mean annual precipitation is 550-950 mm, increasing from northwest to southeast. The province is divided into four topographical zones: (i) Northwestern Shandong Plain, formed by deposits of the Yellow River; (ii) Jiaolai Plain, between central-south Shandong and Jiaodong hilly regions, bounded by bays in the north and south and traversed by the Jiaolai, Weihe and Dagu rivers; (iii) Central-South Shandong hilly area, with elevations >1,000 m above sea level (ASL); and (iv) Jiaodong Hilly Area, the main part of the Shandong Peninsula.

125. Shandong ranks first among PRC provinces in the agriculture production of a variety of products, including cotton and wheat. Other important crops include tobacco, sorghum and maize, as well as peanuts, for which the province is especially well-known, producing nearly a quarter of the country's total. Shandong is also a significant producer of fruits. The province also has extensive deposits of natural gas, iron, diamonds, gold, and bauxite deposits. In 2017, Shandong ranked the third largest provincial economy, contributing 8.79% of the country's total GDP. In 2017, the total GDP of the province was CNY 7.2678.18 trillion and per capita GDP was CNY 72,851.

126. Shandong is one of the leading provinces driving the economic development in the PRC. However, it is facing increasing pressure to reduce its energy consumption and emissions in light of PRC's objective for achieving 40%–45% carbon intensity reduction by 2020 compared to 2005 levels. Shandong was included in the first three provinces to implement province-wide circular economy.

127. The Yellow River passes through Shandong's western areas, entering the sea along Shandong's northern coast; in its traversal of Shandong it flows on a levee, higher than the surrounding land, and dividing western Shandong into the Hai River watershed in the north and the Huai River watershed in the south. The Grand Canal of China enters Shandong from the northwest and leaves on the southwest. Weishan Lake is the largest lake in the province. Shandong Peninsula has a rocky coastline with cliffs, bays, and islands; the large Laizhou Bay, the southernmost of the three bays of Bohai Sea, is located to the north, between Dongying and Penglai; Jiaozhou Bay, which is much smaller, is to the south, next to Qingdao. The Miaodao Islands extend northwards from the northern coast of the peninsula.

128. The province has 30.58 billion m^3 of water resources and 307.4 m^3 per capita in 2016. Based on the standard of water quantity for municipal residential use in Shandong, daily average water consumption per capita is 85-120 l/d. Water resources in Shandong can just meet the requirements. The groundwater resources of Shandong are large, but are being exploited at an unsustainable rate. The demand for groundwater resources will continue to increase in the future with rising population and higher temperatures predicted in climate change scenarios.

C. Site Physical Resources

Topography. Jinan City occupies a transition zone between the northern foothills of the Taishan Massif to the south-southeast of the city and the Yellow River Valley to the north and northwest. Karst aquifers in limestone formations sloping down from the south to the north give rise to many artesian springs in the city center as well as in surrounding areas. Within the component area the topography is generally flat, sloping slightly downwards from the east to the west and from the southern foothills north to the Yellow River (

129. **Figure IV-4**).

Figure IV-4: Jinan topography

Source: Google map, 2018

130. **Geology and seismicity**. According to domestic EIA, the stratigraphic structure of the component area is simple and stable, without unfavorable geological processes, and is therefore suitable for the component construction.

131. The PRC classifies seismic intensity into 12 grades under the China Seismic Intensity Table (GB/T 17742-2008), based on the severity of "shaking" of the earth surface and the extent of potential impact. According to the China Seismic Ground Motion Parameters Zoning Map (GB18306-2001, Amendment 1), the seismic intensity in the component area is Grade 6, with a design peak ground acceleration of 0.05 g, a 10% probability of exceedance in 50 years, and a return period of 475 years.

132. According to the domestic EIA, the component site is class II under the Code for Seismic Design of Buildings (GB50011-2010), applicable to medium dense and loose gravel, dense and medium dense coarse and sands, and clays with a bearing capacity >250 kPa. The component site is thus considered as suitable for construction activities, and there is no significant risk of potential disasters like landslides, mud flows, land subsidence or geological faults.

133. **Land use.** The component site is in developing urbanized commercial and residential area,

and is predominantly in existing road right-of-ways.

134. **Hydrology.** Jinan lies on the south shore of the Yellow River, and it is the main river in Jinan. With an estimated length of 5,464 km, the Yellow River is the second-longest river in Asia, and the sixth-longest river system in the world. It originates in the Bayan Har Mountains in Qinghai province of western China, then it flows through nine provinces and enters into the Bohai Sea near Dongying in Shandong province. It has a watershed area of 742,443 km^2. The Xiaoqing River is the other main river in Jinan and is the main river near the component site. Originating west of Jinan, it is 220 km long and has a watershed area of 10,336 km^2. It flows south of, and roughly parallel to, the Yellow River, in Jinan passing through Huaiyin, Tianqiao, and Licheng Districts, and also enters into the Bohai Sea. It is fed by a series of tributaries flowing north through the urban areas of Jinan. In recent years it has become contaminated as a result of industrial wastewater and domestic sewage discharges.

135. **Hydrogeology.** The ground near the component site is pore phreatic water in loose rock mass. The ground water at the depth from 0-2,000 m can be divided into shallow freshwater (0-60 m), middle level saltwater (60 – 200 m) and deep freshwater (200- 2,000 m).

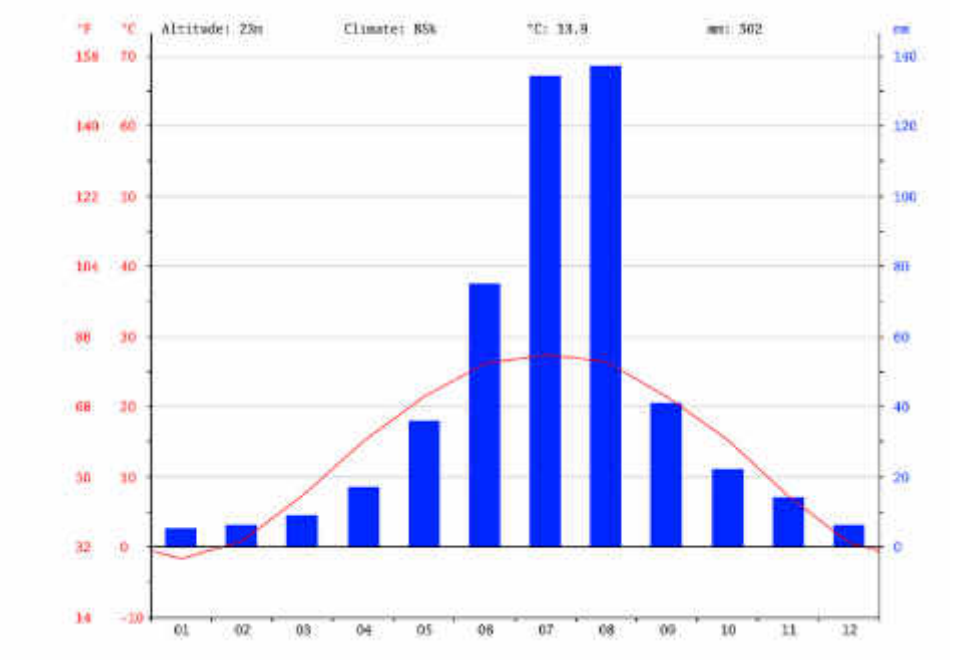
136. **Meteorology and Climate.** Jinan has a temperate continental climate with four distinct seasons. It is dry in the spring, hot and rainy in the summer, cool in the autumn, and dry and cold in the winter. The average annual temperature in Jinan is 16.6°C, the average summer average temperature is 26°C and the maximum recorded summer temperature was 42.7°C. The average temperature in the 4 coldest months of winter is below 0°C, and the lowest maximum recorded temperature is -19.5°C (**Figure IV-5**).

137. The average annual precipitation is 685 mm, with a recorded maximum of 1,160 mm and a minimum of 320.7 mm. In winter months, precipitation is low (average 20 mm–25 mm/month), and majority of precipitation occurs during the summer months. Average annual average humidity is 58%. The dominate wind direction is from the southeast (**Figure IV-6**).

138. **Sunshine and humidity.** Sunshine hours of Jinan in 2016 were 2,617 hours, or 60.6% of the annual daytime hours.

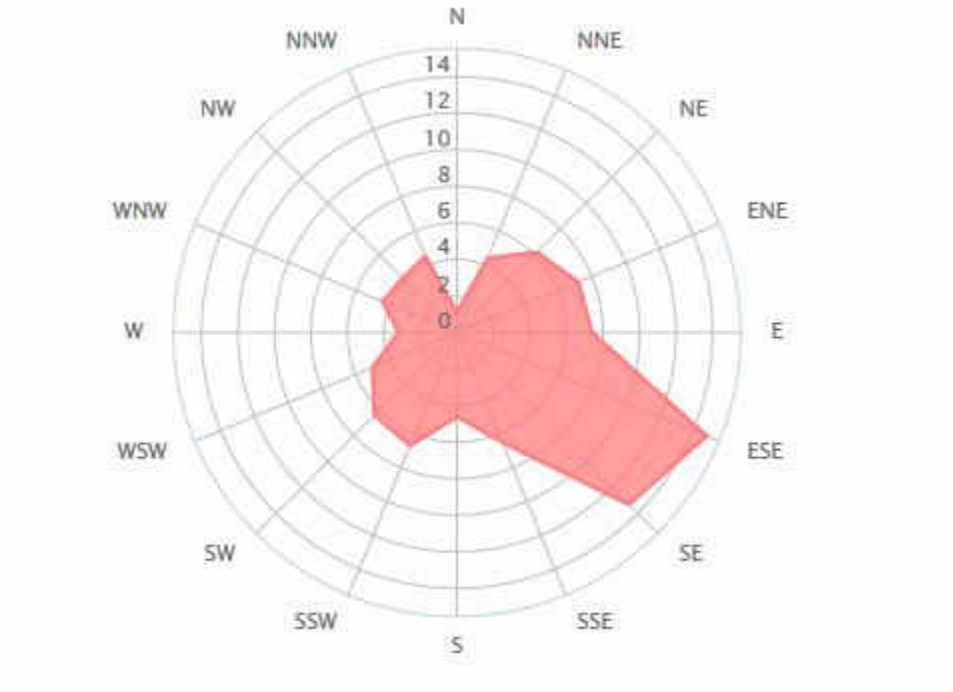
139. **Frost-free Days.** There is an average of 178 frost free days per year. The first frost typically occurs in the first 10 days of October, and the last frost day is typically in the first 10 days of March.

Figure IV-5: Average Temperature Profile of Jinan



Source: https://en.climate-data.org/location/2259/

Figure IV-6: Jinan Wind Rose



Source: https://www.windfinder.com/windstatistics/jinan

140. **Surface water - rivers and reservoirs**. Surface water resource in the component area is presented in **Figure IV-7**. Jinan lies on the south shore of the Yellow River and south of Tuhai River. Yellow River, Daming Lake and Xiaoqing River are the main rivers in the component area.

141. With an estimated length of 5,464 km, the Yellow River is the second-longest river in Asia, and the sixth-longest river system in the world. It originates in the Bayan Har Mountains in Qinghai province of western China, it flows through nine provinces, and it empties into the Bohai Sea near Dongying in Shandong province. It has a watershed area of 742,443 km^2.

142. The Xiaoqing River is the other main river in Jinan and is the main river near the component site. Originating west of Jinan, it is 220 km long and has a watershed area of 10,336 km^2. It flows south of, and roughly parallel to, the Yellow River, in Jinan passing through Huaiyin, Tianqiao, and Licheng Districts, and also enters into the Bohai Sea

143. Water reservoirs for drinking water in Jinan include the Queshan, Yuqing, Wohushan, Langmaoshan and Jinxiuchuan. The nearest reservoir is Queshan reservoir which is about 11.0 km away from the component site in northwest direction.

Figure IV-7: Water resources in the component area

Source: Google map and domestic EIA

144. **Groundwater and springs.** Jinan is well known for its artesian karst springs and lakes and is referred to as the Spring City. Daming Lake, located in the historical city center, is the largest lake in Jinan, and one of the city's main natural and cultural landmarks. Fed by the artesian karst springs, the lake maintains a fairly constant water level and temperature throughout the entire year. Other key karst artesian springs include Batou, Heihu, Wulong and Zhenzhu, and in total there are more than 70 named springs in Jinan. There are no reservoirs or springs in the component site and the nearest spring is Baotu Spring which is about 5 km away in west direction.

145. Annual average surface water resource of Jinan City in 2017 is 1,158 million m^3 and underground freshwater resource is 958 million m^3. The total water resource is 2,116 million m^3. The total water resource is 1,674.5875 million m^3. The per capita water resource is only 292 m^3.[12] Based on the standard of water quantity for municipal residential use in Shandong, daily average water consumption per capita is 85-120 l/d. Water resources in Jinan can just meet the requirements.

D. Ambient environment baseline and environmental monitoring

146. **Baseline data.** According to Jinan's Environmental Quality Bulletin (2017), urban air quality in Jinan has improved compared with 2016, but pollution levels remain high. The quality of drinking water sources is good but surface water quality has slightly improved. The acoustic environmental quality is relatively good and biological environment is ordinary.

1. Air Quality Monitoring

Air quality index. MEE monitors air pollution in cities throughout the PRC and presents the results in an Air Quality Index (AQI) based on the level of 6 pollutants (

[12] Jinan Water Affairs Bureau, 2017. The 2016 Bulletin on the Jinan Water Resource. Jinan.

147. **Figure IV-8**).

148. The AQI was introduced in 2012 and replaces the old Air Pollution Index (API). The MEE measures airborne pollution using AQI. The AQI is based on the concentration levels of six major atmospheric pollutants: SO_2, NO_2, PM_{10}, carbon monoxide (CO), ozone (O_3), and $PM_{2.5}$. The AQI is employed at monitoring stations in 367 cities across the nation.

149. The MEE measures and assigns an individual air quality score (IAQI) to each of the six pollutants over a period of one, eight, or 24 hours. A city's final AQI is the highest of those six scores with that particular pollutant being the city's major pollutant. When the index is lower than 50, the ministry does not name the major pollutant. The AQI ranges from zero to over 300.

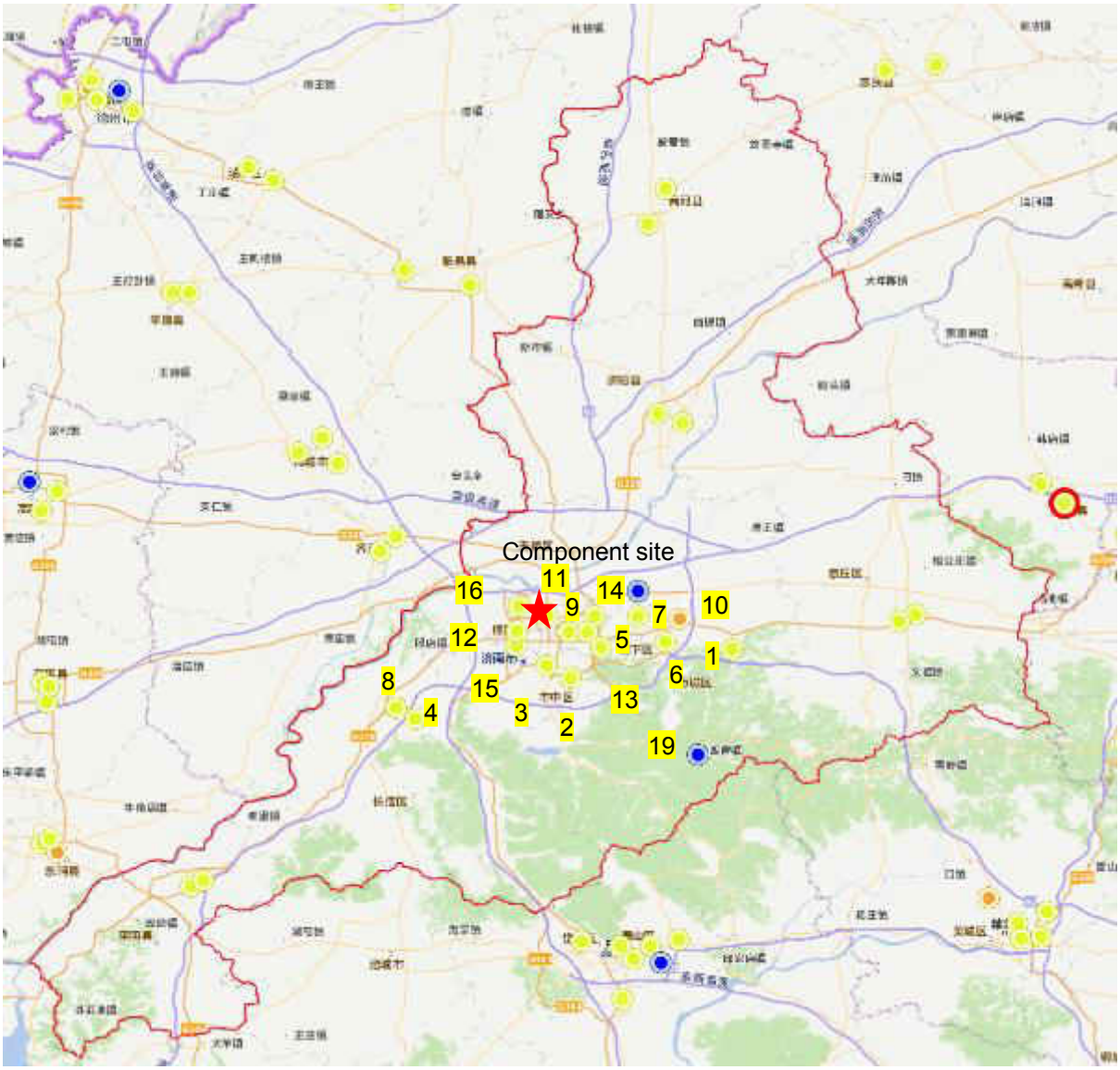
Figure IV-8: The PRC's Air Quality Index (AQI) System

AQI	Air Pollution Level	Health Implications
0–50	Excellent	No health implications.
51–100	Good	Few hypersensitive individuals should reduce outdoor exercise.
101–150	Lightly Polluted	Slight irritations may occur, individuals with breathing or heart problems should reduce outdoor exercise.
151–200	Moderately Polluted	Slight irritations may occur, individuals with breathing or heart problems should reduce outdoor exercise.
201–300	Heavily Polluted	Healthy people will be noticeably affected. People with breathing or heart problems will experience reduced endurance in activities. These individuals and elders should remain indoors and restrict activities.
300+	Severely Polluted	Healthy people will experience reduced endurance in activities. There may be strong irritations and symptoms and may trigger other illnesses. Elders and the sick should remain indoors and avoid exercise. Healthy individuals should avoid out door activities.

Source: Li and Dong-Jun Liu (2014) and http://multimedia.scmp.com/china-air-pollution-in-2014/

150. **Air quality in Jinan City**. There are 21 automatic air quality monitoring stations in Jinan City, 14 of them are in the urban area (**Figure IV-9**). Pollutants monitored in the stations include PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO, and O_3. Summary data on stations and monitoring results for 2017 are presented in **Table IV-1**.

Figure IV-9: Location of Jinan EPB Automated Continuous Air Quality Monitoring Stations



Source: Jinan EPB, 2018.

Table IV-1: Air Quality Index and Annual Mean Ambient Air Quality at Monitoring Stations in Jinan City, 2017. (Unit: μg/m^3, excluding CO)

No.	Station name	District	No. of Good AQI days[13]	PM_{10}	$PM_{2.5}$	SO_2	NO_2	CO (mg/m^3)	O_3 (8 hours)
1	Business, Vocational & Technical College	Licheng	196	93	53	28	28	2.0	215
2	Shandong Luneng	Shizhong	220	122	57	19	36	1.7	171

[13] Good AQI days mean the AQI is no more than 100.

3	Cadre's Sanitarium	Shizhong	220	121	59	19	39	1.8	172
4	Changqing college town	Changqing	178	99	56	24	45	1.9	216
5	Economic college	Lixia	192	114	60	20	38	2.1	204
6	Experimental school	High Tech Zone	224	133	60	28	46	2.0	152
7	Development zone	High Tech Zone	176	117	57	29	43	2.1	217
8	Party school	Changqing	167	121	63	28	44	1.9	200
9	Quancheng square	Lixia	204	131	63	25	45	2.1	174
10	Building engineering school	Licheng	187	127	57	29	51	2.2	202
11	Jinan Chemical Factory	Tianqiao	202	125	60	25	62	2.1	163
12	Agricultural Science Institute	Huaiyin	162	149	62	23	49	2.3	194
13	Provincial seed warehouse	Licheng	158	133	69	27	51	2.4	189
14	Municipal monitoring station	Lixia	153	131	70	29	51	2.1	219
15	The 2nd machine tool factory	Huaiyin	138	144	76	25	51	2.4	202
16	Lanxiang Vocational School	Tianqiao	135	151	77	28	53	2.4	190
17	Jinan Baosheng	Licheng	—	—	—	—	—	—	—
18	Jinan City	—	186	130	63	25	46	2.1	190
19	Paomaling	Changqing	262	81	44	22	17	1.0	172
20	Jinping middle school	Lixia	234	125	55	18	42	1.8	158
21	City Museum	Lixia	197	112	59	27	27	2.3	196
22	Western urban area	Huaiyin	156	142	64	24	44	2.2	207

Note: 1. Shading denotes exceedance of relevant standard (Class II of Ambient Air Quality Standard GB3095-2012).

2. Because Jinan Baosheng station was stopped operation from October 2017, annual data is not available.

151. Among 21 stations, Station 1, Station 2 and Station 3 rank top three while Station 14, Station 15 and Station 16 rank last three. Station 14 is the nearest station to proposed component site and the distance is around 5.5 km.

152. In 2017, average daily concentrations of PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO, and O_3 in Jinan were 130 μg/m^3, 63 μg/m^3, 25 μg/m^3, 46 μg/m^3, 2.1 mg/m^3 and 190 μg/m^3, respectively (**Table IV-2**). Of these, the concentrations of PM_{10}, $PM_{2.5}$, NO_2, and O_3 exceeded the National Ambient Air Quality Standard (GB3095-2012) by 0.86, 0.80, 0.15 and 0.19 times, while the concentrations of sulfur dioxide and carbon monoxide met the PRC standard. The concentrations of O_3, CO and NO_2 are slightly increased compared to 2016, while concentrations of PM_{10}, $PM_{2.5}$ and sulfur dioxide, are decreased by 7.8%, 13.47% and 34.2%, respectively.

Table IV-2: 24-hour Mean Ambient Air Quality in 2017 Jinan City Urban Area (unit: μg/m^3, excluding CO)

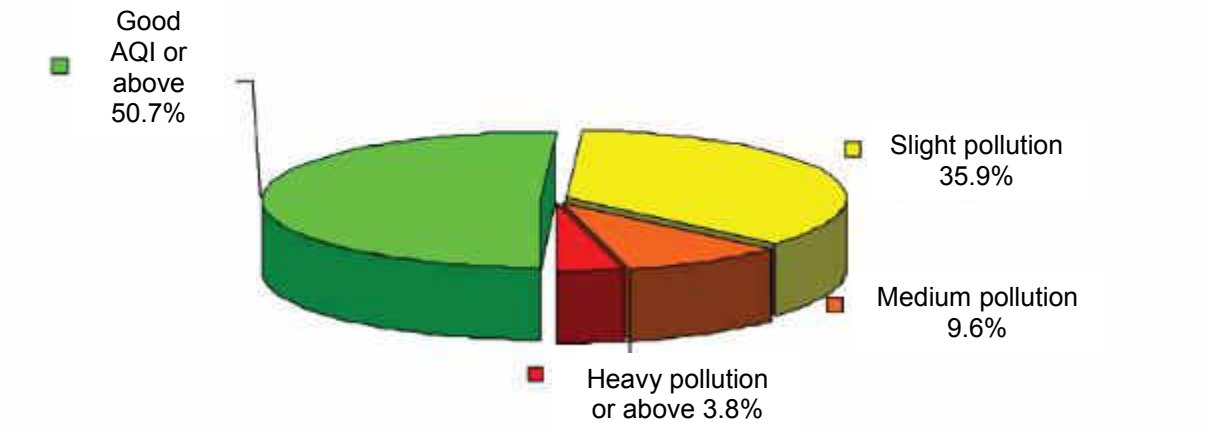
No.	Item	PM_{10} (μg/m^3)	$PM_{2.5}$ (μg/m^3)	SO_2 (μg/m^3)	NO_2 (μg/m^3)	CO (mg/m^3)	O_3 (8 hours)
1	Range of 24-hr mean concentrations	15-504	10-266	7-99	15-103	0.4-5.9	6-275
2	Samples exceeding the standard, %	27.1%	27.4%	0	3.0%	0.8%	19.5%
3	Annual mean concentration	130	63	25	46	2.1	190
4	Ratio of average 24-hr concentration exceedance of standard	0.86	0.80	In compliance	0.15	In compliance	0.19
5	Change compared to 2016, %	-7.8%	-13.47%	-34.2%	2.2%	5.0%	1.1%
6	24-hr mean standard (GB3095-2012)	150	75	150	80	4	160
7	Annual mean standard (GB3095-2012)	70	35	60	40	—	—

Source: Jinan Environmental Quality Bulletin (2017).

In 2017, Jinan had 186 days with a Good AQI level, an increase of 22 days over 2016. 14 days were Heavily Polluted or Severely Polluted AQI level, a decrease of 4 days compared to 2016. The frequency distribution of all levels of AQI in 2017 is presented in

153. **Figure IV-10**.

Figure IV-10: AQI Levels in Jinan, 2017

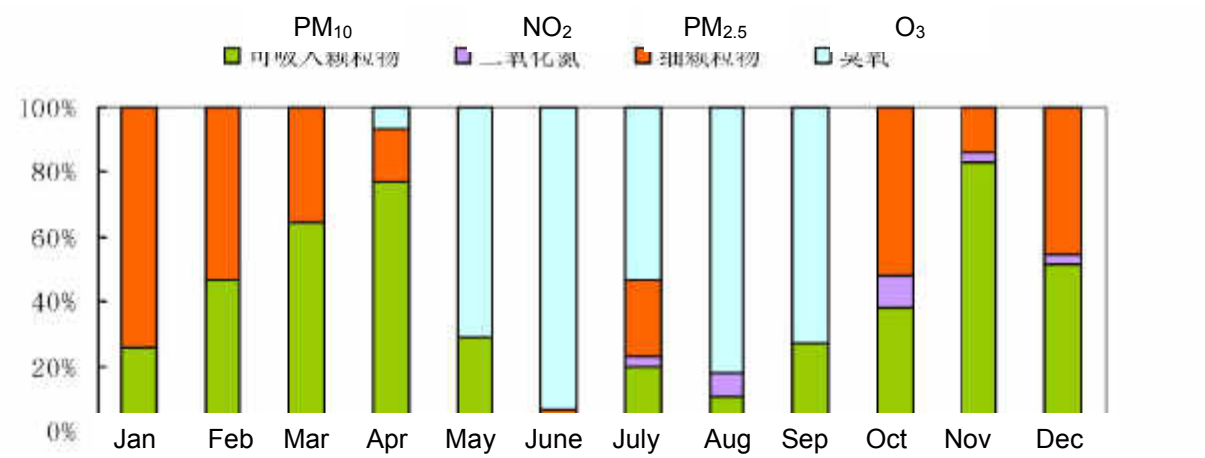


Source: Jinan Environmental Quality Bulletin (2017).

In 2017, PM_{10}, $PM_{2.5}$ and O_3 were identified as primary pollutants on 141, 96 and 122 days respectively. Fine particulates are more frequently primary pollutants in the heating season (November to February) due to coal-based heating, and less so in the summer. O_3 is generally identified as the primary pollutant from May to September, with the highest level in June (

154.).

Figure IV-11: Distribution of Primary Pollutants in Jinan, 2017



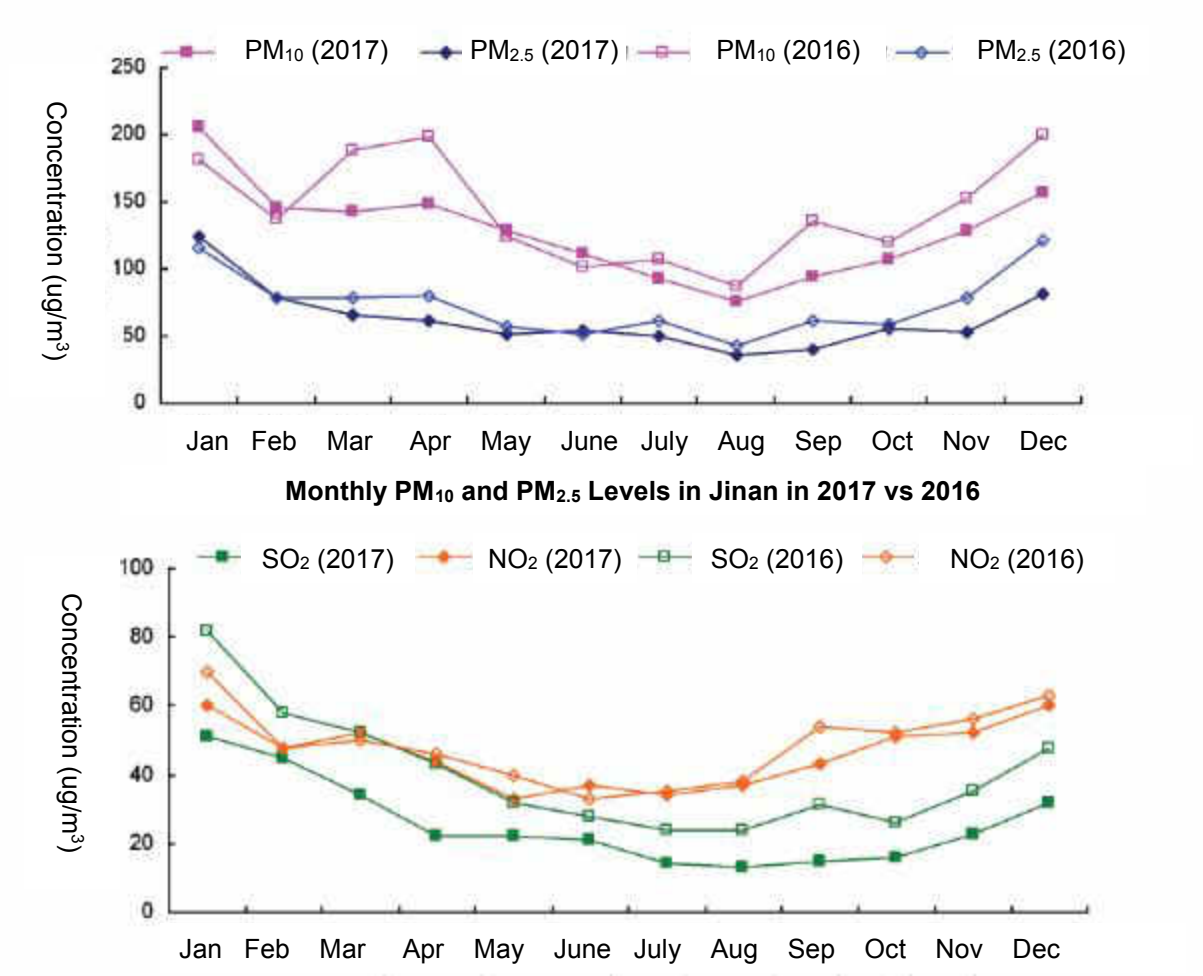
Source: Jinan Environmental Quality Bulletin (2017).

155. In 2017, MEE ranked Jinan's AQI tenth from the bottom of a list of 74 key environmental protection key cities.

156. **Monthly variation of pollutants.** Pollutant levels in Jinan vary substantially over a year, with concentrations typically being higher during the winter heating season and lower in the summer. In 2017 the monthly average concentration of PM_{10} in the worst month (January) was 2.71 times higher than in the lowest month (August). Similarly, the monthly average concentration of $PM_{2.5}$ in January was 3.44 times that of the month with lowest average concentration (August). The monthly average concentration of SO_2 in the worst month (January) was 3.92 times higher than in the lowest months (August), and the monthly average concentration of NO_2 in the worst month (January and December) was 1.82 times higher than in the lowest month (May).

157. Compared with 2016, PM_{10} concentrations in Jinan in 2016 were higher in January, February and June, consistent in May, and lower in the remaining months; $PM_{2.5}$ concentrations were higher in January, consistent in February, June and October and lower in the remaining months; SO_2 concentrations were lower in all twelve months; and NO_2 concentrations were lower in the January, May and September and consistent in remaining months (**Figure IV-12**).

Figure IV-12: Average Monthly Concentration of $PM_{2.5}$, PM_{10}, SO_2 and NO_2 in 2016 and 2017

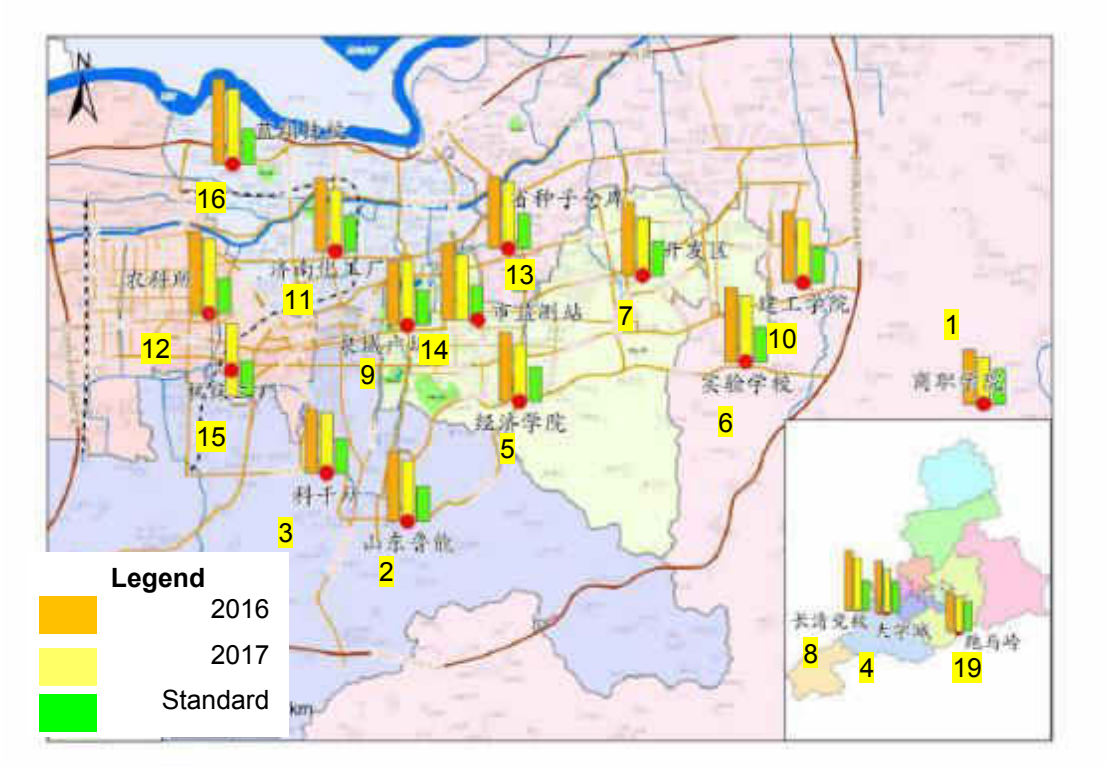


Source: Jinan Environmental Quality Bulletin (2017).

158. **Spatial variation of pollutants.** According the Jinan Environmental Bulletin, in 2017 the annual average concentration of PM_{10} exceeded the Class II annual standard (Ambient Air Quality Standard GB3095-2012) at all monitoring stations and was highest in west and northwest and lowest in the southeast (**Figure IV-13**). The annual average concentration of PM2.5 exceeded the Class II annual standard at all monitoring stations and was highest in northwest and southwest and central core area, and lowest in the southeast (**Figure IV-14**).

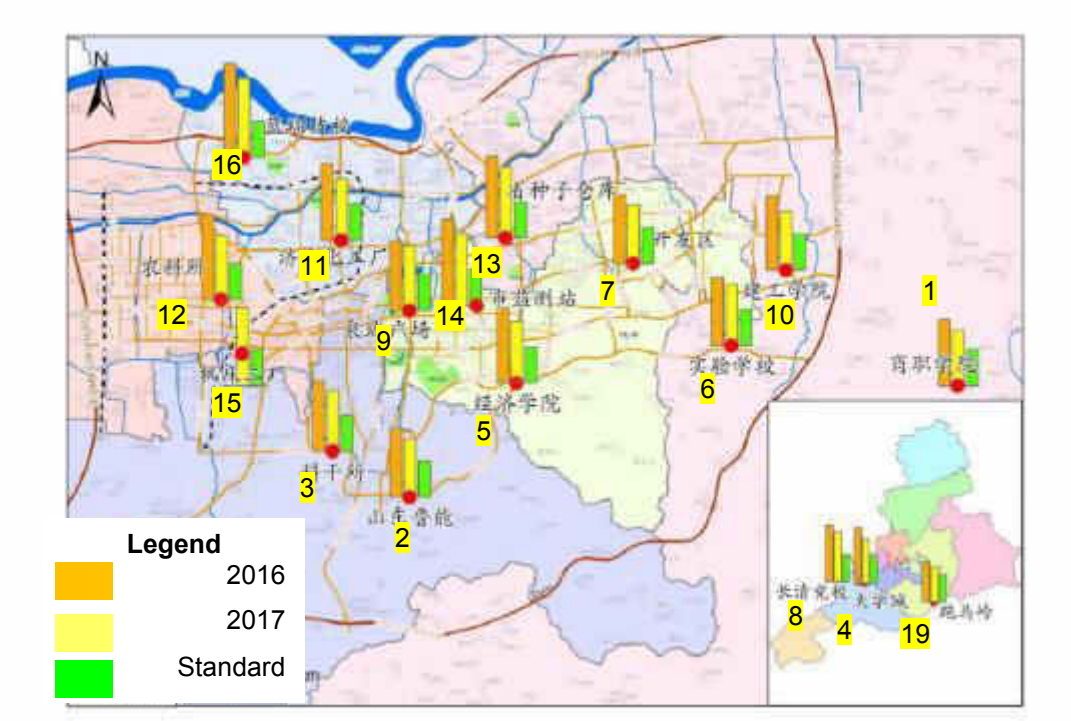
159. The annual average concentration of SO_2 met the Class II annual standard at all monitoring stations and was highest in the east and central core area, and lowest in the south (**Figure IV-15**). The annual average concentration of NO_2 exceeded the Class II annual standard at all monitoring stations except station 1, 2, 3 and 5 and was highest in the northwest and central core area, and lowest in the southeast (**Figure IV-16**).

Figure IV-13: Average Annual Concentrations of PM_{10} at National, Provincial, and Municipal Monitoring Stations in Jinan City urban area, 2016 and 2017



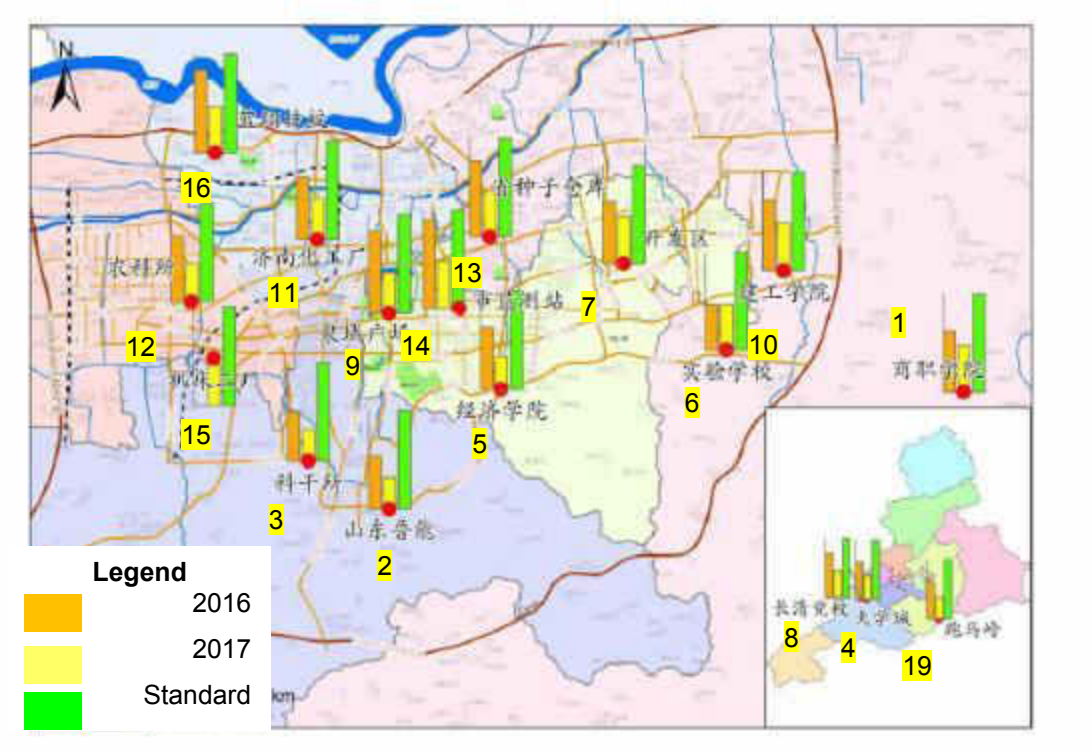
Source: Jinan Environmental Quality Bulletin (2017).

Figure IV-14: Average Annual Concentrations of $PM_{2.5}$ at National, Provincial, and Municipal Monitoring Stations in Jinan City urban area, 2016 and 2017



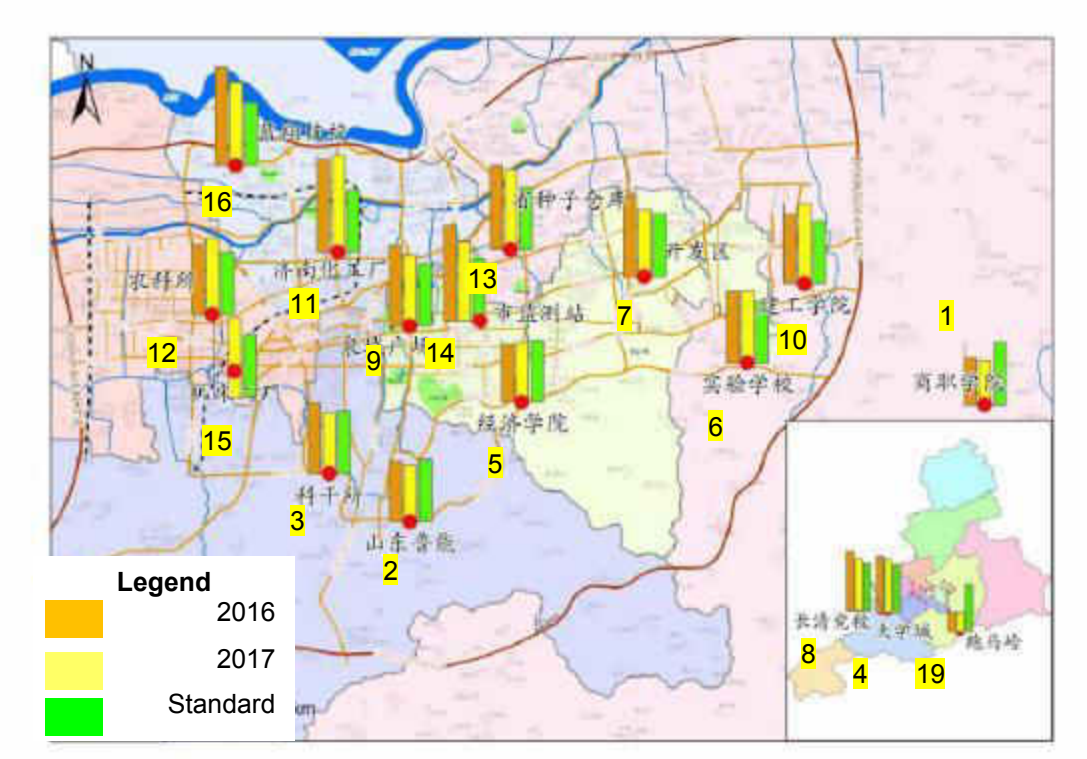
Source: Jinan Environmental Quality Bulletin (2017).

Figure IV-15: Average Annual Concentrations of SO_2 at National, Provincial, and Municipal Monitoring Stations in Jinan City urban area, 2016 and 2017



Source: Jinan Environmental Quality Bulletin (2017).

Figure IV-16: Average Annual Concentrations of NO_2 at National, Provincial, and Municipal Monitoring Stations in Jinan City urban area, 2016 and 2017



Source: Jinan Environmental Quality Bulletin (2017).

2. Haze

160. In 2017, 153 days were considered to be hazy, of which 76.5% were slightly hazy, 16.3% were mildly hazy, 2.6% were medium hazy, and 4.6% were seriously hazy. During hazy days, the average concentrations of PM_{10}, $PM_{2.5}$, SO_2 and NO_2 were 160 μg/m^3, 90 μg/m^3, 29 μg/m^3, and 54 μg/m^3. SO_2 was in compliance with Class II annual standard (Ambient Air Quality Standard GB3095-2012), and the PM_{10}, $PM_{2.5}$ and NO_2 exceeded the PRC standard by 1.29 times, 1.57 times and 0.35 times, respectively.

161. During hazy days the average concentrations of PM_{10}, $PM_{2.5}$, SO_2 and NO_2 are 48.1%, 104.5%, 26.1%, and 35.0% higher than concentrations in non-hazy days. The data is presented in **Table IV-3**.

Table IV-3: Ambient Air Quality data in hazy and non-hazy days (unit: μg/m^3, excluding CO)

Weather	Item	PM_{10}	$PM_{2.5}$	SO_2	NO_2	CO (mg/m^3)	O_3 (8 hours)
Hazy	Concentration	160	90	29	54	2.5	152
	Exceedance of standard, %	1.29	1.57	In compliance	0.35	In compliance	In compliance
	Concentration	1.08	44	23	40	1.2	206

Non-hazy	Exceedance of standard, %	0.54	0.26	In compliance	In compliance	In compliance	0.29
Annual mean standard (GB3095-2012)		70	35	60	40	4	160

Source: Jinan Environmental Quality Bulletin (2017).

162. Of the 21 provincial and municipal automatic air quality monitoring stations in the Jinan City, 14 are in the main urban area, Station 16 is the nearest station to proposed component site and the distance is around 5 km.

163. As part of the domestic EIA process, baseline environmental monitoring was conducted at eight locations near component site (

Figure IV-17 and **Table IV-4**). Monitoring was undertaken continuously over a 7 days period from March 3 to 9, 2018 (during the heating season) for CO, SO_2 and NO_2 (1-hour average concentrations), and TSP, PM_{10}, $PM_{2.5}$, SO_2 and NO_2 (24-hour average concentration). The monitoring methods are presented in

Table IV-5 .Meteorological parameters such as wind direction, wind speed, air temperature, barometric pressure and cloud cover were also monitored. The meteorological parameters are presented in

164. **Table IV-6**.

Table IV-4: Air quality monitoring locations

No.	Location	Direction	Distance from the boundaries of Maoling Area (m)	Description
1	Zhongtie Community	E	200	Sensitive receptor at down wind direction of prevailing wind direction
2	Wenbojiayuan	S	250	Sensitive receptor at down wind direction of prevailing wind direction
3	Shandong Human Resource Department	S	220	Sensitive receptor
4	Haixin Community	W	400	Nearby sensitive receptor
5	Xinxinjiayuan Community	N	350	Sensitive receptor at up wind direction of prevailing wind direction
6	Xinchengyuan Community	NW	550	Sensitive receptor at up wind direction of prevailing wind direction
7	Wanke Community	NE	750	Nearby sensitive receptor
8	Huaxiannanyuan Community	N	980	Nearby sensitive receptor
9	Maolinghuayuan Community	W	300	Nearby sensitive receptor

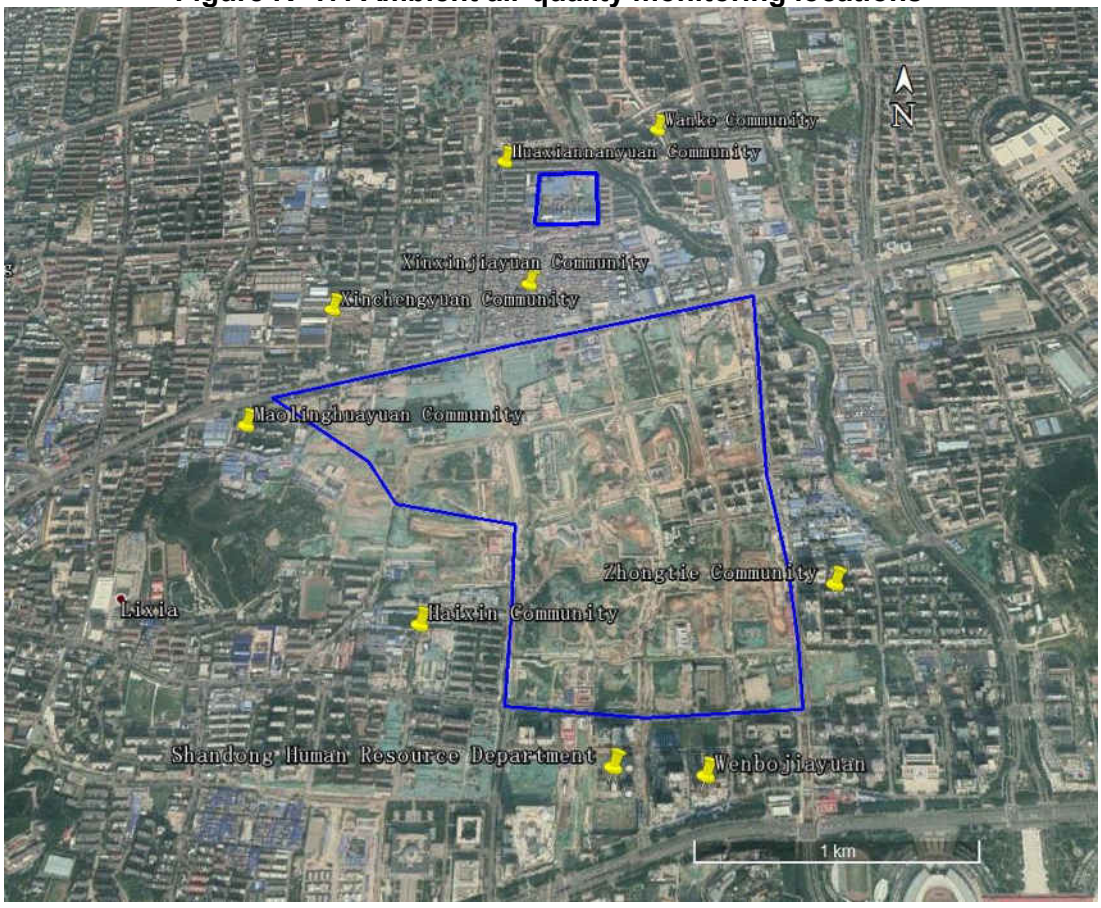
Source: Domestic EIA (2018).

Table IV-5: Air quality monitoring methods

Pollutants	Reference standard	Method	Detection limit
SO2	HJ/T482-2009	Formaldehyde absorbing-pararosaniline spectrophotometric method	1-hour mean: 0.007 mg/m^3 24-hour mean: 0.004 mg/m^3
NO_2	HJ/T479-2009	Saltzman method	1-hour mean:0.005 mg/m^3 24-hour mean:0.003 mg/m^3
TSP	GB/T15432-1995	Gravimetric method	0.001mg/m^3
PM_{10}	HJ 618-2011	Gravimetric method	0.010 mg/m^3
$PM_{2.5}$	HJ 618-2011	Gravimetric method	0.010 mg/m^3

Source: Domestic EIA (2018).

Figure IV-17: Ambient air quality monitoring locations



Source: Domestic EIA and Google earth (2018).

Table IV-6: Meteorological parameters of air quality monitoring

Date		Temperature (°C)	Barometric pressure (hPa)	Wind speed (m/s)	Wind direction	Total cloud/low cloud
04.04	02:00	12.1	1021.3	2.2	SE	2/2
	08:00	12.0	1023.7	1.3	SW	10/0
	14:00	16.3	1027.2	1.6	SE	5/4
	20:00	11.7	1021.9	2.7	SE	8/4
04.05	02:00	5.7	1010.7	2.0	MW	1/1
	08:00	9.0	1012.6	1.9	NE	0/0
	14:00	15.9	1013.6	2.0	SW	0/0
	20:00	15.0	1017.2	2.3	SW	1/1
04.06	02:00	11.9	1022.3	0.9	NW	0/0
	08:00	12.0	1021.2	1.2	NE	6/5
	14:00	18.7	1019.8	0.8	NW	5/5
	20:00	15.0	1029.7	1.3	NE	7/3
04.07	02:00	12.0	1019.9	3.2	SW	1/1
	08:00	12.3	1021.2	2.7	SE	0/0
	14:00	22.0	1022.2	0.9	SE	5/4
	20:00	17.0	1019.3	1.3	SW	3/2
04.08	02:00	15.9	1022.3	1.9	SW	1/1
	08:00	13.8	1023.1	2.7	SW	1/1
	14:00	23.7	1021.7	3.9	SE	0/0
	20:00	19.2	1022.3	1.9	SE	2/2
04.07	02:00	17.2	1012.9	2.2	SE	6/5
	08:00	16.8	1013.7	3.0	NE	2/2
	14:00	20.7	1016.9	1.9	NW	7/4
	20:00	19.0	1020.2	1.6	NW	2/2
04.10	02:00	16.2	1009.1	1.6	NW	5/3

08:00	15.9	1015.7	2.3	NW	6/5
14:00	21.0	1019.2	1.3	NW	2/2
20:00	16.2	1020.7	2.7	NE	1/1

Source: Domestic EIA (2018).

The monitoring results are presented in **Table IV-7** and summarized in

165. **Table IV-8**. The data show that all 24-hour average SO_2, NO_2 concentrations and 1-hour average SO_2, NO_2, PM_{10} and $PM_{2.5}$ concentrations were in compliance with the relevant PRC ambient air quality standard, Class II of *Ambient Air Quality Standards (*GB3095-2012). 24-hour average PM_{10}, $PM_{2.5}$ and TSP concentrations were not in compliance with relevant PRC standard. 71.4% of $PM_{2.5}$, 56.3% of PM_{10} and 42.2% of TSP 24-hour concentrations exceeded relevant standard and the worst case $PM_{2.5}$, PM_{10} and TSP concentration were 1.67, 1.39 and 1.19 times of relevant standard respectively.

166. The results show that air quality in the component area is poor, with 24-hour mean concentrations of PM_{10}, $PM_{2.5}$ and TSP exceeding PRC standards

Table IV-7: Air quality monitoring results (mg/m^3)

No.	Item	Sample No.		1-hour mean concentration rage	24-hour mean concentration rage	Exceedance of standard, %	
		1-hour mean	24-hour mean			1-hour mean	24-hour mean
1	SO_2	28	7	0.024 - 0.082	0.035-0.056	0	0
	NO_2	28	7	0.018-0.048	0.032-0.042	0	0
	CO	28	—	1.0-3.7	—	0	—
	$PM_{2.5}$	—	7	—	0.055-0.124	—	64.3
	PM_{10}	—	7	—	0.134-0.191	—	53.6
	TSP	—	7	—	0.205-0.34	—	57.1
2	SO_2	28	7	0.029-0.115	0.056-0.069	0	0
	NO_2	28	7	0.022-0.065	0.030-0.057	0	0
	CO	28	—	1.0-3.8	—	0	—
	$PM_{2.5}$	—	7	—	0.065-0.116	—	57.1
	PM_{10}	—	7	—	0.102-0.195	—	42.9
	TSP	—	7	—	0.234-0.344	—	60.7
3	SO_2	28	7	0.022-0.082	0.035-0.062	0	0
	NO_2	28	7	0.025-0.067	0.029-0.053	0	0
	CO	28	—	0.4-3.4	—	0	—
	$PM_{2.5}$	—	7	—	0.078-0.105	—	64.3
	PM_{10}	—	7	—	0.134-0.196	—	46.4
	TSP	—	7	—	0.217-0.314	—	28.6
4	SO_2	28	7	0.032-0.089	0.040-0.053	0	0
	NO_2	28	7	0.029-0.065	0.037-0.055	0	0
	CO	28	—	0.5-3.2	—	0	—
	$PM_{2.5}$	—	7	—	0.045-0.092	—	71.4

	PM_{10}	—	7	—	0.117-0.165	—	42.9
	TSP	—	7	—	0.214-0.312	—	21.4
5	SO_2	28	7	0.029-0.096	0.051-0.072	0	0
	NO_2	28	7	0.020-0.059	0.032-0.051	0	0
	CO	28	—	1.0-3.3	—	0	—
	$PM_{2.5}$	—	7	—	0.072-0.125	—	85.7
	PM_{10}	—	7	—	0.119-0.209	—	57.1
	TSP	—	7	—	0.223-0.348	—	42.9
6	SO_2	28	7	0.023-0.104	0.056-0.079	0	0
	NO_2	28	7	0.028-0.077	0.039-0.068	0	0
	CO	28	—	1.0-4.0	—	0	—
	$PM_{2.5}$	—	7	—	0.065-0.109	—	71.4
	PM_{10}	—	7	—	0.113-0.189	—	64.3
	TSP	—	7	—	0.209-0.325	—	35.7
7	SO_2	28	7	0.032-0.118	0.056-0.079	0	0
	NO_2	28	7	0.029-0.077	0.053-0.068	0	0
	CO	28	—	1.0-3.8	—	0	—
	$PM_{2.5}$	—	7	—	0.071-0.113	—	71.4
	PM_{10}	—	7	—	0.118-0.175	—	71.4
	TSP	—	7	—	0.219-0.335	—	42.9
8	SO_2	28	7	0.025-0.104	0.046-0.069	0	0
	NO_2	28	7	0.030-0.065	0.033-0.048	0	0
	CO	28	—	0.7-3.2	—	0	—
	$PM_{2.5}$	—	7	—	0.071-0.113	—	85.7
	PM_{10}	—	7	—	0.112-0.185	—	71.4
	TSP	—	7	—	0.222-0.335	—	48.4

Source: Domestic EIA.

Table IV-8: Summary of air quality monitoring results

Item	1-hour mean concentration				24-hour mean concentration			
	Sample No.	Concentration rage(mg/m^3)	Exceedance of limit, %	Worst case exceedance of limit	Sample No.	Concentration rage (mg/m^3)	Exceedance of limit, %	Worst case exceedance of limit
SO_2	168	0.022-0.118	0	—	42	0.035-0.079	0	—
NO_2	168	0.018-0.068	0	—	42	0.029-0.068	0	—
CO	168	0.4-4.0	0	—	0-	—	—	—
$PM_{2.5}$	0	—	—	—	42	0.045-0.124	71.4	0.67
PM_{10}	0	—	—	—	42	0.102-0.209	56.3	0.39
TSP	0	—	—	—	42	0.205-0.348	42.2	0.19

Source: Domestic EIA.

3. Groundwater quality

167. There are both groundwater and surface water sources of drinking water in Jinan.

168. In 2017, 39 parameters were monitored at the Dongjiao and Dongyuan Water Plants, both of which utilize groundwater as a source of drinking water. The Dongyuan Water Plant is 10.8 km away from the component in east direction while Dongjiao Water Plant is 8.6 km away in west direction. Groundwater is extracted at the depth of 30m at the two plants. The Dongjiao Water Plant achieved the Class III standard of Underground Water Quality Standard (GB/T 14848－2017), and compared with 2016, total hardness, permanganate index, sulfate, electrical conductivity and fluoride concentrations decreased slightly while NO_3-N and increased slightly, NH_3-N was consistent. The Dongyuan Water Plant also achieved the Class III standard, and compared with 2016, sulfate and NO_3-N decreased slightly while total hardness increased slightly and permanganate index, NH_3-N, fluoride concentration and electric conductivity increased slightly. (**Table IV-9**).

Table IV-9: Monitoring Results of Groundwater at Water Supply Plants (Unit: mg/L

Name	Year	pH	Total hardness	Sulfate	Permanganate index	NO_3-N	NO_2-N	NH_3	Fluoride	Conductivity
Dongjiao water supply plant	2017	7.61	391	76.54	0.65	11.63	0.0028	0.032	0.274	82.6
	2016	7.39	40	89.58	0.69	9.35	0.0030	0.026	0.282	94.5
Dongyuan water supply plant	2017	7.61	391	87.28	0.64	10.53	0.0025	0.031	0.257	84.9
	2016	7.40	387	90.00	0.64	10.80	0.0015	0.028	0.255	84.7
Limit		6.5-8.5	450	250	3.0	20	0.1	0.5	1.0	—

Source: Jinan Environmental Quality Bulletin (2017).

169. Main springs. Monitoring of 24 parameters is undertaken for the four big spring groups (Baotu, Heihu, Wulong and Zhengzhu) in January and July. The four big spring groups are located at urban area of Jinan which are about 5.0 km away from the component in west direction. All parameters for 2016 and 2017 complied with the Class III standard of Underground Water Quality Standard (GB/T 14848－2017) (**Table IV-10**).

Table IV-10: Water Quality Monitoring Results for the Four Main Spring Groups, Jinan City Urban Area, 2016 and 2017. (Unit: μg/L, except pH)

Name	Year	pH	Total hardness	Sulfate	Permanganate index	NO_3-N	NO_2-N	NH_3	Fluoride
Baotu	2017	7.77	363	74.0	0.61	9.16	0.003	0.019	0.173
	2016	7.62	344	78.3	0.77	8.93	0.003	0.025	0.203
Heihu	2017	7.87	415	95.2	0.68	10.07	0.003	0.015	0.196
	2016	7.58	380	92.4	0.57	10.79	0.003	0.025	0.214
Wulong	2017	7.68	311	76.6	0.41	7.91	0.003	0.020	0.249
	2016	7.67	319	84.6	0.83	7.8	0.004	0.053	0.266
Zhengzhu	2017	7.67	327	83.5	0.71	7.59	0.005	0.028	0.232
	2016	7.71	306	84.9	1.00	6.54	0.005	0.03	0.312
Limit		6.5-8.5	450	250	3.0	20	0.1	0.5	1.0

Source: Jinan Environmental Quality Bulletin (2017).

170. Based on site visit and information collection, there is no lake, pool, pond, river, and springs and groundwater well within 500m of the Maoling boundaries. Because the component will not have impacts to ground water, groundwater monitoring was not conducted.

4. Surface water quality

171. Key surface water bodies in Jinan City include the Yellow River (Jinan section), the Xiaoqing River (Jinan section) and its tributaries (including the Tuhai River located to the north of the Yellow River, outside the component assessment area), Daming Lake and a number of reservoirs. Both the Yellow River and the Xiaoqing River are drinking water sources, and both should comply with the Class III standard of the Surface Water Environmental Quality Standard (GB3838－2002).The urban sections of the Xiaoqing River and its tributaries are primarily used as a source of landscape water, while the Huanxiangdian section downstream as well as its tributary are agricultural water, all of which should comply with Class V standard of the Surface Water Environmental Quality Standard (GB3838－2002). Daming Lake is classified for non-contact entertainment water, and Tuhai River is classified for industrial water. Both should with the Class IV standard of the Surface Water Environmental Quality Standard (GB3838－2002). The reservoirs are drinking water sources and should comply with the Class III standard.

172. **Table IV-11** presents a summary of water quality compliance with Surface Water Environmental Quality Standard (GB3838－2002), Jinan City, 2017.

173. One section of Yellow River is monitored on a monthly basis for 31 parameters. All parameters can meet class III standard.

174. Four sections of Xiaoqing River are monitored on a monthly basis for 26 parameters. Water quality of the Mulizhuang section at the source comply with class III standard and water quality of left three sections is not compliant with class V standard. The annual average concentrations of COD and NH_3-N of the Mulizhuang section of the Xiaoqing River were respectively 8 mg/L and 0.49 mg/L, both of which complied with class III standard. The majority of Xiaoqing River tributaries in Jinan City in 2017 were not in compliance with relevant standards, primarily for NH_3-N and total phosphorus (TP).

175. There are 12 branches of Xiaoqing River in Jinan and each branch has one monitoring section. Xiahouqiao and Zhanagqigou sections are monitored on a monthly basis for 26 parameters while other sections are for 11 parameters. Sections of Beitaiping River, Gongshang River, Xiluo River, Xingji River and Quanfu River are not compliant with class V standard, primarily for NH_3-N and COD. Other sections comply with class V standard.

176. Three sections of Tuhai River are monitored on a monthly basis for 26 parameters. Water qualities of the all sections are in compliance with class IV standard.

177. Three points of Daming Lake are monitored on a monthly basis for 34 parameters. In 2017, water quality in Daming Lake was in compliance with class IV standard, thus meeting the requirements of non-human body direct contact with recreational water area. Compared with 2016, the concentration of total nitrogen increased 4.7%, and the lake is slightly to moderately eutrophic.

178. Main reservoirs in Jinan City are Queshan, Yuqing, Jinxiuchuan, Wohushan and Langmaoshan reservoirs. Each reservoir has two monitoring sections: one in inlet and the other in outlet. In 2017, water quality of Queshan, Yuqing, Jinxiuchuan, Wohushan and Langmaoshan reservoirs all met the Class III standard of the Surface Water Environmental Quality Standard (GB3838－2002) and Yuqing, Jinxiuchuan and Laogmaoshan Reservoirs met Class II standard.

Table IV-11: Summary of Water Quality in Compliance with Functional Zoning for Surface Waters, Jinan City, 2017

Water Body	Section	Applicable Standards	Compliance Status	Actual Water Quality Category	Exceedance parameter
Queshan Reservoir	Inlet	Drinking water source protected area (Class III)	Yes	Class III	NA
	outlet		Yes	Class II	NA
Yuqing Reservoir	Inlet and outlet	Drinking water source protected area (Class III)	Yes	Class II	NA
Jinxiuchuan Reservoir	Inlet and outlet	Drinking water source protected area (Class III)	Yes	Class II	NA
Wohushan Reservoir	Inlet and outlet	Drinking water source protected area (Class III)	Yes	Class III	NA
Langmaoshan Reservoir	Inlet and outlet	Drinking water source protected area (Class III)	Yes	Class II	NA

Daming Lake	Lixiating, Wumingting, Huiboqiao	Non- human body direct contact with recreational water area (Class IV)	Yes	Class III	NA
Yellow River	Luokou	Drinking water source protected area (Class III)	Yes	Class II	NA
Tuhai River	Xiakou	Industrial water area (Class IV)	Yes	Class IV	COD, NH_3
	Shangqiao	Industrial water area (Class IV)	Yes	Class IV	NH_3
	Shenqiao	Industrial water area (Class IV)	Yes	NA	NA
	Shenqiao	Provincial control assessment section on transboundary rivers	Yes	NA	NA
Main stream of Xiaoqing River	Mulizhuang	Water source protected area (Class III)	Yes	Class III	NA
	Huanxiangdian	Agriculture (Class V)	No	Worse than Class V	NH_3 and TP
	Damatou	Agriculture (Class V)	No	Worse than Class V	NH_3 and TP
	Xinfengzhuang	Agriculture (Class V)	No	Worse than Class V	NH_3 and TP
	Xinfengzhuang	Provincial control assessment section on transboundary rivers	No	NA	NH_3
Branches of Xiaoqing River	Luo River	Class V	Yes	Class IV	NA
	Xiahouqiao	Provincial control assessment section on transboundary rivers	Yes	NA	NA
	Zhangqigou	Class V	Yes	Class IV	NA
	Wanghudong Village	Provincial control assessment section on transboundary rivers	Yes	NA	NA

Source: Jinan Environmental Quality Bulletin (2017).

179. Based on site visit, the surface water body near the component site is Xiaoqing River (4.5 km away in northwest direction) and Yellow River (8.0 km away in northwest direction) (**Figure IV-7**).There is no small local ponds or drains in a radius of 500m near component site. Four sections of Xiaoqing River are monitored. The wastewater of the component will be treated in nearby WWTP and then discharged to Xiaoqing River. Based on Jinan Environmental Quality Bulletin (2017), water quality of Xiaoqing River is presented below:

180. In 2017, annual average concentrations of COD and NH_3-N in Mulizhuang Section (entry section) were 8 mg/L and 0.49 mg/L respectively. Compared to 2016, COD is decreased by 35.0%and NH_3-N is decreased by 3.9%.

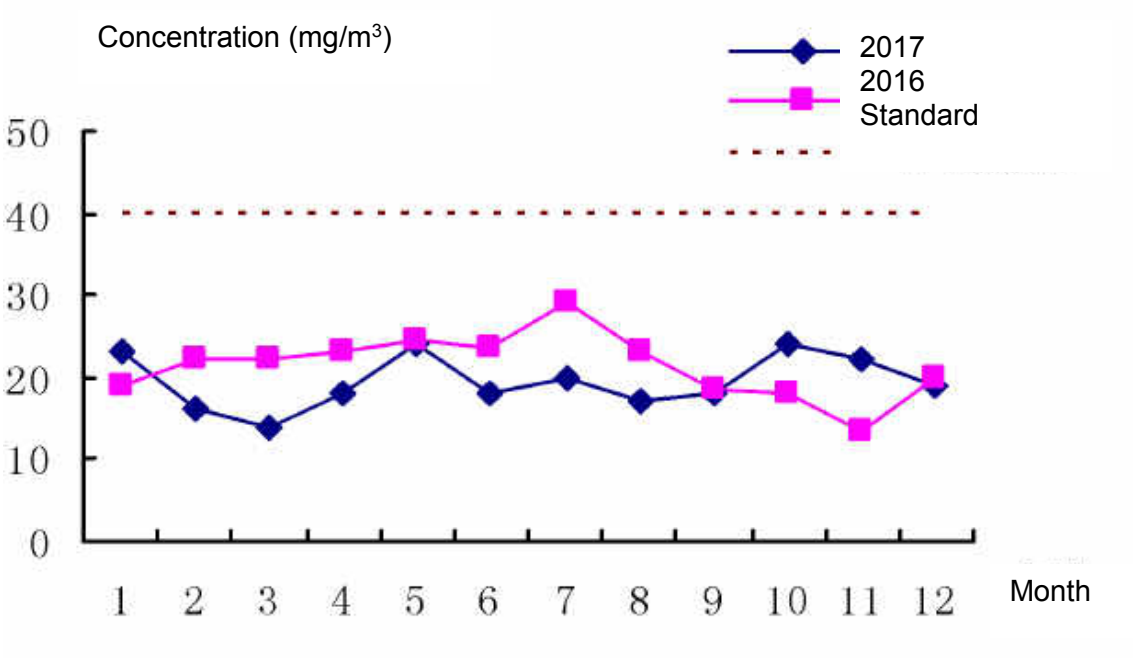
181. In 2017, annual average concentrations of COD and NH_3-N in Xingfengzhuang Section (exit section) were 19 mg/L and 2.95 mg/L respectively. Compared to 2016, COD is decreased by11.2% and NH_3-N is decreased by 30.9%.

Figure IV-18: Monitoring sections of Xiaoqing River

Source: Jinan Environmental Quality Bulletin (2017).

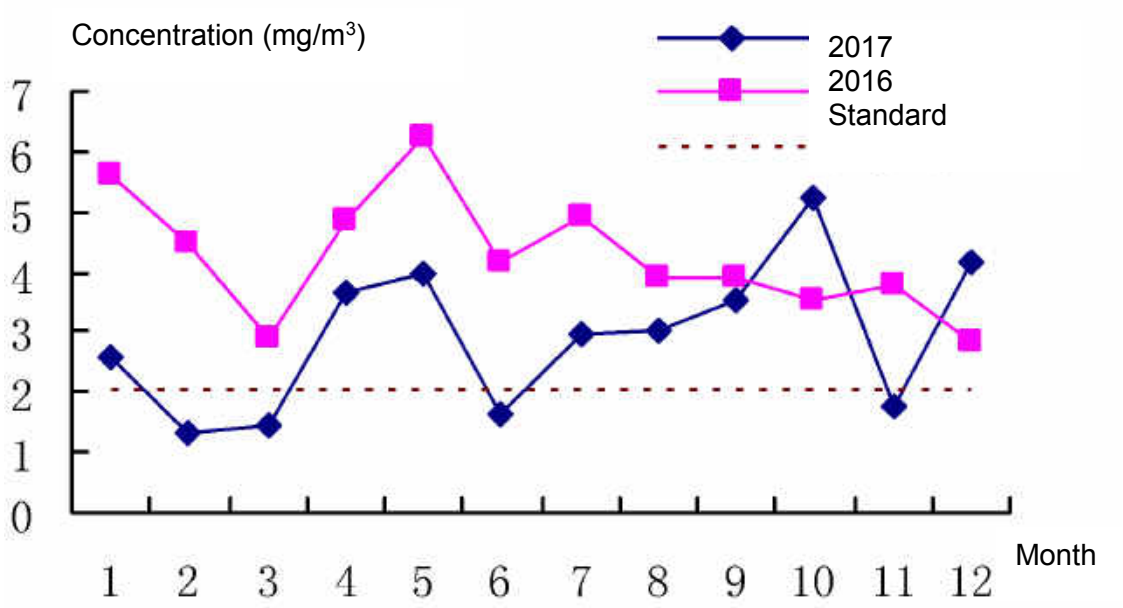
182. In 2017, monthly average concentration range of COD and NH_3-N in Xingfengzhuang Section (exit section) were 14-24 mg/L and 1.34-5.24 mg/L respectively (**Figure IV-19** and **Figure IV-20**). NH_3-N is not compliant with standards.

Figure IV-19: Monthly average COD concentrations of Xingfengzhuang Section



Source: Jinan Environmental Quality Bulletin (2017).

Figure IV-20: Monthly average NH_3-N concentrations of Xingfengzhuang Section



Source: Jinan Environmental Quality Bulletin (2017).

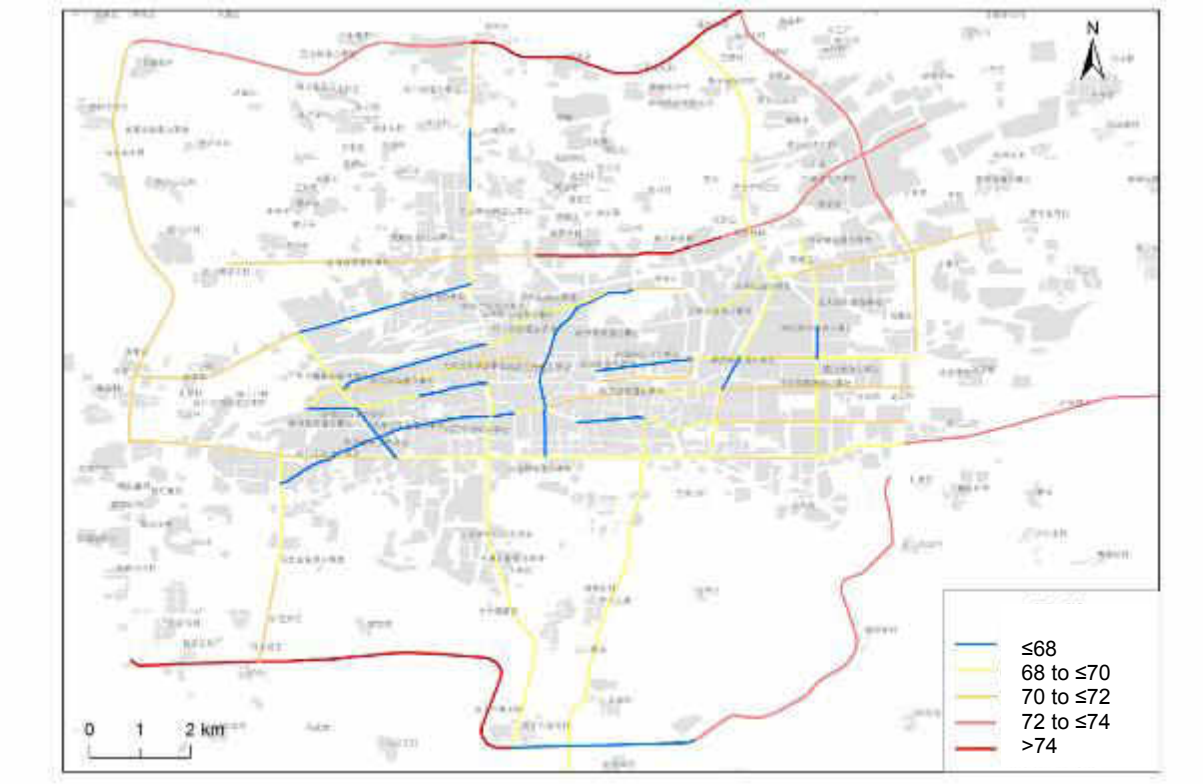
5. Noise

183. **Urban noise.** There were 214 urban noise monitoring sites in Jinan in 2017. The annual average 12-hour daytime noise level in 2016 was 53.7 dB(A), which complies with the Class I

standard of Environmental Quality Standard for Noise (GB3096－2008). Based on noise source analysis, 69.6% is domestic noise, 24.3% is traffic noise, 3.8% is industrial noise and 2.3% is building noise.

184. **Traffic noise.** Traffic noise in Jinan is monitored on 95 road sections of 39 urban trunk roads totaling 166.6 km in length. The results show that the overall average daytime traffic noise is 69.7 dB(A) which marginally complies with the Class 4a standard of Environmental Quality Standard for Noise (GB3096－2008) of 70 dB(A), applicable to urban trunk roads. Compared with 2016 the traffic noise level has decreased by 0.1 dB(A). Of the 39 urban trunk roads, 21 (53.8%) comply with the Class 4a standard (**Figure IV-21**).

Figure IV-21: Results of Traffic Noise Monitoring in Jinan, 2017

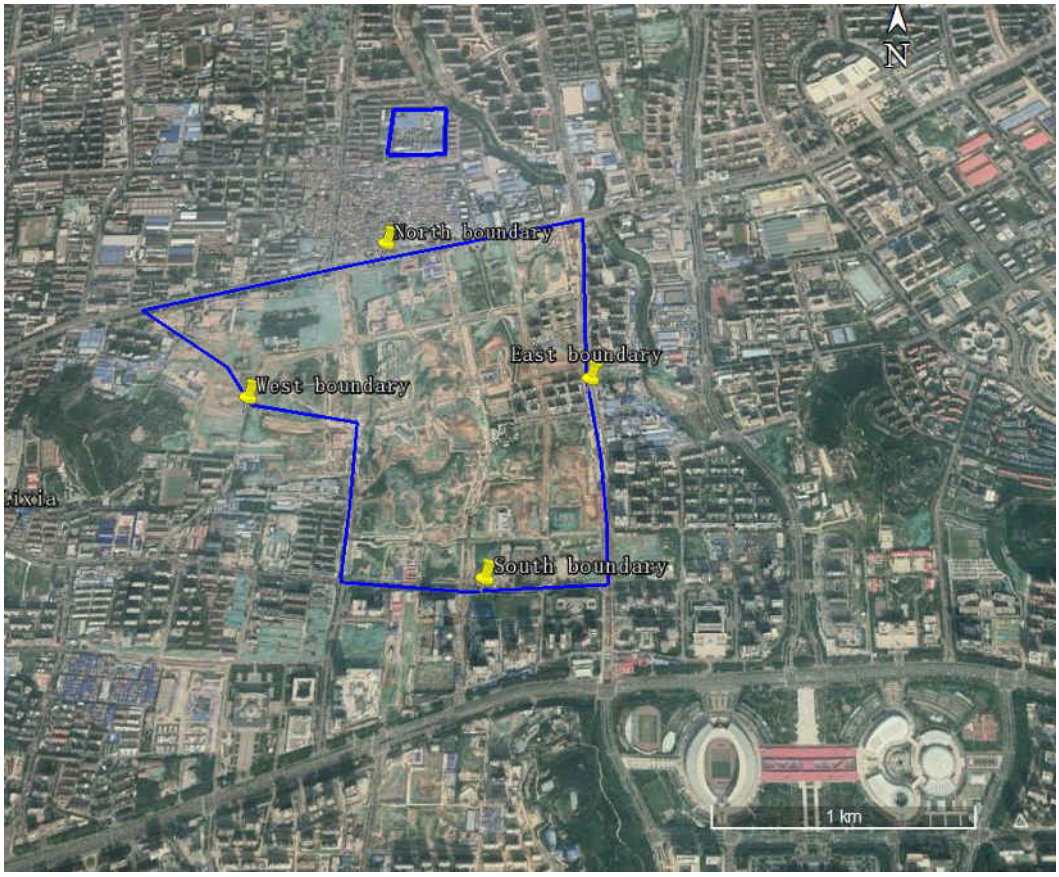


Source: Jinan Environmental Quality Bulletin (2017).

185. Noise monitoring was implemented at the component site boundaries. The monitoring was carried out at over a 24-hour period on May 18 to 19, 2018. Weather conditions were sunny and cloudless with wind speed less than 5.0 m/s, which is in compliance with relevant PRC meteorological requirements for noise monitoring.

186. Monitoring was undertaken with HS 6298 and Aiwa AWA6218 multi-functional ambient noise detectors. Monitoring at the component site boundaries was undertaken in accordance with the relevant requirements in *PRC Noise Standards for Industrial Enterprises at Site Boundary* (GB12348-2008). **Figure IV-22** presents the location of the monitoring points (site boundaries). **Table IV-12** presents the monitoring results.

Figure IV-22: Noise Monitoring location



Source: Domestic EIA (2018).

Table IV-12: Monitoring Results of Noise at Boundaries of Maoling Area(unit: Leq dB(A))

Date	Monitoring period	Monitoring results				Limit
		North	South	West	East	
May 18 -19, 2018	Daytime	51.7-55.5	52.3-54.4	48.1-52.6	51.3-53.1	60
	Nighttime	39.5-42.5	43.5-46.1	38.3-43.6	41.2-45.1	50

Source: Domestic EIA (2018).

187. The results indicate that daytime and nighttime noise levels at the at the site boundaries meet the applicable Class II standards (60 dB(A) daytime, 50 dB(A) nighttime) in *PRC Noise Standards for Industrial Enterprises at Site Boundary* (GB12348-2008).

E. Ecology and Sensitive Resources

188. **Ecology.** Jinan City (the full extent of the administrative boundary, including 6 districts and 4 counties or county level cities) is home to a reported 1,175 plant species in 149 families. This includes 12 families and 18 species of fern; 7 families and 21 species of gymnosperm; 106 families and 870 species of dicotyledon; and 24 families and 266 species of monocotyledon.

There are 382 known species of wild plants, accounting for 33% of the total number of plant species; and 793 species of cultivated plants, accounting for 67% of the total. The fauna resources of Jinan include wild terrestrial and aquatic species typically associated with Yellow River watershed.

189. Natural vegetation is sparse and concentrated in the southern and eastern mountain area. In the vast loess hilly area, the forest coverage rate is lower. Shrub and grass coverage are poor. Dominant flora within the component area is natural and artificial secondary vegetation being repeatedly destruction. Also, there are some artificial afforestation such as Pinus tabulaeformis, Platycladus orientalis, Robinia pseudoacacia, elm, poplar, and walnut, apple, hawthorn, persimmon and other economic forest.

190. The component is located in developing mixed commercial and residential zone, a developing and modified industrial environment and there are no known ecological and/or sensitive resources in or near the component site. Land acquisition was completed 4 years ago.

The component site and supporting pipeline routes (heating, reclaimed water and power transmission line) are in existing developing mixed commercial and residential zone with little or no vegetation cover (

191.). Maoling Area is under construction now and original vegetation cover has been previously removed, and existing site vegetation is typically completely absent as the whole area is under construction, or disturbed dirt with little or no vegetation cover.

Figure IV-23: Component site conditions

(i) Construction site is covered for and dust control

(ii) Construction site is covered for and dust control.

(iii) The whole area is under construction.

192. Based on the domestic EIA, site surveys and records review, there are no known rare or endangered flora or fauna, species with international, national or provincial protection status, areas of natural or critical habitat,[14] parks, nature reserves, or areas with special national, regional or local ecological significance within or adjacent to any of the component site. There are also no known drinking water sources, scenic sites based on both sites surveys and a review of relevant literature, sites with Physical Cultural Resources (PCRs).[15]

193. **Sensitive receptors.** The domestic EIA report identifies 9 sensitive receptors for air and noise impacts near the component site during construction phase and operation phase (**Table IV-13**).

Table IV-13: Sensitive receptors near the boundaries of Maoling Area

No.	Location	Direction	Distance (m)
1	Zhongtie Community	E	200
2	Wenbojiayuan	S	250
3	Shandong Human Resource Department	S	220
4	Haixin Community	W	400
5	Xinxinjiayuan Community	N	350
6	Xinchengyuan Community	NW	550
7	Wanke Community	NE	750
8	Huaxiannanyuan Community	N	980
9	Maolinghuayuan Community	W	300

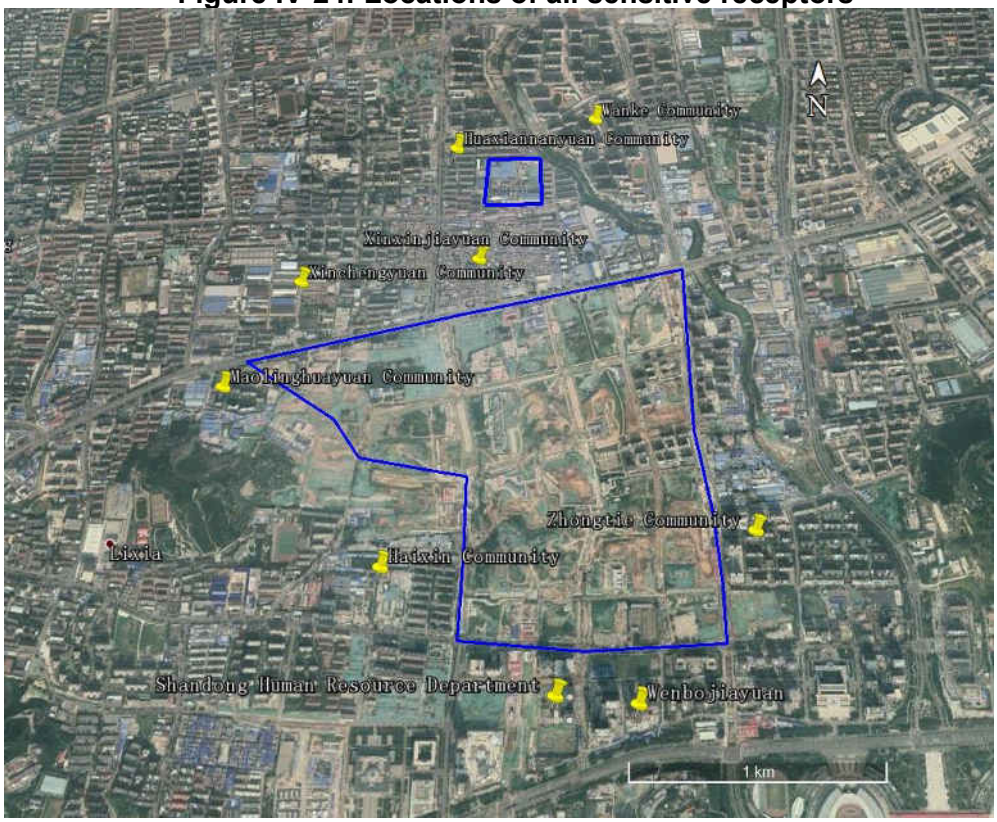
Source: Domestic EIA (2018).

194. Locations of all sensitive receptors are presented in **Figure IV-24**. Sensitive receptors are given special attention in the assessment of impacts (Section V) and the EMP (Appendix I).

[14] Natural habitat is land and water areas where the biological communities are formed largely by native plant and animal species, and where human activity has not essentially modified the area's primary ecological functions. Critical habitat are areas with high biodiversity value, including habitat required for the survival of critically endangered or endangered species; areas having special significance for endemic or restricted-range species; sites that are critical for the survival of migratory species; areas supporting globally significant concentrations or numbers of individuals of congregatory species; areas with unique assemblages of species or that are associated with key evolutionary processes or provide key ecosystem services; and areas having biodiversity of significant social, economic, or cultural importance to local communities (Environment Safeguards: A Good Practice Sourcebook, ADB, 2012).

[15] PCRs are broadly defined as covering all types of tangible cultural heritage, including movable or immovable objects, sites, structures, groups of structures, and natural features and landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic or other cultural significance. PCR are human-made objects, natural features, or a mix of the two. They may be located in urban or rural areas and may be above or below ground or underwater. They may be known and listed on official inventories, but often they are undiscovered (Environment Safeguards: A Good Practice Sourcebook, ADB, 2012).

Figure IV-24: Locations of all sensitive receptors



F. Socio-economic and Cultural Resources

195. **Jinan city**. Jinan City is comprised of 6 districts (Lixia, Shizhong, Huaiyin, Tianqiao, Licheng and Changqing); 3 counties (Pingyin, Jiyang, and Shanghe); and a county level city (Zhangqiu) (**Figure IV-25**). The city has a total area of 8,177 km^2,

196. Total population was 6,328,300 by the end of 2017 (

197. **Table IV-14**).

198. There are 49 ethnicities in Jinan including Hui, Mongolian and Manchu. However, the ethnic minorities only account for 1.84% of the total population while the rest is Han ethnicity. There are no ethnic groups in the component areas, therefore, the component will not have impacts on them.

199. **Economy.** Jinan is the political, economic, cultural, scientific, educational, and financial center of the province, and has been designated with sub-provincial administrative status since 1994.

Figure IV-25: Map of Jinan City administrative divisions

Source: https://en.wikipedia.org/wiki/Jinan

Table IV-14: Data on Jinan City administrative divisions

Subdivision	Land Area (km²)	Population (2016)	Population Density (persons/km²)
Lixia District	100.87	627,400	6220
Shizhong	280.33	617,600	2203
Huaiyin	151.56	409,900	2705
Tianqiao	258.71	516,700	1997
Licheng	1303.88	971,800	745
Changqing	1208.54	559,800	463
Zhangqiu	1721.29	1,029,700	598
Pingyin	715.18	374,700	524
Jiyang	1097.15	578,100	527
Shanghe	1163.19	641,400	551

Source: Jinan Statistical Bureau, 2017

200. In 2017, the city's GDP was CNY 720.196 billion, of which the primary sector accounted for 4.4% or CNY 31.740 billion; the secondary sector accounted for 35.7% or CNY 256.922 billion; and the tertiary sector accounted for 59.9% or CNY 431.534 billion.

201. **Employment.** Jinan's employed population was 3.887 million in 2017, including 718,000

employees in primary industry, 1.247 million in secondary industry, and 1.922 million in tertiary industry, giving an employment ratio for the three industries of 18.5%: 32.1%: 49.5%. In 2015, the registered unemployment rate was 2.0%.

202. **Education.** Jinan had 42 institutions of higher education in 2017, and 544,400 students. Of these, 10 institutions are privately operated with 93,000 students. There are 305,600 students in middle schools and 446,600 students in primary schools.

203. **Public transit and traffic conditions.** The number of vehicles on the roads of Jinan is increasing dramatically. In 2017, 241,000 new vehicles were added, and total vehicle ownership reached 2.065 million vehicles, of which car ownership was 1.95 million, an increase of 11.9%. Private cars were used an average of 2.9 times per day.

204. Jinan has a well-developed railway, highway and aviation transportation network, and has become an important hub connecting with eastern, northern, central and western regions of the PRC.

205. Jinan is one of the 45 national arterial hubs of the highway network. Jinan's own highway network is highly developed with multiple national highways, including highway 104, 305, 309, 220, Jiqing Expressway and Jingfu Expressway, and provincial highways running through it. Currently a half-day travel circle is being established with Jinan in the center and connections to all cities within the province.

206. Jinan is on the Beijing-Shanghai Railway and Jiaozhou-Jinan Railway; Jinan-Handan Railway is connected with Beijing-Kowloon Railway and Beijing-Guangzhou Railway (two major trunk railways). The Beijing-Shanghai high speed railway has already been in operation for many years.

207. **Wastewater treatment and solid waste management**. The Jinan urban area has five urban wastewater treatment plants (WWTPs) and 11 smaller domestic wastewater treatment stations, with a total capacity of 0.84 million m^3/d. They are served by a pipeline network including 1,300 km of sewers, 950 km of storm water lines, and 20 pump stations (Jinan Municipal Utilities Bureau, 2017). According to 2016 and 2017 JEPB monitoring data, the effluent of all the 16 WWTPs and stations is in compliance with applicable standards.

208. In 2017, the urban area of Jinan handled 1,858,000 tons of domestic solid waste, of which 844,500 tons was incinerated and 613,500 tons was landfilled (Information on Environmental Pollution Prevention and Control of Solid Waste, JEPB). Solid waste and hazardous waste generated from the component will be treated at existing certificated facilities following PRC regulations.

209. **Physical Cultural Resources** Jinan is an accredited famous historic and cultural city for its long-standing history and culture unique natural landscape. Historic sites include Chengziya Longshan Culture Site, Guo's Ancestral Temple of Han Dynasty at Xiaotangshan, Four Gates Pagoda of Sui Dynasty, Dragon and Tiger Pagoda of Tang Dynasty, Nine Tops Tower and Luozhuang Han Tomb.

210. Jinan has a rich history. However, the component activities are all on long developed sites within highly developed and modified industrial environment. There are no known PCRs in component site or in a radius of 500 m from the component site and within the airshed that could be affected by the component.

V. ANTICIPATED IMPACTS AND MITIGATION MEASURES

211. Anticipated positive and negative environmental impacts of the proposed component were assessed based on the domestic FSR, domestic EIA, a technical due diligence review of the FSR undertaken by ADB PPTA specialists, public consultations led by the IA and assisted by ADB PPTA consultants and site visits, surveys and consultations undertaken by ADB PPTA consultants.

212. Pre-construction, construction and operation phases were considered separately. The results of the assessment indicate that during the pre-construction phase environmental issues are very limited and are mostly associated with ensuring appropriate incorporation of mitigation measures into the component design.

213. Potential negative environmental impacts during the construction phase are short-term and localized, and are associated with construction noise, fugitive dust, disruption of traffic and community services, and risks to workers and community health and safety. Potential negative operation phase impacts are associated with waste and wastewater, noise, and health and safety risks to workers and community.

214. Potential positive operation phase impacts are significant and long-term and are associated with emissions reductions compared to equivalent heat production from coal-fired boilers and increased efficiency from district cooling.

A. Pre-Construction Phase Measures to be Implemented During Detailed Design

1. Siting and Land Acquisition

215. The component will not entail any permanent or temporary physical displacement or economic displacement. This is because:

(i) Based on PPTA social specialist's work, up to now, compensation work for land acquisition of the Maoling Area has been completed and all compensation fees have been paid off. The certificate for the use of state-owned land has been obtained. Land acquisition has been completed for those components in which new facilities will be constructed, and was found to be in compliance with PRC and ADB requirements

(ii) The compensation rates, resettlement program, and compensation distribution program of the proposed plant have been determined through repeated consultations. Compensation for acquired land has been paid to the affected households timely and in full. As a result, there has been no complaint to the grievance redress mechanism. The compensation rates and resettlement program comply with the applicable state and provincial regulations and policies, and ADB's involuntary resettlement safeguard principles. The APs are satisfied with the resettlement policies, and their income has risen, demonstrating that the resettlement program of the proposed plant has been effective.

216. Overall, the component will not result in any involuntary land acquisition, resettlement or physical displacement. There will be no loss of personal property, structures, crops, trees or other assets. There are also no potential adverse impacts on disadvantaged or vulnerable groups, including the poor, women and children, and Indigenous Peoples.

2. Mitigation Measures and Monitoring during Detailed Design

217. Mitigation measures to be adopted during detailed design to minimize the impacts are as follows:

(i) **Detailed Design.** Environmental mitigation and pollution control measures indicated in this IEE, the EMP and the domestic EIA will be incorporated into the detailed design.

(ii) **Organization.** A PMO will be established and an external Loan Implementation Environmental Consultant (LIEC) will be hired by the IA.

(iii) **Institutional strengthening**: Prior to the start of construction, the institutional strengthening and training program will be delivered by the LIEC. The training will focus on ADB's and PRC's relevant environmental, health and safety laws, regulations and policies; implementation of the EMP, environmental monitoring, chance find procedures for PCRs, and the GRM. Training will be provided to the IA, relevant PMO staff, and contractors.

(iv) **Bidding Documents and Contracts.** Environmental mitigation measures indicated in this IEE, the EMP and the domestic EIA will be included in contracts for civil works and equipment installations. All contractors will be required to strictly comply with the EMP.

(v) **Environmental monitoring.** The environmental monitoring program (EMoP, see **Table 3** in **Appendix I**) will be incorporated into the design to ensure that environmental impacts are closely monitored and activities of the component construction and operation are closely supervised against the PRC environmental laws, regulations and standards, ADB SPS, EMP and the approved domestic EIA.

3. Grievance Redress Mechanism

218. In accordance with the GRM presented in Chapter VIII of the IEE, a staff member from IA will be assigned to be overall responsible for the GRM; GRM training will be provided for PMO, IA and GRM access points; and the GRM access point phone numbers, fax numbers, addresses and emails will be disclosed to the public at the construction site and Energy Centers and HESs.

4. Training and Capacity Building

219. An institutional strengthening and training program will be delivered by LIEC (see **Table 4** in **Appendix I**). The training will focus on ADB's and PRC's environmental, health and safety laws, regulations and policies; implementation of the EMP, EMoP, the GRM and international good EHS practices. Training will be provided to the IA, relevant staff and contractors and the construction supervision company.

5. Permitting

220. All necessary construction permits will be obtained from the relevant authorities.

B. Anticipated Environmental Impacts and Mitigation Measures during Construction Phase

221. Potential impacts during the construction phase could include air pollution, noise, water

pollution, solid waste, poor occupational health and safety practices, and community health and safety. Potential air quality impacts could occur due to fugitive dust generated at construction sites from stockpiles of uncovered earth materials, and vehicles hauling materials. The use of powered mechanical equipment (PME) during construction activities will generate noise. Construction activities will generate process wastewater and construction workers will produce wastewater. Wastewater generation is expected to be limited considering the nature and scale of construction. Construction works will produce construction waste. Workers will face occupational health and safety issues working on construction sites. Potential impacts are assessed and addressed below. Identified impacts can be readily addressed through the application of good construction site practices.

1. Impacts to Flora and Fauna

222. Typical construction impacts on flora and fauna include removal of vegetation and disruption of the ecosystem during construction. If present, rare or endangered flora or fauna may also be impacted. However, the component construction site is located in developing mixed residential and commercial environments with little or no vegetation cover other than recently established grasses and shrubs. It was found in the survey that the component site is residential land before 2014 and after the land acquisition in 2014, the site is transferred to mixed commercial and residential land. It is therefore unlikely that there will be direct impacts on natural lands or ecological values from component site developments.

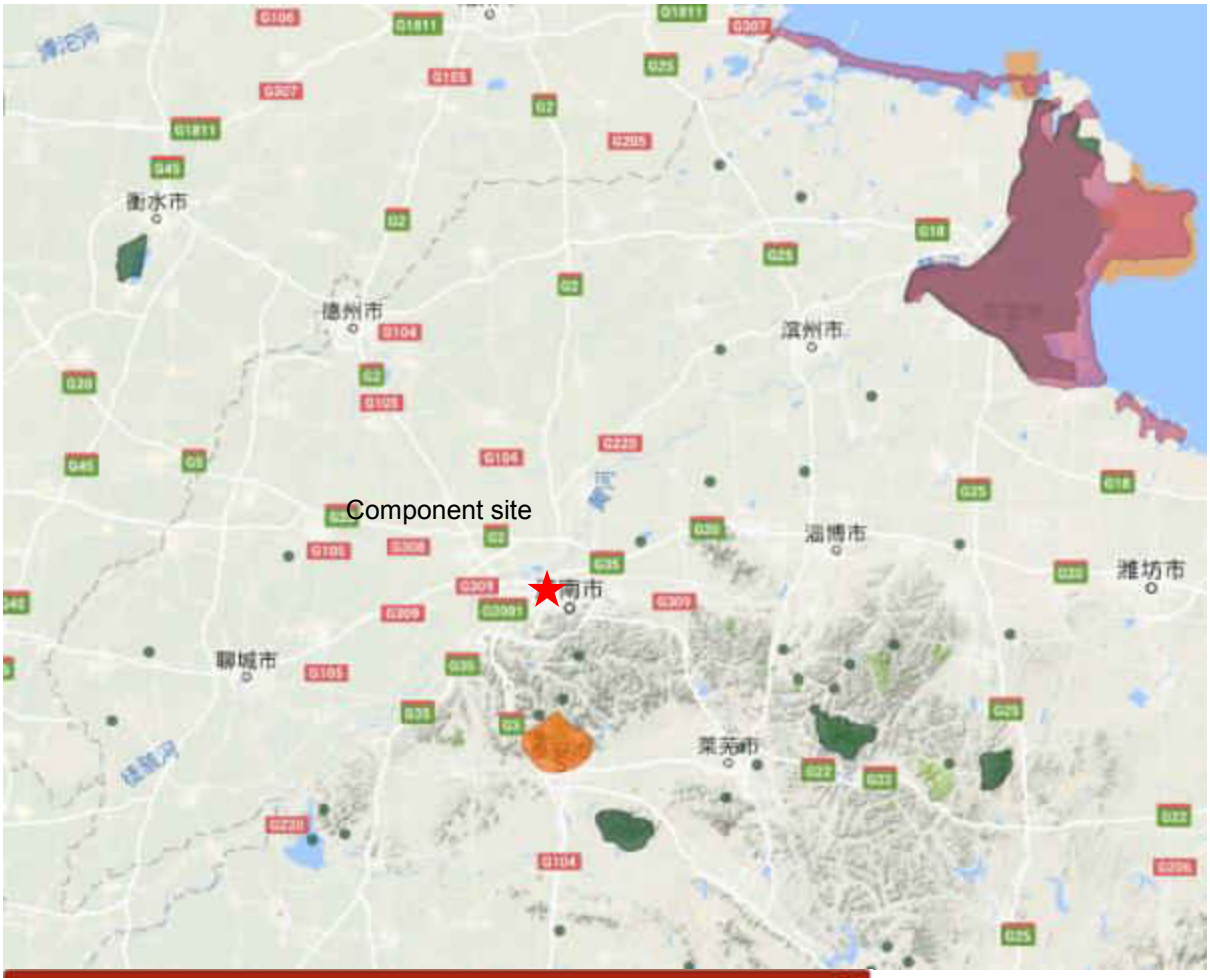
223. The locations of component site have been reviewed against provincial records provided by the IBAT[16] maps of Shandong protected areas and Important Bird and Biodiversity Areas (IBBAs). The component does not encroach on any legally protected natural area or other critical habitats.

224. Based on site visits, there is no known rare or endangered flora or fauna, parks, nature reserves or areas with special ecological significance which will be impacted by the component. Impacts on flora or fauna are thus expected to be minimal and short-term. Nonetheless, to address potential impacts, a greening plan will be implemented. Site vegetation plans will be developed at component site using appropriate local native species. Any existing greening areas impacted by the component will be restored post-construction using appropriate native species.

225. During construction, construction working areas will be demarcated to prevent encroachment and damage to adjacent areas.

[16] International Biodiversity Assessment Tool. https://www.ibat-alliance.org/ibat-conservation/

Figure V-1: IBAT Habitat Areas and Component location



Map Layers

Protected areas: national-level

- ☐ IUCN management categories Ia, Ib, II
- ☑ IUCN management categories III, IV
- ☑ IUCN management categories V, VI
- ☐ IUCN management categories not reported/not assigned

Protected areas: regional

- ☑ Natura 2000
- ☑ Regional Seas

Protected areas: international

- ☑ Natural/Mixed World Heritage sites
- ☑ Ramsar sites
- ☑ UNESCO Man and the Biosphere Reserves

Priority sites for biodiversity

- ☐ Key Biodiversity Areas
- ☑ Important Bird & Biodiversity Areas
- ☑ Alliance for Zero Extinction Sites

Species

- ☐ Species Grid
- ☐ Freshwater Biodiversity

Regions of conservation importance

- ☑ Endemic Bird Areas
- ☑ Biodiversity Hotspots
- ☑ High Biodiversity Wilderness Areas

Completeness

- ☐ KBA Completeness

2. Erosion and Spoil

226. Construction activities such as excavation and filling activities may lead to surface erosion. Spoil generated by the component will be around 1,600 m^3. The most vulnerable soil erosion areas in the construction site include excavation sites, spoil sites, temporary construction sites, and other areas where surface soil is disturbed. Soil erosion can also be more serious on slopes or near water bodies, though based on site visits all construction sites are generally flat and there are no rivers, streams, ditches or lakes that are likely to be affected. Soil erosion can also occur after the completion of construction if site restoration is inadequate. Pipeline excavation and burial may also cause localized erosion and mudding of adjacent road. Finally, construction activities may generate surplus spoil.

227. These impacts can be mitigated through typical good construction practice as set out in EHS Guidelines on Construction and Decommissioning (C&D), erosion controls and site maintenance:

(i) At construction site, the potential for storm water runoff will be assessed and appropriate storm water drainage systems to minimize soil erosion will be implemented, including perimeter bunds and establishment of temporary detention and settling ponds to control topsoil runoff.

(ii) Land excavation and filling will be balanced so as minimize the requirement for fill material transportation.

(iii) During earthworks, the area of soil exposed to potential erosion at any time will be minimized through good project and construction management practices.

(iv) Temporary spoil storage sites will be identified, designed, and operated to minimize impacts. Spoil sites will be restored at the conclusion of storage activities.

(v) Spoil will be reused on-site to the maximum extent feasible as fill. Excess spoil that cannot be used on-site will be transported to an approved spoil disposal site.

(vi) Spoil and aggregate piles will be covered with landscape material and/or regularly watered.

(vii) Waste construction material such as residual concrete, asphalt, etc., will be properly handled for reuse or disposal.

(viii) Construction and material handling activities will be limited or halted during periods of rains and high winds.

(ix) Pipelines will be installed and backfilled in a sequenced section-by-section approach. Open excavation areas during trenching activities will be minimized, and appropriate construction compaction techniques utilized.

(x) Any planned paving or vegetating of areas will be done as soon as practical after the materials are removed to protect and stabilize the soil.

(xi) Once construction is complete disturbed surfaces will be properly sloped and revegetated with native trees and grass (see greening plan).

(xii) Based on site visit, the spoil disposal site is closed to the component site at the east direction. The spoil disposal site is a temporary site during construction of Maoling Area and will be restored after the Maoling Area is finished. Conduct component completion audit to confirm that spoil disposal site rehabilitation meets required standard, hold contractor liable in case of noncompliance.

3. Wastewater

228. Inappropriate disposal of domestic wastewater (from construction workers) or construction wastewater (from drainage of washing construction equipment and vehicles, and oil-containing wastewater from machinery repairs) may cause soil or groundwater resources contamination.

229. Construction wastewater will be produced from the maintenance and cleaning of mechanical equipment and vehicles, wastewater from pipeline cleaning and equipment cleaning. It is unlikely that runoff from site will reach distant water bodies, however to guard against runoff and infiltration impacting the immediately surrounding areas, the contractors shall ensure that runoff from site will not reach distant water bodies.

230. Inappropriate disposal of construction wastewater (from construction site runoff, washing construction equipment and vehicles, and oil-containing wastewater from machinery repairs) could potentially pollute nearby water bodies and clog local drains. Workers will generate but limited amount of domestic wastewater.

231. To prevent pollution of water resources, the following mitigation measures and construction good practice as set out in EHS Guidelines on C&D, will be implemented:

(i) Existing toilets at the component site will be provided for the workers.

(ii) Construction wastewater generated during construction phase will be discharged to the municipal sewer system. All discharged construction wastewater will meet the appropriate PRC standard GB/T 31962-2015 prior to discharge. Discharged water will then be treated in the nearby WWTP.

(iii) All necessary measures will be undertaken to prevent construction materials and waste from entering drainage system.

(iv) Maintenance of construction equipment and vehicles will not be allowed on sites to reduce wastewater generation.

(v) Oil traps are provided for service areas and parking areas, and oil-water separators are installed for oil-containing wastewater;

(vi) All construction machinery is repaired and washed at special repairing shops. No on-site machine repair, maintenance and washing shall be allowed so as to reduce wastewater generation;

(vii) Storage facilities for fuels, oil, and other hazardous materials are within secured areas on impermeable surfaces with 110% volume of the materials stored, and provided with bunds and cleanup kits;

(viii) The contractors' fuel suppliers are properly licensed, follow proper protocol for transferring fuel, and are in compliance with Transportation, Loading and Unloading of Dangerous or Harmful Goods (JT 3145-88).

4. Air Pollution

232. Fugitive emission of dust (measured as TSP) during earthworks and fumes from asphalting and concrete batching off-site are expected to be the main air pollutants during the construction stage. The PRC Shandong Province's integrated particulate matter emission standard for stationary sources in Shandong Province (DB 37/1996-2011) establishes standards for the emission of air pollutants from these activities.

233. Fugitive dust will be generated on construction sites during earthworks from construction activities, uncovered earth material stockpiles on construction sites and temporary spoil storage and disposal areas (and containers), and from vehicles hauling loads, especially if loads are uncovered. Impacts will be short-term and localized, and in line with typical construction works that occur daily in cities throughout the PRC and the world.

234. Anticipated sources of air pollution from construction activities include: (i) dust generated from loading, hauling and unloading; (ii) dust generated from disturbed and uncovered construction areas, especially on windy days; (iii) dust generated by the movement of vehicles and heavy machinery on unpaved access and haul roads; (vi) emissions from construction vehicles (gaseous CO and NO_2) and heavy diesel machinery and equipment.

235. Without appropriate mitigations, construction phase activities may generate significant localized total suspended particulate (TSP)[17] levels, with worst case conditions occurring in clear weather without watering.

236. To reduce air quality impacts during the construction period, the following air quality management measure and construction good practice as set out in EHS Guidelines on C&D will be implemented:

(i) Water will be sprayed on active construction sites including where fugitive dust is being generated on a daily basis, and more frequently during windy days.

(ii) Transport vehicles will be limited to low speeds in construction sites.

(iii) Loads will be covered during truck transportation to avoid spillage or fugitive dust generation. Fine materials will be transported in fully contained trucks.

(iv) Construction site roads will be well maintained and watered and swept on an as-needed basis. Construction site road entry points will be equipped with truck drive through wash ponds.

(v) Transport routes and delivery schedules will be planned to avoid densely populated and sensitive areas, and high traffic times.

(vi) Store petroleum or other harmful materials in appropriate places and cover to minimize fugitive dust and emission.

(vii) Provide regular maintenance to vehicles in order to limit gaseous emissions (to be done off-site).

(viii) Temporary fencing will be erected around pipeline installation activities.

(ix) Construction spoil and other construction materials will be temporary stored using containers, but they may the potential to generate dust. Thus, containers will be covered and/or watered if necessary.

(x) Muddy or dusty materials on public roads outside the exits of works areas will be cleaned immediately.

(xi) On-site asphalting and concrete batching is prohibited.

(xii) Disturbed site will be revegetated as soon as possible after the completion of pipeline installation.

17 Airborne particles or aerosols that are less than 100 micrometers are collectively referred to as total suspended particulate matter (TSP).

237. Overall, air quality impacts from construction activities will be short-term (because of the phased construction approach), localized and low in magnitude, and are in line with typical construction or road works undertaken daily in cities throughout the PRC and around the world.

5. Noise Impacts

238. During the construction phase noise and vibration will be generated by on site construction activities using heavy equipment and by the transport of construction materials and equipment. Noise source during construction phase is considered a point noise source, and the predictive model is as follows:

$$L_i = L_0 - 20\lg\frac{R_i}{R_0} - \Delta L$$

Where, L_i and L_0 are equipment noise sound levels at R_i and R_0, respectively,
ΔL is additional decrement produced by barriers, vegetation and air.

239. For the impact of multiple construction machines on a location, sound level superposition uses the following formula:

$$L = 10\lg\Sigma 10^{0.1\times L_i}$$

240. The component will install fence at the site boundaries which can reduce the noise by 10 dB. A significant increase in localized noise is expected during construction. Noise will be from construction activities including equipment unload and installation and other heavy machinery, as well as noise from goods and material transportation. The major anticipated noise sources at each construction stage are presented in **Table V-1**. Though noise levels may be high, the impacts will be temporary and localized, and can be further mitigated.

Table V-1: Primary noise sources at each construction phase

Construction Phase	Name	Sound Level dB(A)	Distance from the source (m)	Noise level at the 100m away without any fence	Directivity
Earthwork	Excavator	80-85	5	40-45	No
	Loader	85-90	5	45-50	No
	Bulldozer	85-90	3	45-50	No
	Dump truck	85-90	3	45-50	No
Equipment installation	Electrical drill	85-95	5	45-55	No
	Electrical hammer	90-95	5	50-55	No
	Electrical saw	90-95	5	50-55	No
Transport Vehicle	Trailer	70-75	5	30-35	No
	Flat car	70-75	5	30-35	No
	Truck	70-75	5	30-35	No

Source: Domestic EIA.

241. To ensure construction activities meet PRC noise standards and to protect workers and adjacent residents, the following mitigation measures and construction good practice as set out in EHS Guidelines on C&D will be implemented:

(i) Construction activities will be planned in consultation with local authorities and communities so that activities with the greatest potential to generate noise and vibration are planned during periods of the day that will result in the least disturbance.

(ii) Construction activities, and particularly noisy ones, are to be limited to reasonable hours during the day and early evening. Construction activities will be strictly prohibited during the nighttime (22:00 h to 07:00 h). Exceptions will only be allowed in special cases, and only after getting approval of the surrounding residents, local EPB and other relevant departments. And nearby residents should be notified of such night time activities well in advance.

(iii) When undertaking construction planning, simultaneous high-noise activities will be avoided, and high noise activities will be scheduled during the day rather than evening hours. Similarly, construction site will be planned to avoid multiple high noise activities or equipment from operating at the same location.

(iv) Low-noise equipment will be selected as much as possible. Equipment and machinery will be equipped with mufflers and will be properly maintained to minimize noise.

(v) Noise PPE will be provided to workers to meet the requirements in occupational exposure limits for hazardous agents in work place Part 2: physical agents (GBZ 2.2-2007) and EHS Guidelines.

(vi) Transportation routes and delivery schedules will be planned during detailed design to avoid densely populated and sensitive areas and high traffic times.

(vii) Vehicles transporting construction materials or waste will slow down and not use their horn when passing through or nearby sensitive locations, such as residential communities, schools and hospitals.

(viii) Special attention will be paid to protect sensitive sites near the component site: high noise construction activities will be positioned as far away from sensitive sites as possible.

(ix) Noise from cleaning of heating pipelines will be minimized by utilization of low noise valves, mufflers after the valves and sound insulation on the external walls of pipelines.

6. Solid Waste

242. Solid waste generated in the construction phase will include construction and domestic waste. Construction wastes include various waste packing materials and waste generated during equipment and pipeline installation and cleaning. An estimated of 0.5 kg/day per worker of domestic waste will be generated from construction workers. There are 200 workers during construction period and the construction period is 300 days, then the total domestic waste generated during construction period will be 30 tons. Inappropriate waste storage and disposal could affect soil, groundwater and surface water resources, and hence, public health and

sanitation.

243. The following solid waste management measure and construction good practice as set out in EHS Guidelines on C&D will be implemented:

(i) Wastes will be reused or recycled to the extent possible.

(ii) Littering by workers will be prohibited.

(iii) Excavated soil will be backfilled onsite to the extent possible. Excess spoil that cannot be used on-site will be transported to an approved spoil disposal site.

(iv) Existing domestic waste containers will be used for domestic waste collection at work sites. Domestic waste will be collected on a regular basis by the local sanitation departments and transported for recycling, reuse, or disposal at a licensed landfill, in accordance with relevant PRC regulations and requirements.

(v) Construction waste dumpsters will be provided at all construction sites. Construction waste will be collected on a regular basis by a licensed waste collection company and transported for recycling, reuse, or disposal at a licensed landfill, in accordance with relevant PRC regulations and requirements.

(vi) There should be no final waste disposal on site. Waste incineration at or near the site is strictly prohibited.

(vii) Contractors will be held responsible for proper removal and disposal of any significant residual materials, wastes, spoil, that remain on the site after construction.

7. Hazardous and Polluting Materials

244. Inappropriate transportation, storage, use and spills of petroleum products and hazardous materials such as oily waste can cause soil, surface and groundwater contamination. To prevent this, the following mitigation measures and construction good practice as set out in EHS Guidelines on C&D will be implemented:

(i) A hazardous material handling and disposal protocol that includes spill emergency response will be prepared and implemented by contractors.

(ii) Storage facilities for fuels, oil, chemicals and other hazardous materials will be within secured areas on impermeable surfaces provided with dikes with a 110% volume, and at least 300 m from drainage structures and important water bodies. A standalone site within the storage facility will be designated for hazardous wastes.

(iii) Signs will be placed at chemicals and hazardous materials storage sites to provide information on type and name of chemicals and hazardous materials.

(iv) Suppliers of chemicals and hazardous materials must hold proper licenses and follow all relevant protocols and PRC regulations and requirements.

(v) A licensed company will be hired to collect, transport, and dispose of hazardous materials in accordance with relevant PRC regulations and requirements.

8. Impacts on Community Health and Safety

245. Construction activities have the potential to cause community disturbance such as traffic congestion or delays, and public safety risks from heavy vehicles and machinery traffic and risk to kids trying to get onto construction site. Mitigations and construction good practice as set out in EHS Guidelines on C&D and EHS general guidelines will be implemented to address traffic and other community disturbance issues.

(i) Each contractor will undertake H&S risk assessment of construction works and implement relevant construction phase EHS plan in line with construction good practice as set out in EHS Guidelines on C&D and Occupational H&S guidelines

(ii) Transportation routes and delivery schedules will be planned during detailed design to avoid densely populated and sensitive areas and high traffic times.

(iii) Vehicles transporting construction materials or wastes will slow down and not use their horn when passing through or nearby sensitive locations, such as residential communities, schools and hospitals.

(iv) Signs will be placed at construction sites in clear view of the public, warning people of potential dangers such as moving. All sites will be made secure, discouraging access by members of the public through appropriate fencing with security guards whenever appropriate.

9. Workers Occupational Health and Safety

246. Construction may cause physical hazards to workers from noise and vibration, dust, handling heavy materials and equipment, falling objects, work on slippery surfaces, fire hazards, chemical hazards such as toxic fumes and vapors, and others.

247. Contractors will implement adequate precautions to protect the health and safety of their workers:

(i) Each contractor will undertake H&S risk assessment of construction works and implement relevant construction phase EHS plan in line with construction good practice as set out in EHS Guidelines on C&D and Occupational H&S guidelines.

(ii) Identify and minimize the causes of potential hazards to workers. Implement appropriate safety measures.

(iii) Provide training to workers on occupational health and safety, emergency response, especially with respect to using potentially dangerous equipment and storage, handling and disposal of hazardous waste. Induction will be conducted before construction and no worker is allowed on site without induction.

(iv) Ensure that all equipment is maintained in a safe operating condition.

(v) Provide appropriate PPE to workers.

(vi) Provide procedures for limiting exposure to high noise or high temperature working environments in compliance with PRC occupational exposure limits for hazardous agents in work place Part 2: physical agents (GBZ 2.2-2007 and EHS Occupational Health and Safety Guidelines).

(vii) Ensure regular safety meetings with staff.

10. Physical Culture Resources

248. Based on site visits, there are no known cultural heritage or archaeological sites at or near the component sites. However, construction activities have the potential to disturb as yet unknown underground cultural relics. To address this issue, a construction phase chance find procedure will be established and activated if any chance finds of PCRs are encountered:

(i) construction activities will be immediately suspended if any PCRs are encountered;

(ii) destroying, damaging, defacing, or concealing PCRs will be strictly prohibited in accordance with PRC regulations;

(iii) local Cultural Heritage Bureau will be promptly informed and consulted; and,

(iv) construction activities will resume only after thorough investigation and with the permission of the local Cultural Heritage Bureau.

(v) In case of any PCR is found, ADB SPS 2009 requirements as well as PRC laws and regulations will be followed.

C. Anticipated Operation Phase Impacts and Mitigation Measures

249. The component may cause some adverse impacts during operation including use of water, production of wastewater and solid wastes, fire and safety hazards, and community and workers health and safety.

1. Water supply and wastewater pollution

250. The component will have 69 staff and daily domestic water consumption is 3.45 tons and annual is 931.5 tons (270 working days). The total water supply plant in Jinan urban is 910,000 tons per day. The total municipal water consumption is very limited compared to Jinan's water supply capacity. This is not expected to result in any significant negative impact on Jinan's water supply. Water supply agreement will be signed before the operation of the component.

251. The component will use municipal water as domestic water and production water. Domestic wastewater will be produced from production wastewater and toilet facilities. Production wastewater will include wastewater from boilers, cooling towers soften water treatment workshop and heating and cooling system.

Once operational, annual wastewater including domestic waste water, cooing water blow down, wastewater from soften water treatment process and regeneration processes etc. discharged by the component will be 150,552m^3 and pollutants concentration in the wastewater is presented in

252. **Table V-2** which can meet Class B maximum acceptable concentrations (MACs) in *Wastewater Quality Standards for Discharge to Municipal Sewers* (GB/T 31962-2015). The wastewater will be treated in nearby WWTP and discharged to Xiaoqing River. Estimated COD and ammonia nitrogen discharged by the component are 71.24 and 7.59 tons respectively.

Table V-2: Wastewater quantity and quality

Item	Annual flow (m^3)	Unit	COD	Ammonia nitrogen
Wastewater generated in heating season	398,214.0	mg/L	127.2	13.2
		tons	50.67	5.25
Wastewater generated in cooling season	236,491.2	mg/L	87.0	9.9
		tons	20.57	2.34
Total	634,705.2		71.24	7.59

253. To address production and domestic wastewater, good practice water management measures per the general EHS Guidelines and the following measures will be implemented:

(i) Wastewater from soften water treatment process and regeneration processes will be discharged to the municipal sewerage system.

(ii) Boiler blow down, cooling tower blow down and heating and cooling system blow down will be discharged to the municipal sewerage system.

(i) No metal (chromium or zinc) permitted to use as scaling and corrosion additive.

(ii) Because wastewater generated by equipment and pump contains oil, the wastewater will be treated in oil separator and will be discharged to the municipal sewerage system.

(iii) Domestic wastewater will be produced from worker sanitation facilities. Domestic wastewater will be treated in digestion tank and will be discharged to the municipal sewerage system.

2. Solid Waste

254. The component will generate a domestic waste and production waste. Production waste will be generated from equipment maintenance and waste thermal insulation materials. If not properly managed, this waste can cause visual and environmental impacts. To mitigate this risk, the following measures and good practice waste management measures per the EHS General Guidelines, EHS Guidelines for Environmental Waste Management and national regulations will be implemented:

(i) Domestic waste bins will be provided and domestic waste will be routinely collected by the local sanitation department for recycling, if possible, or final disposal at an approved waste disposal site.

(ii) No permanent on-site solid waste disposal will be permitted at the component site.

(iii) No burning of wastes will be permitted at the component site.

(iv) Oily waste from equipment maintenance will be collected, transported and treated by a certified 3rd party hazardous waste treatment company.

3. Chemicals and Hazardous Materials

255. Toxic, hazardous, and harmful materials present in the operation of the component include solvents, scale and corrosion inhibitors and chemicals used for water analysis and purification (which are Ethylene Diamine Tetraacetic Acid, Silver nitrate standard solution, Dilute sulphuric acid standard solution, Potassium chromate indicator, Erio-chrome black T indicator, Methyl orange indicator, Ammonia - ammonium chloride buffer solution, Sodium hydroxide solution and Phenolphthalein indicator), waste lubrication oil and waste oil-contained fabric, and waste ion exchange resin. Toxic chemicals and hazardous wastes can have negative impacts on human health and the environment if not appropriately managed. Special care and good practice hazardous materials measures per the EHS General Guidelines and will be taken to mitigate these risks, including:

(i) A registry of all activities that involve the handling of potentially hazardous substances will be developed, including protocols for the storage, handling and spill response. This will include all fuels, oils, grease, lubricants, and other chemicals.

(ii) All chemicals, toxic, hazardous, and harmful materials will be transported in spill proof tanks with filling hoses and nozzles in working order.

(iii) All chemicals, toxic, hazardous, and harmful materials will be stored in secure areas with impermeable surfaces and protective dikes such that spillage or leakage will be contained from affecting soil, surface water or groundwater systems. The area should be 110% volume of storage capacity. Their usage will be strictly monitored and recorded.

(iv) Material safety data sheets (MSDSs) will be posted for all hazardous materials.

(v) Oil absorbents will be readily accessible in marked containers.

(vi) Good housekeeping procedures will be established to avoid the risk of spills.

(vii) Spills will be dealt with immediately, and personnel will be trained and tasked with this responsibility.

(viii) Workers will be properly trained before handling hazardous wastes and have the requisite PPE.

(ix) Hazardous waste will be temporarily stored in closed containers away from direct sunlight, wind, water and rain in secure designated areas with impermeable surfaces and protective dikes such that spillage or leakage will be contained.

(x) Hazardous wastes including oily waste, waste chemicals and waste ion exchange resin will be collected and disposed by licensed contractors.

(xi) Engineering and administrative control measures will be implemented to avoid or minimize the release of hazardous substances into the work environment keeping the level of exposure below internationally established or recognized limits.

(xii) Keep the number of employees exposed, or likely to become exposed, to a minimum to hazardous substances.

(xiii) Communicating chemical hazards to workers through labeling and marking according to national and internationally recognized requirements and standards, including the International Chemical Safety Cards (ICSC), Materials Safety Data Sheets (MSDS), or equivalent. Any means of written communication should be in

an easily understood language and be readily available to exposed workers and first-aid personnel.

(xiv) Training workers in the use of the available information (such as MSDSs), safe work practices, and appropriate use of PPE.

4. Noise

256. Noise sources during operation will mainly be from noise from pumps, boiler, power generator, transformer etc. To mitigate noise impacts the component will:

(i) Low-noise equipment will be used as far as possible, and noise reduction measures such as noise elimination, shock absorption, insulated enclosures and sound dampening materials on exterior walls will be implemented.

(ii) All equipment will be properly maintained in order to minimize noise.

(iii) Appropriate noise PPE will be provided to the workers who are likely to be exposed to high noise level environments to meet the requirements in occupational exposure limits for hazardous agents in work place Part 2: physical agents (GBZ 2.2-2007) and EHS Guidelines on Occupational H&S.

(iv) Layout for component site will be reasonable planned to reduce noise.

257. Noise emission by the component is presented in **Table V-3**.

Table V-3: Main noise sources and mitigation measures

Noise Source	Estimated Noise Emission dB(A)	Mitigation Measures	Estimated Noise Emission after mitigation dB(A)
Boilers	80-85	Sound absorber, vibration attenuation, acoustic shield, exhaust-gas muffler	65-70
Circulating water pump	70-75	Vibration attenuation, sound insulation	60-65
Make-up pump	65-70	Vibration attenuation, sound insulation	55-60
Air compressor	80-85	Vibration attenuation, sound insulation	70-75
Transformer	70-75	Vibration attenuation, sound insulation and reasonable layout	60-65
Cooling tower	70-75	Vibration attenuation, sound insulation and fence	60-65

Source: Domestic EIA, 2018.

258. Noise modeling was conducted for the cooling towers based on Technical Guidelines for EIA – Acoustic Environment (HJ 2.4-2009). There are three prediction modes in this guideline for predicting point noise sources at outdoor, for indoor noise sources and cumulative results for different noise sources. The estimated noise levels at the site boundaries of Dongxin Thermal Power Plant are presented in **Table V-4**.

259. **Table V-4** indicates that noise levels during operation can comply with relevant standards.

Table V-4: Estimated noise level at the site boundaries during operation

Location	Daytime (dB(A))		Compliance status	Nighttime (dB(A))		Compliance status
	Estimated noise level	Limit		Estimated noise level	Limit	
West boundary	50.5	60	Yes	49.2	55	Yes
South boundary	56.8	60	Yes	53.4	55	Yes
East boundary	51.1	60	Yes	50.0	55	Yes
North boundary	50.7	60	Yes	50.0	55	Yes
Huaxiannanyuan Community (sensitive receptor)	50.3	55	Yes	49.5	45	A little bit over EHS Guidelines standard during night time. Further mitigation measures will be taken during operation.

Source: Domestic EIA, 2018.

5. Community and Occupational Health and Safety

260. Plant operation poses potential risks to workers and community, including fire and noise pollution.

261. To mitigate potential health and safety risks to workers, the following measures and good practice measures per the EHS Guidelines on occupational H&S will be taken:

(i) Operation phase EHS plan and traffic management plan will be developed and implemented and workers will be trained regularly on their implementation.

(ii) PPE including goggles, gloves, safety shoes will be provided to workers. Noise protection equipment will be provided to workers in high-noise area. Noise areas with more than 85 dB(A) shall be marked and hearing protections shall be provided to workers.

(iii) Noise level inside control room should be no more than 60 dBA.

(iv) Provide training to workers on occupational health and safety, and emergency response.

(v) Pipelines will be grounded and equipped with anti-lightning devices where applicable.

(vi) Vehicles transporting materials or wastes will slow down and not use their horn when passing through or nearby sensitive locations, such as residential communities, schools and hospitals.

(vii) Safe traffic control measures, including road signs and flag persons to warn of dangerous conditions will be taken as needed. Regular maintenance of vehicles to minimize potential accidents caused by equipment malfunction.

(viii) Energy centers and HESs will be fence with restricted public access.

(ix) Potential occupational electric and magnetic fields (EMF) exposure should be prevented/minimized through identifying potential exposure levels in the workplace, training of workers in the dentification of occupational EMF levels and hazards, implementing action plans to address potential or confirmed exposure levels that exceed reference occupational exposure levels developed by international organizations. Personal exposure monitoring equipment should be set to warn of exposure levels that are below occupational exposure reference levels (e.g., 50 percent).

(x) Regular inspection and maintenance of pressure vessels and piping will be conducted. Adequate ventilation in work areas to reduce heat and humidity will be installed. Surfaces where workers come in close contact with hot equipment will be shielded. Warning sign will be placed in high temperature areas.

6. Emergency Response Plan

262. An emergency risk and response plan will be established in accordance with the "National Environmental Emergency Plan" (24 January 2006) and other relevant PRC laws, regulations and standards and will include measures in the World Bank EHS guidelines with respect to occupational and community health and safety. The main risks include fire hazard. Major elements of the emergency response plan are presented in **Table 2** of Appendix I.

D. Anticipated Positive Operation Phase Impacts

263. The component will deliver significant positive social impacts to beneficiaries through the delivery of heating and cooling by clean energy.

264. Instead of coal the component will use a mix of cleaner heat sources such as waste heat. When compared to the equivalent production of heat and cooling through traditional coal-fired sources and air conditioner, once operational the component will: (i) result in annual energy savings equivalent to 59,069.28 tce, thereby providing a global public good by avoiding the annual emission of 214,516.21 tons of CO_2; (ii) improve local air quality through the estimated annual reduction of emissions of SO_2 by 280.99 tons, NOx by 345.43 tons, and PM by 51.32 tons; and (iii) eliminate the negative impacts of coal transportation through urban areas by truck or train.

Table V-5: Coal and emission reduction calculations

Item	Technology adopted	Heating or cooling area (million m^2)	Energy consumption	Energy consumption TCE (tons)	Pollutants emission (tons)			
					CO_2	SO_2	NOx	PM
Component	Waste heat recovery	6.22	0	0	0	0	0	0
	Electrode boiler	0.70	33.43 GWh[18]	10,430.16[19]	24,244.01[20]	13.04	12.03	2.67
	Ice storage AC and electric cooling equipment	2.2	9.35 GWh[18]	2,917.2[19]	6,783.66	3.65	3.37	0.75
Baseline	Coal based CHP	6.22	87210.62 TCE	64,416.1[621]	228,491.8[22]	271.8	271.8	45.3
	Gas-fired boiler	0.70	3.49 million m^3 natural gas	4234.66[23]	8,299.37	21.17	84.69	8.47
	AC for building	2.2	12.07 GWh	3,765.84[19]	8,752.71	4.71	4.34	0.97
Savings	NA	NA	NA	59,069.28	214,516.21	280.99	345.43	51.32

[18] From domestic FSR.
[19] 1 kWh is equality to 0.1229 kg standard coal;
[20] Based on the China Power Sector Annual Development Report 2017 issued by CEC (China Electricity Council), the PM, SO_2, and NOx emission factor of thermal power generation was 0.08, 0.39, and 0.36gce/kWh respectively in 2016. NDRC (National Development and Reform Commission) issues CO_2 emission per kWh every year for CDM project development. The carbon emission factor of North China Grid was 0.7253 t CO_2/MWh in 2016.
[21] Based on operating data of JHG, in 2017-2018 heating season, coal consumption intensity for heat supply was 0.014tce/m^2/a
[22] According to Air Pollutants Emission Standards for Boilers (GB13271-2014), the PM, SO2, and NOx emission standard is 30mg/m^3, 200 mg/m^3, and 200 mg/m^3respectively. Burning 1kg standard coal produces 9.6Nm³ waste gas, and produces 1.92 g SO2, 1.92 g NOx and 0.288 g PM.
[23] According to Environment Protect Practical Data Handbook, CO2 emission is 1.96kg per $m^3$of natural gas. With Jinan being in key area of air pollution control, the PM, SO_2, and NOx emission standard for Jinan is 20mg/m^3, 50mg/m^3 and 150 mg/m^3 respectively (Here m^3 refers to the volume of waste gas). Burning 1m^3 natural gas produces 12.14m^3 waste gas. According to Technique Guidance for Emission Inventory of Primary Fine Particles, PM2.5 emission intensity of natural gas is 0.03g per $m^3$of natural gas.

VI. ANALYSIS OF ALTERNATIVES

265. An analysis of component alternatives was undertaken during the feasibility stage to determine the most financially and technically feasible way of achieving the project objectives while minimizing environmental and social impacts.

A. No Project Alternative

266. Jinan, the capital of Shandong Province, is situated in the northeastern part of PRC. The winter temperature drops to as low as –19°C, and sub-zero temperatures typically last for 4 months a year; under this climate heating service is an essential requirement for sustaining people's livelihoods. Heat demand in Jinan is increasing substantially due to rapid ongoing urban expansion. Current district heating coverage in Jinan is approximately 147 million m^2, compared to 87.6 million m^2 in 2012.

267. The existing system in Jinan is a large scale district heating system driven by coal-fired heat source plants or CHP plants. However, the expansion of the existing coal-based district heating system to meet the increasing demand is not an option as Jinan has been experiencing significant pollution problems in the winter heating seasons including hazy skies and high levels of particulates.

268. Coal-based heating is the major cause of rising level of outdoor and indoor air pollution during the winter. According to PM source analysis result in Jinan in 2017 by Jinan EPB, 24.6% of $PM_{2.5}$ and 17.4% of PM_{10} are from coal combustion.

269. The component's implementation will: (i) fulfil rapidly increasing heat and cooling demand in Maoling Area; (ii) significantly reduce coal consumption; (iii) improve air quality; and (iv) reduce GHG emissions. It will also provide valuable hands on experience and help to explore various uses of different energy sources like waste heat and power source, which will support the development of sustainable energy system solutions for rapid urban development. For these reasons the "no project" alternative is considered unacceptable.

B. Energy Sources

270. There are several heat sources options for district heating, including CHP plants, large coal, natural gas or biomass-fired heat source plants (HSPs), solar energy, wind energy, industrial or residential waste heat, geothermal energy, and heat pumps.

271. CHPs and HSPs are considered the most proven, economically viable, energy efficient and environmentally friendly heat source options for northern China.

272. Based on No Project Alternative analysis, coal based CHPs and HSPs are not acceptable. China is not in rich in natural gas. In 2017, China purchased 92.0 billion m^3 natural gas from foreigner countries and the total natural gas consumption in China in 2017 was 237.3 billion m^3. Considering the natural gas shortage of northern China occurred in 2017 heating season led by coal-to-gas switch in northern China and Jinan is not rich in natural gas, natural gas in Jinan is not a good choice in recent years.

273. The component is located at urban area of Jinan, there is no biomass resource available in a radius of 18 km. Therefore, biomass is not a good choice.

274. Annual average sunshine hours near the component site from 1997-2016 were 2,177.5 hours and is classified as middle level solar energy area. Therefore, solar power is not a good choice.

275. Average wind speed near the component site from 1997-2016 were 1.9 m/s and is classified as middle level wind power area. Therefore, wind power is not a good choice.

276. Because Maoling Area is now under construction, heat load in this area will not increase fast from 2018 to 2022. Therefore, HSP plant is not a good choice.

277. Waste heat is the cleanest source for heat supply and there is enough waste heat from Zhangqiu Thermal Power Plant.

278. Overall, the component has selected the most appropriate fuel type.

C. District cooling

279. In Maoling Area, commercial building groups include 5 high-rise buildings (more than 24m high) and many commercial buildings for rent, totaling over 2 million m² of floor area. These buildings all have cooling demand. There are two cooling methods for large commercial buildings: 1. Set independent cooling rooms in every building and set cooling towers on the roof. This is the commonly adopted cooling solution. 2. Adopt district cooling, which means that no independent cooling room and cooling tower is set in every building. It is conducive to reduce water pollution and noise pollution, and can enormously ease the environmental influence from conventional cooling method. Thus, district cooling is promising in areas with huge cooling demand.

280. Considering the resource status quo in Jinan CBD, following techniques can be adopted for district cooling: lithium bromide absorption chiller and electrical air conditioner.

281. Compared to air conditioner, lithium bromide absorption chiller can improve cooling efficiency, energy efficiency, and using rate of building space and reduce water wasted in cooling towers and sound pollution. Besides, the combination of district cooling technique and cooling storage technique reduces the installed capacity of cooling devices, as well as the initial investment. Chillers use electricity at off-peak time during night and provide cooling energy by melting ice at peak time during the day, which shifts peak load, narrows differences between the peak time and valley time in the grid, and enables users using peak-valley tariff to save operation cost. Furthermore, cold source is easy to optimize control and maintenance management, which is helpful to improve operation efficiency, save energy, and cut labor cost in management.

D. Piloting Electrode Boilers

282. The Project will pilot the use of electric boilers. Electric boilers have several key advantages over fossil fuel fired boilers: they have extremely quick response times; they are flexible for cyclical or intermittent operations; they are clean firing, produce no combustion emissions and do not require stacks; they are greater than 99% efficient; and they are smaller in volume and footprint than fossil fired boilers.

283. There are two main types of electric boilers:

Electrode Boilers

- Works by passing current through the water between two electrodes. The resistance of the water produces heat.
- Supply voltage: 6 – 14 kV.
- Power output: 6 to 100 MW.

Electric Resistance Boilers

- Works by passing current through an electrically resistive element to transfer heat to the water.
- Supply voltage: 380 – 690 V.
- Power output: up to 6 MW.

284. Electrode boilers have been selected for the Project due to their higher output which requires fewer units, and their higher supply voltage (electrode boilers use high voltage connection which eliminates the need for step-down transformers; resistive boilers utilize low voltage so more transformers are required). Based on the heating needs of Maoling Area it was determined that the component will pilot the use of one 24 MW and one 6 MW high-efficiency zero-emission demonstration 10 kV Electrode Boilers.

E. Pipeline Network

285. The component will utilize direct-buried pre-insulated bonded pipeline, which is by far the most commonly used technology for both new district heating and cooling systems and for rehabilitation of existing systems. Steel pipes and insulation materials made of polyurethane foam and high density polyethylene are bonded into one piece in a sandwich-like structure. Compared to onsite insulated pipe buried in a tunnel, direct-buried pre-insulation bonded pipe has many advantages including lower capital costs, reduced heat losses and improved energy efficiency, better anti-corrosive and insulation performance, longer service life, limited land acquisition requirement and shorter installation cycles. Although pre-insulated bonded pipe is designed for direct-bury installation, some sections of pipeline may need to run overhead and/or use trench laying modes, depending on local site conditions.

286. The component will also install low temperature heat supply secondary networks. Pre-insulated plastic pipes will be directly buried, and twin-pipe can be utilized where both supply and return pipe can be inserted into one insulation jacket. Construction of secondary networks is easier when bendable plastic pipes are used.

F. Overall Alternative Analysis

287. Based on the analysis of alternatives, the component has selected the most appropriate and sustainable heat and cooling sources and pipeline type.

VII. INFORMATION DISCLOSURE AND PUBLIC CONSULTATION

A. PRC and ADB Requirements for Disclosure and Public Consultation

1. PRC Requirements

288. Relevant provisions in the PRC *Environmental Impact Assessment Law* (revised in 2016) and the *Regulations on the Administration of Construction Project Environmental Protection* (No. 253 Order of the State Council, 1998, revised in 2017) require that an EIA study for a construction project shall solicit opinions from affected residents, as well as other organizations and concerned stakeholders. However, the requirements for public consultation are different for various sectors and projects. For an environmental Category A project a full EIA report is required including two rounds of public consultations, while for a Category B project only a simplified tabular EIA is required without the need for public consultation.

289. The "Provisional Regulations on Public Participation in Environmental Impact Assessment" (2006) promulgated by State Environmental Protection Administration further improved the legislation of public participation in EIA in China. It provides detailed requirements for the public participation process, including information disclosure standards, consultation methods, and public enquiry process. It is significant since it was the first document clearly regulating public participation in EIA in China.[24]

290. In 2014, former MEE released "Guiding Opinions on Promoting Public Participation in Environmental Protection" (2014, No. 48) which defines public participation as 'citizens, legal persons and other organizations' voluntary participation in environmental legislation, enforcement, judicature and law obedience, and the development, utilization, protection and transformation activities related to environment.

291. The public disclosure and consultation process undertaken during the preparation of the domestic EIA was undertaken in compliance with the relevant PRC requirements, including the "Provisional Regulations on Public Participation in Environmental Impact Assessment" (2006) and the "Guiding Opinions on Promoting Public Participation in Environmental Protection" (2014, No. 48).

2. ADB Requirements

292. ADB's SPS (2009) has specific requirements for information disclosure and public consultation. Information disclosure involves delivering information about a proposed project to the general public and to affected communities and other stakeholders, beginning early in the project cycle and continuing throughout the life of the project. Information disclosure is intended to facilitate constructive engagement with affected communities and stakeholders over the life of the project.

293. The SPS requires that borrowers take a proactive disclosure approach and provide relevant information from environmental assessment documentation directly to affected peoples and stakeholders. In addition, in order to make key documents widely available to the general public, the SPS requires submission to ADB for posting on the ADB website as follows:

24 Wang Ya Nan, 2012. Public Participation in EIA, SEA and Environmental Planning in China. Environmental Impact Assessment Research Centre.

(i) a draft full EIA (including the draft EMP) at least 120 days prior to ADB Board consideration for Category A projects, and/or environmental assessment and review frameworks before project appraisal, where applicable;
(ii) the final EIA/IEE;
(iii) a new or updated EIA/IEE, EMP and corrective action plan prepared during project implementation, if any; and
(iv) environmental monitoring reports.

294. The SPS also requires that the borrower carry out meaningful consultation with affected people and other concerned stakeholders, including civil society, and facilitate their informed participation. Consultations should include presentations on environmental impacts, benefits and mitigation measures, the project GRM, and ADB's Accountability Mechanism. For category A projects, such consultations should include consultations both at an early stage of EIA field work and when the draft EIA report is available.

B. Project Information Disclosure

295. EIA Institute has undertaken one round of public consultation and two rounds of information disclosure in accordance with the Interim Guidelines on Public Consultation for EIA (2006) during domestic EIA process. The public consultation are implemented by EIA Institute and PPTA consultant.

1. Information Disclosure by EIA Institute

296. IA disclosed the information of the component in two steps. The first public information notice was posted on the Jinan EPB's website in June 2018, early in the domestic EIA preparation process. The information in the first public notification (The link is http://jnepb.jinan.gov.cn/art/2018/6/20/art_24998_2029860.html) is listed below:

(i) Name and summary of the component.
(ii) Name and contact information of the construction company.
(iii) Name and contact information of the institute responsible for preparing the EIA of the component.
(iv) EIA procedures and content.
(v) Type of EIA notification notice.
(vi) Request for questions, suggestions and feedback from the public.

297. A second public information notice was also posted on the Jinan EPB's website from August 7 to August 20, 2018, prior to the submission of the draft EIA report to the Jinan EPB. The link is http://jnepb.jinan.gov.cn/art/2018/8/7/art_10494_2398278.html. The notice included Project name and information below:

(i) Name and summary of the component.
(ii) Name and contact information of the institute responsible for preparing the EIA report.
(iii) Name and contact information of the institute responsible for approval of the EIA report.

(iv) Name and contact information of the construction company.

(v) Potential project environmental impacts and mitigation measures during construction phase and operation phase.

(vi) Key conclusions of the EIA report.

(vii) Contact information to get abridged versions of the EIA report.

298. No public feedback was received during two rounds of public information disclosure.

299. This IEE prepared will be disclosed on the JHG's website and ADB website. Two rounds of information disclosure have been implemented by the JHG.

Figure VII-1: Information disclosure on Jinan EPB's website


济南市环保局关于受理《济南热力集团有限公司利用亚洲开发银行贷款建设济南中央商务区区域能源工程环境影响报告表》的公示

(i) First information disclosure


济南市环保局关于对《利用亚洲开发银行贷款建设济南中央商务区区域能源工程环境影响报告表》拟审查的公示

(ii) Second information disclosure

2. Public Consultation

300. As part of the social safeguards due diligence undertaken for the component by ADB PPTA team, a social analysis was undertaken to (i) assess social patterns influenced by the component including the identification of any adverse effects; (ii) assess the current status of poverty within the heating areas and analyzed the poverty reduction impact resulting from the Project; and (iii) analyze and proposes activities which would complement the Project by enhancing the livelihood of the vulnerable people within the heating area of the component.

301. The methodology for the social analysis included socioeconomic surveys (carried out from March – April 2018) and local consultations. The consultants visited all heating areas and held meetings with the IA and local people and various district government agencies including the development and reform committees, land administration bureaus, civil affairs bureaus, urban construction bureaus and women's federations, etc.

302. The social analysis results are presented in the social analysis report.

303. According to ADB SPS's requirements, the JHG held a public consultation meeting on 10 March 2018 during the preparation of the domestic EIA and IEE. A public project information notice was posted in the nearby communities for two weeks prior to the meeting. The meeting was held in the office of JHG and 36 nearby residents were invited to the meeting. During the meeting information on the component construction content and status was presented by the JHG while information on potential environmental impacts and proposed mitigation measures, GRM requirements of ADB and component benefits was presented by social consultant and

environmental consultant. Then questions and subsequent discussions focused on environmental issues of the component and benefits of the component especially clean district heating and employment promotion. During the meeting ,most of believed that the component can provide a clean district heating service and provide more job opportunities to the nearby communities and 100% of participants supported the construction of component.

304. During the public consultant meeting, a total of 36 questionnaires (**Table VII-1**) were distributed and 36 completed questionnaires were received. The main contents of the questionnaire are potential impacts and mitigation measures. Completed questionnaires and some photos of the consultation meeting and survey are shown in **Figure VII-2**.

305. **Table VII-2** presents summary data on the questionnaire respondents, while **Table VII-3** presents a summary of the questionnaire results.

306. Most of the respondents work and live within a 5 km radius of the project. 44.4% of the participants were female. 58.3% of respondents knew about the component either from other person, newspapers or information signs, and 94.4% of respondents indicated that they were already familiar with the component benefits after the introduction of the project. 43.3% of the respondents were female. The top three environment issues respondents identified in their neighborhoods are air quality (63.9%), noise (41.7%) and surface water (16.7%). Dust and noise were identified as the top two issues during the construction phase. Air pollution and noise were identified as the top two issues during the operation phase. However, most participants also indicated that potential air, waste water, solid waste and noise impacts can be appropriately mitigated.

307. Overall support for the component is very strong; 83.3% of the respondents indicated that the component will improve local economic development; 88.9% indicated that the component will improve quality of life; and 91.7% of respondents indicated that they support the proposed component.

Table VII-1: Project public consultation questionnaire (2018)

Name		Sex		Age	
Education level		Occupation		Nationality	
Contact information					
Question		**Choices**		**Yes**	**Comments**
1. In your opinion, what are the major environment pollution issues in your areas?		Ambient air			
		Noise			
		Surface water			
		Ground water			
		Soil			
		Solid waste			
		Odor			
		Risks associated with chemicals and hazardous chemicals			
		Other concern			
2. Distance between your working place and project site		<1 km			
		1-3 km			
		3-5 km			
		> 5km			
3. Distance between your house and project site		<1 km			
		1-3 km			
		3-5 km			
		> 5km			
4. Do you know this project before this public consultation?		Yes			
		No			
5. Do you understand environment impacts of this project before this public consultation?		Yes			
		No			
		Not clear			
6. After knowing about the EIA findings, are all the potential positive and adverse impacts of the proposed project components clear to you?		Clearly understand			
		Somewhat understand			
		Barely understand			
		Do not understand			
		Exhaust air efficiency treatment			

7. In your opinion, what should be the most critical area that the project should focus on?	Controlling fugitive emissions		
	Wastewater treatment		
	Groundwater protection		
	Soil protection		
	Chemicals handling		
	Odor control		
	Make use of recyclable resources to reduce solid waste		
	Noise disturbing to residents		
	Protection for community health and safety		
	Protection to workers health and safety		
	Others		
8. Do you understand the potential adverse impacts during the construction of the proposed project components?	Clearly understand		
	Somewhat understand		
	Barely understand		
	Do not understand		
9. What do you think about the project construction? Do you think it is necessary?	Necessary		
	Barely necessary		
	Not necessary		
	It does not matter		
10. What would be the major impacts during project construction?	Noise		
	Dust		
	Solid waste		
	Traffic congestion		
	Others		
	No major impacts		
11. Without mitigation measures, do you accept anticipated construction phase impacts?	Accept		
	Barely accept		
	Do not accept		
	Have no idea		
12. After learning about mitigation measures during the construction, do you accept anticipated construction phase impacts?	Accept		
	Barely accept		
	Do not accept		
	Have no idea		
13. Do you agree with project construction after comprehensive consideration?	Yes		
	No		
	I do not know		
14. Do you understand all the anticipated environmental adverse impacts of the project during operation?	Clearly understand		
	Somewhat understand		
	Barely understand		
	Do not understand		
15. Do you understand all the anticipated health and safety adverse impacts of the project during operation?	Clearly understand		
	Somewhat understand		
	Barely understand		
	Do not understand		
16. Do you understand the proposed mitigation measures during the project operation?	Clearly understand		
	Somewhat understand		
	Barely understand		
	Do not understand		
	Accept		
	Barely accept		

17. Do you accept the impacts to ambient air quality by this project?	Do not accept		
	Have no idea		
18. Do you accept the impacts to surface water quality by this project?	Accept		
	Barely accept		
	Do not accept		
	Have no idea		
19. Do you accept the impacts to ground water quality by this project?	Accept		
	Barely accept		
	Do not accept		
	Have no idea		
20. Do you accept the impacts to acoustic environment quality by this project?	Accept		
	Barely accept		
	Do not accept		
	Have no idea		
21. Do you accept the solid waste pollution by this project?	Accept		
	Barely accept		
	Do not accept		
	Have no idea		
22. Do you accept the impacts to ecological environment by this project?	Accept		
	Barely accept		
	Do not accept		
	Have no idea		
23. Do you accept environment, health, and safety risks caused by this project?	Accept		
	Barely accept		
	Do not accept		
	Have no idea		
24. What are the major concerns of this project	Ambient air		
	Noise		
	Surface water		
	Ground water		
	Soil		
	Solid waste		
	Odor		
	Risks associated with chemicals and hazardous chemicals		
	Other concern		
25. Which is your top concern of this project?	Ambient air		
	Noise		
	Surface water		
	Ground water		
	Soil		
	Solid waste		
	Odor		
	Risks associated with chemicals and hazardous chemicals		
	Other concern		
26. Do you think construction of this project can improve local economic development or not?	Yes		
	No		
	I do not know		
27. Do you think whether construction of this project can improve your living quality such as better hear supply service?	Yes		
	No		
	I do not know		

28. Do you support the project?	Yes		
	No		
	I do not know		
Suggestions or requirements for environment protection of the project.			

Figure VII-2: Public consultation activities

(i) Presentation on project information by IA.

(ii) Discussion

(iii) Questionnaire fill up

Table VII-2: Summary data on questionnaire respondents

Parameter	Indicator	No.	%
Sex	Male	20	55.6%
	Female	16	44.4%
Age	Below 30	2	5.6%
	31-40	2	5.6%
	41-50	12	33.3%
	Above 50	19	52.8%
Nationality	Han people	36	100.0%
	Other	0	0.0%
Education Level	Primary School or Below	12	33.3%
	Junior school	19	52.8%
	High school, including technical secondary school	2	5.6%
	Bachelor degree or above, including junior college	2	5.6%
Occupation	Farmer	10	27.8%
	Employee	21	58.3%
	Civil servant	4	11.1%
	Other	0	0.0%

Table VII-3: Public consultation questionnaire results

Question	Item	No.	% (shading denotes highest ranked)
1. In your opinion, what are the major environment pollution issues in your areas?	Ambient air	23	63.9%
	Noise	15	41.7%
	Surface water	6	16.7%
	Ground water	2	5.6%
	Soil	5	13.9%
	Solid waste	3	8.3%

	Odor	0	0
	Risks associated with chemicals and hazardous chemicals	0	0
	Other concern	0	0
2. Distance between your working place and project site	<1 km	2	5.6%
	1-3 km	15	41.7%
	3-5 km	9	25.0%
	> 5km	10	27.8%
3. Distance between your house and project site	<1 km	9	25.0%
	1-3 km	10	27.8%
	3-5 km	11	30.6%
	> 5km	5	13.9%
4. Do you know this project before this public consultation?	Yes	21	58.3%
	No	15	41.7%
5. Do you understand environment impacts of this project before this public consultation?	Yes	16	44.4%
	No	14	38.9%
	Not clear	6	16.7%
6. After this public consultation, are all the potential positive and adverse impacts of the proposed project components clear to you?	Clearly understand	28	77.8%
	Somewhat understand	6	16.7%
	Barely understand	2	5.6%
	Do not understand	0	0
7. In your opinion, what should be the most critical area that the project should focus on?	Exhaust air efficiency treatment	5	13.9%
	Controlling fugitive emissions	8	22.2%
	Wastewater treatment	6	16.7%
	Groundwater protection	3	8.3%
	Soil protection	2	5.6%
	Chemicals handling	1	2.8%
	Odor control	0	0.0%

	Make use of recyclable resources to reduce solid waste	0	0.0%
	Noise disturbing to residents	22	61.1%
	Protection for community health and safety	8	22.2%
	Protection to workers health and safety	3	8.3%
	Others	0	0.0%
8. Do you understand the potential adverse impacts during the construction of the proposed project?	Clearly understand	23	63.9%
	Somewhat understand	8	22.2%
	Barely understand	3	8.3%
	Do not understand	2	5.6%
9. What do you think about the project construction? Do you think it is necessary?	Necessary	27	75.0%
	Barely necessary	4	11.1%
	Not necessary	2	5.6%
	It does not matter	2	5.6%
10. What would be the major impacts during project construction?	Noise	13	36.1%
	Dust	8	22.2%
	Solid waste	3	8.3%
	Traffic congestion	5	13.9%
	Others	0	0.0%
	No major impacts	6	16.7%
11. Without mitigation measures, do you accept anticipated construction phase impacts?	Accept	29	80.6%
	Barely accept	5	13.9%
	Do not accept	0	0.0%
	Have no idea	2	5.6%
12. After learning about mitigation measures during the construction, do you accept anticipated construction phase impacts?	Accept	28	77.8%
	Barely accept	3	8.3%
	Do not accept	2	5.6%
	Have no idea	3	8.3%

13. Do you agree with project construction after comprehensive consideration?	Yes	30	83.3%
	No	3	8.3%
	I do not know	3	8.3%
14. Do you understand all the anticipated environmental adverse impacts of the project during operation?	Clearly understand	29	80.6%
	Somewhat understand	5	13.9%
	Barely understand	2	5.6%
	Do not understand	0	0.0%
15. Do you understand all the anticipated health and safety adverse impacts of the project during operation?	Clearly understand	27	75.0%
	Somewhat understand	5	13.9%
	Barely understand	1	2.8%
	Do not understand	3	8.3%
16. Do you understand the proposed mitigation measures during the project operation?	Clearly understand	30	83.3%
	Somewhat understand	4	11.1%
	Barely understand	2	5.6%
	Do not understand	0	0.0%
17. Do you accept the impacts to ambient air quality by this project?	Accept	31	86.1%
	Barely accept	4	11.1%
	Do not accept	0	0.0%
	Have no idea	1	2.8%
18. Do you accept the impacts to surface water quality by this project?	Accept	31	86.1%
	Barely accept	5	13.9%
	Do not accept	0	0.0%
	Have no idea	0	0.0%
19. Do you accept the impacts to ground water quality by this project?	Accept	32	88.9%
	Barely accept	3	8.3%
	Do not accept	0	0.0%
	Have no idea	1	2.8%

20. Do you accept the impacts to acoustic environment quality by this project?	Accept	32	88.9%
	Barely accept	4	11.1%
	Do not accept	0	0.0%
	Have no idea	0	0.0%
21. Do you accept the solid waste pollution by this project?	Accept	33	91.7%
	Barely accept	2	5.6%
	Do not accept	0	0.0%
	Have no idea	1	2.8%
22. Do you accept the impacts to ecological environment by this project?	Accept	31	86.1%
	Barely accept	2	5.6%
	Do not accept	0	0.0%
	Have no idea	3	8.3%
23. Do you accept environment, health, and safety risks caused by this project?	Accept	32	88.9%
	Barely accept	4	11.1%
	Do not accept	0	0.0%
	Have no idea	0	0.0%
24. What are the major concerns of this project	Ambient air	5	13.9%
	Noise	16	44.4%
	Surface water	6	16.7%
	Ground water	3	8.3%
	Soil	3	8.3%
	Solid waste	2	5.6%
	Odor	0	0
	Risks associated with chemicals and hazardous chemicals	1	2.8%
	Other concern	0	0.0%
25. Which is your top concern of this project?	Ambient air	6	16.7%
	Noise	21	58.3%

	Surface water	2	5.6%
	Ground water	2	5.6%
	Soil	0	0.0%
	Solid waste	2	5.6%
	Odor	0	0
	Risks associated with chemicals and hazardous chemicals	3	8.3%
	Other concern	0	0.0%
26. Do you think construction of this project can improve local economic development or not?	Yes	30	83.3%
	No	4	11.1%
	I do not know	2	5.6%
27. Do you think whether construction of this project can improve your living quality such as better hear supply service?	Yes	32	88.9%
	No	2	5.6%
	I do not know	2	5.6%
28. Do you support the project?	Yes	33	91.7%
	No	1	2.8%
	I do not know	2	5.6%

C. Future Consultation Activities

308. This IEE will be disclosed on the ADB website. Any update in the IEE resulting from a change in project scope will be similarly disclosed.

309. The IA will continue to conduct regular community liaison activities during the construction and operations phases, including the implementation of the GRM (see Chapter VIII). Ongoing consultation will ensure that public concerns are understood and dealt with in a timely manner.

VIII. GRIEVANCE REDRESS MECHANISM

A. Introduction

310. A project grievance can be defined as an actual or perceived project related problem that gives ground for complaint by an affected person (AP). As a general policy, a PMO will be established by IA and it will work proactively toward preventing grievances through the implementation of mitigation measures and community liaison activities that anticipate and address potential issues before they become grievances. In addition, as the project has strong public support and will not involve any involuntary land or property acquisition or resettlement, significant grievance are unlikely to happen. Nonetheless, during construction and operation it is possible that unanticipated impacts may occur if the mitigation measures are not properly implemented, or unforeseen issues arise. In order to address complaints if or when they arise, a component-level GRM has been developed in accordance with ADB requirements. A GRM is a systematic process for receiving, recording, evaluating and addressing AP's project-related grievances transparently and in a reasonable timeframe.

B. ADB's GRM Requirements

311. The ADB's SPS 2009 requires a project to establish a GRM to receive and facilitate resolution of AP's concerns and complaints about the project's environmental performance during construction as well as operation phases of the project. The GRM should be scaled to the risks and adverse impacts of the project; should address affected people's concerns and complaints promptly, using an understandable and transparent process; should be readily accessible to the community at no cost and without retribution; and, should not impede access to the PRC's judicial or administrative remedies.

C. Current GRM Practices in the PRC

312. At the national level, a framework to address grievance has been established. State Council Decree No. 431 "Regulations on Letters and Visits" (January 2005) establishes a complaint mechanism at all levels of government, and safeguards the complainants from any retaliation. The former MEP Decree No. 34 "Environmental Letters and Visits System" provides specific guidelines to establish a system and address environmental complaints. When APs are affected by project activities, they may complain to the contractors and the project company by themselves or through their community organizations, or complain directly to local EPBs. If the issue is not resolved they may take legal action, though that is typically considered as a last option.

D. Project Level GRM

313. The objective of the component GRM is to prevent and address community concerns, reduce risks, and assist the project to maximize environmental and social benefits. In addition to serving as a platform to resolve grievances, the sub-project level GRM has been designed to (i) open channels for effective communication, including the identification of new environmental issues of concern arising from the component; (ii) demonstrate concern about community members and their environmental well-being; and (iii) prevent and mitigate any adverse environmental impacts on communities caused by component implementation and operations. The GRM will be accessible to all members of the community through public information disclosure at IA's website, project site and community center, etc.

314. The overall approach of the GRM is to deal with grievances at a local level first in an efficient manner and escalate to higher level of authority if the grievance cannot be resolved. The designated person from the PMO will be responsible for implementation of the GRM. The PMO will be the key contact point for residents, businesses, government departments and other stakeholders who may require information about the component or who have an issue they would like to discuss.

315. The GRM will be implemented through five escalating steps, advancing to the next level only if the grievance was unable to be redressed at the previous level.

(i) **Step 1**: If a concern arises, the AP can try to resolve the issue of concern either directly with the contractor or with the contactor via GRM access points (community leaders, neighborhood organizations, PMO, local EPB) during the construction phase, and/or the operator during the operation phase. If the concern is resolved successfully no further follow-up action is required. Nonetheless, the contractor (during construction) and/or the operator (during operation) shall record any complaint and actions taken to resolve the issues and report the results to the PMO and the AP. If no solution is found within 10 working days or if the AP is not satisfied with the suggested solution under Step 1, proceed to Step 2. The AP may also skip Step 1 and directly file the complaint with the PMO.

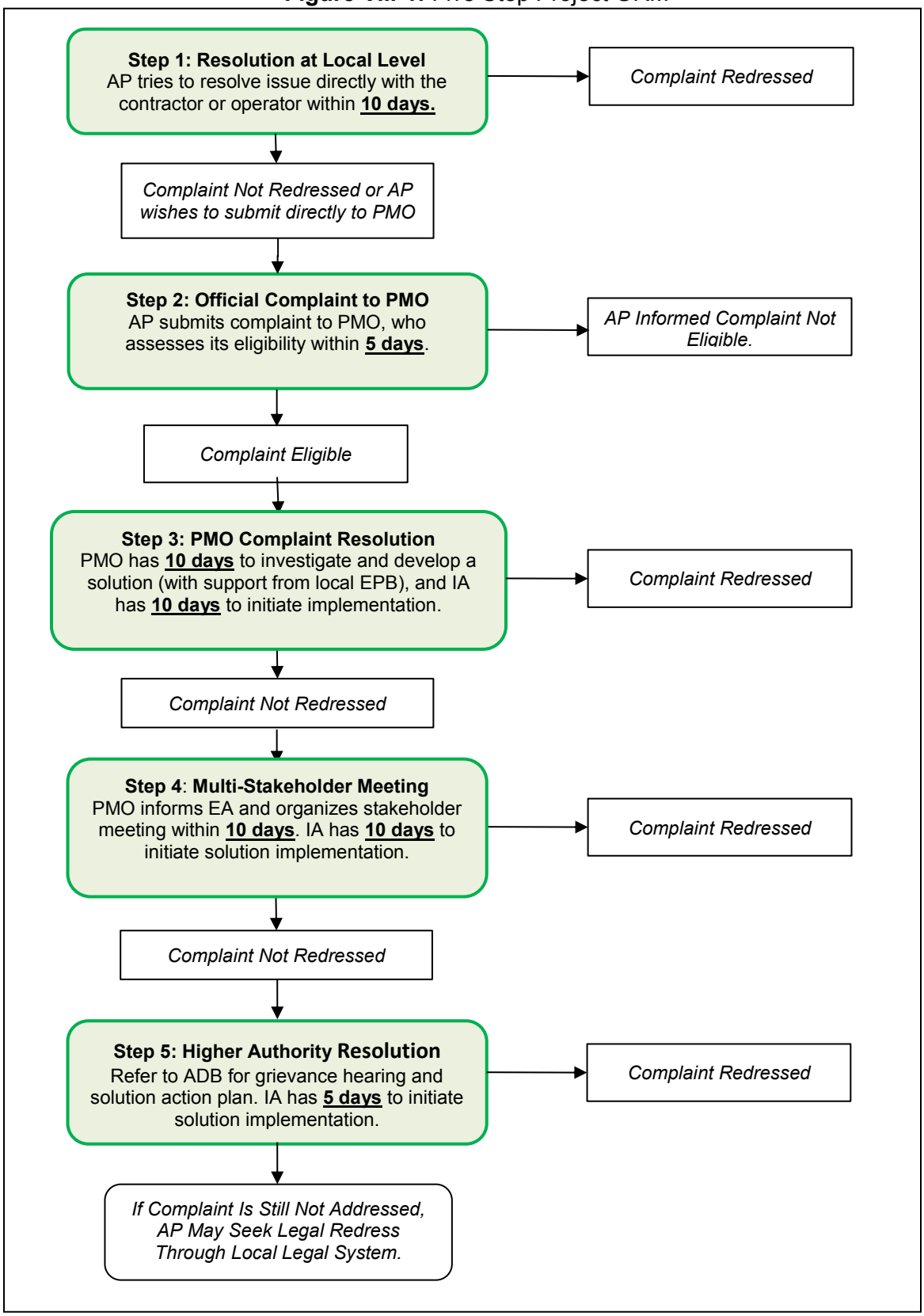
(ii) **Step 2:** The AP will submit the grievance to the PMO, who will record the grievance, assess its eligibility and report back to the AP within 5 working days. If the grievance is eligible, proceed to Step 3.

(iii) **Step 3:** The PMO will investigate the complaint, and consult with the IA, local EPB, and other stakeholders as appropriate to identify a solution. The PMO will give a clear reply to the AP within 10 working days with the suggested solution, and the IA will ensure that implementation of the agreed-upon redress solution begins within 10 working days. If no solution is found or if the complainant is not satisfied with the suggested solution under Step 3, proceed to Step 4.

(iv) **Step 4:** The PMO will inform the EA the grievance and will organize a multi-stakeholder meeting within 10 days, where all relevant stakeholders, including the complainant, EA, IA, and local EPB, can discuss the issue. The multi-stakeholder meeting will aim to find a solution acceptable to all and identify responsibilities and an action plan. The IA will ensure that the implementation of agreed-upon redress solution begins within 10 working days of the completion of the multi-stakeholder meeting.

(v) **Step 5:** If the complainant is still not satisfied with the suggested solution under Step 4, the grievance will be directed to ADB. ADB will direct the EA to organize a hearing process and shall determine a solution acceptable to all. Based on the hearing results, an action plan shall be developed and the IA will ensure that the implementation of the agreed-upon redress solution begins within 5 working days of the completion of the hearing.

Figure VIII-1: Five Step Project GRM



IX. CONCLUSIONS

316. This IEE report is prepared for the proposed East Jinan Low-Emission Combined District Heating and Cooling Component of the Shandong Clean Heating and Cooling Project (the Project) in Shandong Province of the PRC. The proposed Project is the fourth in a multi-year multi-sectoral ADB support for air quality improvement in the greater BTH region.

317. This component will utilize long-distance pipelines to transmit hot water recovered from the waste heat of Zhangqiu Thermal Power Plant to provide district heating and cooling services to Maoling Area (3.2 km^2), in eastern Jinan City. The component will provide district heating to 3.15 million m^2 area and district heating to 2.2 million m^2 area. The component is innovative as the long-distance pipe network will be the first of its kind in the province to provide heating and cooling services. The network will use "large temperature gradient" transmission technology, to increase capacity and efficiency of the district heating system. The pipes will transport waste heat from Zhangqiu Thermal Power Plant, and cold water using a steam absorption refrigeration unit located within that plant. The component also utilizes ice-storage technology that uses off-peak electricity at night to provide refrigeration services during the day. These innovations will reduce peak load and improve efficiency by using district cooling and other sources of refrigeration to replace distributed air conditioning systems. In turn this reduces the need to use expensive peaking power. In addition, the heating part of the component will reduce coal combustion for urban heating, contributing to better air quality in Jinan City.

318. The component scope includes: (i) one South Energy Center with a cooling capacity of 1.8 million m^2 and one North Energy Center a cooling capacity of 0.4 million m^2. Both the two energy centers will be installed with heat and ice storage systems; (ii) 16.85 km of primary and 20.0 km of secondary network; (iii) four open transverse flow cooling towers in existing Dongxin Thermal Power Plant; and (iv) 35 heat exchange stations (HESs) (phase I[25]) with a heating area of 3.15 million m^2. Once completed, the component will provide district heating to an area of 3.15 million m^2 and district cooling to an area of 2.2 million m^2.

319. The component will bring significant positive environmental benefits. It will reduce the emission of greenhouse gases and other air pollutants in Jinan City. When compared to equivalent heat and cool through traditional coal-fired sources and air conditioner. Once operational the component will: (i) result in annual energy savings equivalent to 59,069.28 tce, thereby providing a global public good by avoiding the annual emission of 214,516.21 tons of CO_2; (ii) improve local air quality through the estimated annual reduction of emissions of SO_2 by 280.99 tons, NOx by 345.43 tons, and PM by 51.32 tons; and (iii) eliminate the negative impacts of coal transportation through urban areas by truck or train.

320. The Component has: (i) selected appropriate technologies to reduce the emission of pollutants; (ii) identified potential negative environment impacts and appropriately established mitigation measures; (iii) received public support from the project beneficiaries and affected people; (iv) established effective project GRM procedures; and (v) prepared a comprehensive EMP including environmental management and supervision structure, environmental mitigation and monitoring plans, and capacity building and training.

[25] The phase II HESs will be built from 2023 and will be financed by counterpart fund.

321. It is concluded that the project will not result in adverse environmental impacts that are irreversible, diverse, or unprecedented. Any minimal adverse environmental impacts associated with the project will be prevented, reduced, or minimized through the implementation of the project EMP.

Appendices

Appendix I: Environmental Management Plan

Appendix II: Existing Facility Due Diligence Environmental Review –Dongxin Thermal Power Plant

Appendix III: Associated Facility Due Diligence Environmental Review –Zhangqiu Thermal Power Plant

APPENDIX I: ENVIRONMENTAL MANAGEMENT PLAN

A. Objectives

1. This EMP is for East Jinan Low-Emission Combined District Heating and Cooling Component of the proposed Shandong Clean Heating and Cooling Project in Shandong Province of the PRC. The proposed project is the fourth in a multi-year multi-sectoral ADB support for air quality improvement in the greater BTH region.

2. This component will utilize long-distance pipelines to transmit hot water recovered from the waste heat of Zhangqiu Thermal Power Plant to provide district heating and cooling services to Maoling Area (3.2 km2), in eastern Jinan City. The component will provide district heating to 3.15 million m^2 area and district heating to 2.2 million m^2 area. The component is innovative as the long-distance pipe network will be the first of its kind in the province to provide heating and cooling services. The network will use “large temperature gradient” transmission technology, to increase capacity and efficiency of the district heating system. The pipes will transport waste heat from Zhangqiu Thermal Power Plant, and cold water using a steam absorption refrigeration unit located within the plant. The component also utilizes ice-storage technology that uses off-peak electricity at night to provide refrigeration services during the day. These innovations will reduce peak load and improve efficiency by using district cooling and other sources of refrigeration to replace distributed air conditioning systems. In turn this reduces the need to use expensive peaking power. In addition, the heating part of the component will reduce coal combustion for urban heating, contributing to better air quality in Jinan City.

3. The component will be implemented through five outputs:

(i) **Output 1**: One South Energy Center with a cooling capacity of 1.8 million m^2 and one North Energy Center a cooling capacity of 0.4 million m^2. Both the two energy centers will be installed with heat and ice storage systems for peak adjustment.

(ii) **Output 2**: Four cooling towers in existing Dongxin Thermal Power Plant for cooling system.

(iii) **Output 3**: District heating and cooling pipeline network including 16.85 km of primary and 20.0 km of secondary network will be constructed. The pipeline network will used for cold water transfer in summer and hot water transfer in winter. The pipe networks will utilize two-pipe system. One is water supply pipe and another is water return pipe.

(iv) **Output 4**: 35 HESs (phase I) will be built for heat and cool supply with a heating area of 3.15 million m^2 and cooling area of 1.35 million m^2.

(v) **Output 5**: Strengthened capacity to install and maintain clean heating and cooling technologies.

4. The objectives of the EMP are to ensure (i) implementation of the identified mitigation and management measures to avoid, reduce, mitigate, and compensate for anticipated adverse

environment impacts; (ii) implementation of monitoring and reporting; and (iii) the component compliance with the PRC's relevant environmental laws, standards and regulations and ADB's SPS 2009. Organizational responsibilities and budgets are clearly identified for implementation, monitoring and reporting.

5. The EMP is to be implemented in all phases of the project cycle, including design, pre-construction, construction, and operation. In the detailed design stage, the EMP will be used by the design institute for incorporating mitigation measures into the detailed designs. The EMP will be updated at the end of the detailed design, as needed.

6. The EMP will be included as a separate annex in all bidding and contract documents. The contractors will be informed of their obligations to implement the EMP, and to provide for EMP implementation costs in their bids for project works.

B. Implementation Arrangements

7. SPG will be the EA and responsible for overall guidance during project preparation and implementation. JHG, a state-owned company will be the IA of the component and responsible for implementing project components and administering and monitoring contractors and suppliers. A PMO led by the Jinan Municipal Bureau of Housing and Urban-rural Development will be responsible for day-to-day management of the project.

8. The IA will implement project components, administer and monitor contractors and suppliers, and be responsible for construction supervision and quality control. The IA will ensure that the EMP is implemented proactively and responds to any adverse impact beyond those foreseen in the IEE. The IA will also attend to requests from relevant agencies and ADB regarding the mitigation measures and monitoring program. It will nominate dedicated, trained, and qualified environment specialists to (i) supervise contractors and ensure compliance with the EMP; (ii) conduct regular site inspections; (iii) coordinate periodic environmental quality monitoring in compliance with the approved monitoring plan; (iv) act as local entry point for the project GRM; and (v) submit semi-annual monitoring results to the EA and ADB. The IA will also appoint a Project Management Office Environment and Safety Officer (PMO ESO) and engage a local EMS for environmental monitoring.

9. Jinan Municipal Bureau of Housing and Urban-rural Development will establish a PMO, which will be responsible for day-to-day management of the project. The PMO will designate a qualified PMO ESO, who will take overall responsibility for supervising the implementation of environmental mitigation measures, coordinating the project level GRM and preparing monitoring reports for submission by the PMO to ADB. The PMO ESO with support of the LIEC will (i) provide overall coordination and support on environmental aspects; (ii) supervise contractors and construction supervision companies (CSCs) and their compliance with the EMP; (iii) conduct regular site compliance inspections; (iv) act as PMO entry point for the project GRM; (v) collect and submit environmental monitoring data provided by (a) contractors and/or CSCs to the PMO, and (b) the EMS to the PMO; and (vi) support PMO with preparation of EMP progress section as a part of semiannual project progress reports and semiannual environmental monitoring reports (EMRs). The IA will be responsible for EMP implementation during operation.

10. The PMO will engage a LIEC, a part-time national environmental, health, and safety specialist prior to the engagement of construction contractors and the project construction, who will support the PMO in mitigation implementation, environmental monitoring, reporting, and addressing any environment-related issues that arise including grievances. The LIEC will also

support contractors in developing construction site-specific environmental management plans (CEMPs) prior to construction and operation.

11. A local EMS will be engaged by the IA to undertake construction and operation phase ambient environmental monitoring, as per the requirements of the environmental monitoring plan (EMoP) presented in this EMP.

12. Construction contractors will be responsible for implementing the mitigation measures during construction under supervision of the IA and the PMO. In their bids, the contractors will prepare CEMPs which detail how the contractors will comply with the EMP. Each contractor will identify a lead focal point for environmental issues (e.g., Environment, Health and Safety Officer), who will oversee CEMP implementation, take all reasonable measures to minimize the impact of construction activities on the environment, develop and prepare monthly reports for submission to the IA. Contractors are also required to report any spills, accidents, and grievances received, and take appropriate action. The Environment, Health and Safety Officer will also be responsible for developing CEMPs and an Occupational Health and Safety Plan (OHSP).

13. CSCs will be responsible for supervising and guiding construction contractors during project construction phase. CSCs will have a qualified Environment, Health and Safety Officer who will be responsible for supervising construction contractors to ensure proper the implementation of EMP and CEMPs; and preparing and submitting consolidated quarterly EMRs to the PMO based on the CEMPs implementation.

14. ADB will conduct due diligence of environment issues during project review missions. ADB will also review the semiannual EMRs submitted by the PMO and will disclose the reports on its website. If the PMO fails to meet safeguards requirements described in the EMP, ADB will seek corrective measures and advise the IA on items in need of follow-up actions. IA will engage loan implementation environment consultant (LIEC).

15. Roles and responsibilities for the EMP implementation are presented in **Table 1**.

Table 1: Project implementation and management organizations

Organization	Role and Responsibility
EA	- -Coordinating and overseeing project preparation and implementation. - -Coordination of strategic issues at regional or national level. - -Providing policy guidance and facilitation during implementation. - -Facilitating interagency coordination with other involved parties at the regional level (and facilitate issues and decision making at the national level, if required).
IA	- Main responsibilities include: - Contracting and administering contractors and suppliers. - Supervising construction and monitoring quality control. - Appointing a PMO ESO. - Engaging a local EMS for environmental monitoring. - Engaging a LIC including a LIEC. - Ensuring compliance with EMP and RP. - Responding to any adverse impact beyond those foreseen in the IEE and ensuring that if there are any changes in scope, the IEE/EMP will be updated as needed. - Responding to requests from relevant agencies and ADB regarding the mitigation measures and environmental monitoring program. - Identifying and implementing O&M arrangements. - Take corrective actions if needed. - Prepare environmental monitoring reports semi-annually during construction and annually during operation.
PMO	- On behalf of the EA, the PMO will be responsible for all project organization and implementation activities, including the following:

	- Updating IEE/EMP if needed, including EMoP. - -Ensuring that mitigation measures are included in engineering detailed design. - -Ensuring project's compliance with loan and project agreements and safeguards requirements. - Managing the activities of the design institutes, procurement agents, and consultants in accordance with government and ADB regulations. - Coordination with concerned offices, including SPG, and with external contacts. - Taking part in capacity development and training. - Establishing and operating the project complaint center with hotline. - Overseeing the project program and activities of the IA in the implementation of the project outputs. - Monitoring the project's physical and financial progress and compliance with project's reporting requirements, ensuring project progress reports are prepared and submitted to ADB on time. - Preparing progress reports for submission to the IA and/or PMO. - -Coordinating the activities of and meeting the requirements of ADB's review missions.
Loan Implementation Environmental Consultant (LIEC)	The LIEC will: - Review the updated IEE and EMP. - Confirm that mitigation measures have been included in detailed engineering design. - Review bidding documents to ensure that the EMP clauses are incorporated. - Review CEMPs to ensure compliance with the EMP. - Provide technical assistance and support to the PMO and contractors on mitigation measures and EMP implementation. - Deliver the construction and operation phase capacity building programs to the staff of the IA, PMO, and contractors. - Conduct site inspections in compliance with the environmental monitoring plan. - Review reports prepared by contractors and assist the PMO in preparing semiannual environmental monitoring reports.
EMS	- A qualified independent environmental monitoring station will be recruited to implement the ambient monitoring portion of the EMoP.
Contractors	- Ensure sufficient funding and human resources for proper and timely implementation of required mitigation and monitoring measures in the EMP and CEMPs throughout the construction phase. - Responsible for GRM operation during construction phase.
Construction supervision company(ies) (CSCs)	- Ensure sufficient funding and human resources for supervising and instructing contractors for proper and timely implementation of required mitigation and monitoring measures in the EMP and CEMPs throughout the construction phase. - Appoint an EHS officer to supervise and instruct contractors and their EHS officers for EMP and CEMPs implementation related to environment, occupational health and safety on construction site. - Prepare and submit quarterly EMP and CEMP monitoring reports to the PMO.
ADB	- Responsible for the following: - Review and clear the IEE and EMP and disclose on ADB website. - Approve updated IEE/EMP if appropriate and disclose on ADB website - Provide guidance to the executing and implementing agencies. - Conducting review missions. - Monitoring status of compliance with loan and project covenants, including safeguards. - Regularly updating the project information documents for public disclosure at ADB website, including the safeguards documents.

ADB = Asian Development Bank, EMP = Environmental Management Plan, O&M = operation and maintenance, PMO = project management office.

C. Potential Impacts and Mitigation Measures

16. The potential impacts of the project during pre-construction, construction and operation have been identified and appropriate mitigation measures developed (see Chapter V of the IEE). Potential impacts and the mitigation measures are presented in **Table 2.**

D. Environment Monitoring Plan

17. An EMoP to monitor the environmental impacts of the project and assess the effectiveness of mitigation measures is presented in **Table 3.** The EMoP includes both compliance inspection undertaken by the PMO Environment Officer, and ambient air, noise, and wastewater monitoring undertaken by the 3rd party environmental monitoring entity. Ambient monitoring will be conducted in compliance with relevant PRC regulations, methods and technical specifications.

18. The data and results of environmental compliance inspection and monitoring activities will be used to assess: (i) the extent and severity of actual environmental impacts against the predicted impacts and baseline data collected before the project implementation; (ii) performance or effectiveness of environmental mitigation measures or compliance with pertinent environmental rules and regulations; (iii) trends in impacts; (iv) overall effectiveness of EMP implementation; and (v) the need for additional mitigation measures and corrective actions if non-compliance is observed.

E. Institutional Strengthening and Capacity Building

19. The institutional strengthening and capacity building focuses on the safeguard requirements of relevant PRC laws and regulations and the ADB SPS 2009. The training will focus on the ADB SPS; PRC safeguard requirements; development and implementation of EHS plans during construction and operation; implementation of the EMP, the EMoP, and the GRM; and worker and community health and safety issues and measures (**Table 4).**

Table 2: Environment Impacts and Mitigation Measures

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
A. Detailed Design Phase					
Incorporate Mitigation Measures and Monitoring in Detailed Design and Bidding and Contracting	Include mitigation measures and monitoring program in detailed design	Environmental mitigation and pollution control measures identified in the IEE, the EMP and the domestic EIAs will be incorporated into the detailed design.	PMO supported by LIEC	IA	Detailed Design Budget
	Include mitigation measures and monitoring program in bidding documents	Environmental mitigation measures identified in the IEE, EMP and the domestic EIA will be incorporated in the bidding documents for the project and will be included in contract documents for civil constructions and equipment installations. All contractors shall be required to strictly comply with the EMP.	PMO supported by LIEC	IA	Detailed Design Budget
	Environmental monitoring incorporated into design.	The environmental monitoring program will be incorporated into the design to ensure that environmental impacts are closely monitored and activities of the project construction and operating are closely supervised against the PRC environmental laws, regulations and standards, ADB SPS, and the project EMP and approved domestic EIA.	PMO supported by LIEC	IA	Detailed Design Budget
Grievance Redress Mechanism (GRM)	Impacts on project Affected Persons	In accordance with the GRM presented in Chapter VIII, a staff member within the PMO will be assigned overall responsibility for the GRM; GRM training will be provided for PMO members and GRM access points; and the GRM access point phone numbers, fax numbers, addresses and emails will be disclosed	PMO supported by LIEC	EA, ADB	PMO Operating Budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		to the public.			
	Earthquake	Seismic risk needs to be incorporated in the detailed design.	PMO	EA, ADB	PMO Operating Budget
B. Construction Phase					
Flora and Fauna	Removal of vegetation	A greening plan will be implemented: – Site vegetation plans will be developed using appropriate native species. – Any existing vegetated areas impacted by pipeline works or construction of boiler rooms, workshops will be restored post-construction using appropriate native species.	DI (plan design), Contractors (plan implementation)	IA supported by LIEC	Contractor construction budget
Wastewater	Surface and groundwater contamination from construction wastewater, and domestic water	Good wastewater management practices as set out in EHS Guidelines on Construction and Decommissioning and EHS General Guidelines: – Existing toilets at the component site will be provided for the workers. – Construction wastewater generated during construction phase will be discharged to the municipal sewer system. All discharged construction wastewater will meet the appropriate PRC standard GB/T 31962-2015 prior to discharge. Discharged water will then be treated in the nearby WWTP. – All necessary measures will be undertaken to prevent construction materials and waste from entering drainage system.	Contractors	IA supported by LIEC	Contractor construction budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		– Maintenance of construction equipment and vehicles will not be allowed on sites to reduce wastewater generation. – Oil traps are provided for service areas and parking areas, and oil-water separators are installed for oil-containing wastewater; – All construction machinery is repaired and washed at special repairing shops. No on-site machine repair, maintenance and washing shall be allowed so as to reduce wastewater generation; – Storage facilities for fuels, oil, and other hazardous materials are within secured areas on impermeable surfaces with 110% volume of the materials stored, and provided with bunds and cleanup kits; – The contractors' fuel suppliers are properly licensed, follow proper protocol for transferring fuel, and are in compliance with Transportation, Loading and Unloading of Dangerous or Harmful Goods (JT 3145-88).			
Erosion and Spoil	Soil erosion, spoil disposal	Good practice construction erosion controls and site maintenance as set out in EHS Guidelines on C&D and EHS General Guidelines: – At construction site, the potential for storm water runoff will be assessed and appropriate storm water drainage systems to minimize soil erosion will be implemented, including perimeter bunds and establishment of temporary detention and settling ponds to control topsoil runoff.	Contractors	IA supported by LIEC	Contractor construction budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		– Land excavation and filling will be balanced so as minimize the requirement for fill material transportation. – During earthworks, the area of soil exposed to potential erosion at any time will be minimized through good project and construction management practices. – Temporary spoil storage sites (and storage containers at lane modification and stations construction sites) will be identified, designed, and operated to minimize impacts. Spoil sites will be restored at the conclusion of storage activities. – Spoil will be reused on-site to the maximum extent feasible as fill. Excess spoil that cannot be used on-site will be transported to an approved spoil disposal site. – Spoil and aggregate piles will be covered with landscape material and/or regularly watered. – Waste construction material such as residual concrete, asphalt, etc., will be properly handled for reuse or disposal. – Construction and material handling activities will be limited or halted during periods of rains and high winds. – Pipelines will be installed and backfilled in a sequenced section-by-section approach. Open excavation areas during trenching activities will be minimized, and appropriate construction compaction techniques utilized. – Any planned paving or vegetating of areas will be done as soon as practical after the materials are removed to			

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		protect and stabilize the soil. – Once construction is complete disturbed surfaces will be properly sloped and revegetated with native trees and grass (see greening plan). – Based on site visit, the spoil disposal site is closed to the component site at the east direction. The spoil disposal site is a temporary site during construction of Maoling Area and will be restored after the Maoling Area is finished. Conduct component completion audit to confirm that spoil disposal site rehabilitation meets required standard, hold contractor liable in case of noncompliance.			
Air Pollution	Dust, vehicle emissions	The following air quality management measure and construction good practice as set out in EHS Guidelines on C&D and EHS General Guidelines will be implemented: – Water will be sprayed on active construction sites including where fugitive dust is being generated on a daily basis, and more frequently during windy days. – Transport vehicles will be limited to low speeds at construction sites. – Loads will be covered during truck transportation to avoid spillage or fugitive dust generation. Fine materials will be transported in fully contained trucks. – Construction site roads will be well maintained and watered and swept on an as-needed basis. Construction site road entry points will be equipped with truck drive	Contractors	IA supported by LIEC	Contractor construction budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		through wash ponds. – Transport routes and delivery schedules will be planned to avoid densely populated and sensitive areas, and high traffic times. – Store petroleum or other harmful materials in appropriate places and cover to minimize fugitive dust and emission. – Provide regular maintenance to vehicles in order to limit gaseous emissions (to be done off-site). – Temporary fencing will be erected around pipeline installation activities. – Construction spoil and other construction materials will be temporary stored using containers, but they may the potential to generate dust. Thus, containers will be covered and/or watered if necessary. – Muddy or dusty materials on public roads outside the exits of works areas will be cleaned immediately. – On-site asphalting and concrete batching is prohibited. – Disturbed site will be revegetated as soon as possible after the completion of pipeline installation.			
Noise	Impacts from construction noise on sensitive resources	To ensure construction activities meet PRC noise standards (Noise Standards for Construction Site Boundary, GB 12523-2011) and to protect workers, the following mitigation measures and construction good practice as set out in EHS Guidelines on C&D and EHS	Contractors	IA supported by LIEC	Contractor construction budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		General Guidelines will be implemented: – Construction activities will be planned in consultation with local authorities and communities so that activities with the greatest potential to generate noise and vibration are planned during periods of the day that will result in the least disturbance. – Construction activities, and particularly noisy ones, are to be limited to reasonable hours during the day and early evening. Construction activities will be strictly prohibited during the nighttime (22:00 h to 07:00 h). Exceptions will only be allowed in special cases, and only after getting approval of the surrounding residents, local EPB and other relevant departments. And nearby residents should be notified of such night time activities well in advance. – When undertaking construction planning, simultaneous high-noise activities will be avoided, and high noise activities will be scheduled during the day rather than evening hours. Similarly, construction site will be planned to avoid multiple high noise activities or equipment from operating at the same location. – Low-noise equipment will be selected as much as possible. Equipment and machinery will be equipped with mufflers and will be properly maintained to minimize noise. – Noise PPE will be provided to workers to meet the requirements in occupational exposure limits for hazardous agents in work place Part 2: physical agents (GBZ 2.2-2007) and EHS Guidelines.			

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		– Transportation routes and delivery schedules will be planned during detailed design to avoid densely populated and sensitive areas and high traffic times. – Vehicles transporting construction materials or waste will slow down and not use their horn when passing through or nearby sensitive locations, such as residential communities, schools and hospitals. – Special attention will be paid to protect sensitive sites near the component site: High noise construction activities will be positioned as far away from sensitive sites as possible. – To minimize noise from cleaning of heating pipelines will be minimized by utilization of low noise valves, mufflers after the valves and sound insulation on the external walls of pipelines.			
Solid Waste	Inappropriate Waste Disposal	The following solid waste management measure and construction good practice as set out in EHS Guidelines on C&D and EHS General Guidelines will be implemented: – Wastes will be reused or recycled to the extent possible. – Littering by workers will be prohibited. – Excavated soil will be backfilled onsite to the extent possible. Excess spoil that cannot be used on-site will be transported to an approved spoil disposal site. – Existing domestic waste containers will be used for	Contractors, local sanitation departments (domestic waste), licensed waste collection companies (construction waste)	IA supported by LIEC	Contractor construction budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		domestic waste collection at work sites. Domestic waste will be collected on a regular basis by the local sanitation departments and transported for recycling, reuse, or disposal at a licensed landfill, in accordance with relevant PRC regulations and requirements. – Construction waste dumpsters will be provided at all construction sites. Construction waste will be collected on a regular basis by a licensed waste collection company and transported for recycling, reuse, or disposal at a licensed landfill, in accordance with relevant PRC regulations and requirements. – There should be no final waste disposal on site. Waste incineration at or near the site is strictly prohibited. – Cuttings are typically reused if they are non-toxic (e.g. as construction fill) or disposed of in a certified and engineered landfill facility. – Contractors will be held responsible for proper removal and disposal of any significant residual materials, wastes, spoil, waste from contaminated soils that remain on the site after construction.			
Hazardous and Polluting Materials	Inappropriate transportation, storage, use and spills	The following mitigation measures and construction good practice as set out in EHS Guidelines on C&D and EHS General Guidelines will be implemented: – A hazardous material handling and disposal protocol that includes spill emergency response will be prepared and implemented by contractors. – Storage facilities for fuels, oil, chemicals and other	Contractors, waste management companies	IA supported by LIEC	Contractor construction budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		hazardous materials will be within secured areas on impermeable surfaces provided with dikes with a 110% volume, and at least 300 m from drainage structures and important water bodies. A standalone site within the storage facility will be designated for hazardous wastes. – Signs will be placed at chemicals and hazardous materials storage sites to provide information on type and name of chemicals and hazardous materials. – Suppliers of chemicals and hazardous materials must hold proper licenses and follow all relevant protocols and PRC regulations and requirements. – A licensed company will be hired to collect, transport, and dispose of hazardous materials in accordance with relevant PRC regulations and requirements.			
Socioeconomic Resources	**Community Disturbance and Safety**	– Transportation routes and delivery schedules will be planned during detailed design to avoid densely populated and sensitive areas and high traffic times. – Vehicles transporting construction materials or wastes will slow down and not use their horn when passing through or nearby sensitive locations, such as residential communities, schools and hospitals. – Signs will be placed at construction sites in clear view of the public, warning people of potential dangers such as moving. All sites will be made secure, discouraging access by members of the public through appropriate fencing with safety guards whenever appropriate.	DI (plan design), Contractors (plan implementation)	IA supported by LIEC	Contractor construction budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
	Worker Occupational Health and Safety	Contractors will implement adequate precautions to protect the health and safety of their workers: – Each contractor will undertake H&S risk assessment of construction works and implement relevant construction phase EHS plan in line with construction good practice as set out in EHS Guidelines on C&D and Occupational H&S guidelines.	EHS Plan Developed by LIEC	IA supported by LIEC	LIEC Budget
		– Identify and minimize the causes of potential hazards to workers. Implement appropriate safety measures. – Provide training to workers on occupational health and safety, emergency response, especially with respect to using potentially dangerous equipment and storage, handling and disposal of hazardous waste. Induction will be conducted before construction and no worker is allowed on site without induction. – Ensure that all equipment is maintained in a safe operating condition. – Provide appropriate PPE to workers. – Provide procedures for limiting exposure to high noise or high temperature working environments in compliance with PRC occupational exposure limits for hazardous agents in work place Part 2: physical agents (GBZ 2.2-2007) and EHS Occupational Health and Safety Guidelines. – Ensure regular safety meetings with staff.	EHS Plan implemented by contractors	IA supported by LIEC	Contractor construction budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
Physical Cultural Resources	As yet unknown PCRs may be damaged if proper precautions are not taken.	A construction phase chance find procedure will be established and activated if any chance finds of PCRs are encountered: – construction activities will be immediately suspended if any PCRs are encountered; – destroying, damaging, defacing, or concealing PCRs will be strictly prohibited in accordance with PRC regulations; – local Cultural Heritage Bureau will be promptly informed and consulted; and, – construction activities will resume only after thorough investigation and with the permission of the local Cultural Heritage Bureau. – In case of any PCR is found, ADB SPS 2009 requirements as well as PRC laws and regulations will be followed.	Contractors	IA supported by LIEC and local Cultural Heritage Bureau	In the event that a PCR is discovered, the direct cost for comp-ensation to contractor will be covered by a special fund to be devel-oped for cultural relic protection.
C. Operation Phase					
Wastewater	Discharge of Production and Domestic Wastewater	– Wastewater from soften water treatment process and regeneration processes will be discharged to the municipal sewerage system. – Boiler blow down, cooling tower blow down and heating and cooling system blow down will be discharged to the municipal sewerage system.	IA	EA supported by LIEC, EPB	IA operation budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		– No metal (chromium or zinc) permitted to use as scaling and corrosion additive. – Because wastewater generated by equipment and pump contains oil, the wastewater will be treated in oil separator and will be discharged to the municipal sewerage system. – Domestic wastewater will be produced from worker sanitation facilities. Domestic wastewater will be treated in digestion tank and will be discharged to the municipal sewerage system.			
Solid Waste	Collection and Disposal	– Domestic waste bins will be provided and domestic waste will be routinely collected by the local sanitation department for recycling, if possible, or final disposal at an approved waste disposal site. – No permanent on-site solid waste disposal will be permitted at project site. – No burning of wastes will be permitted at project site. – Oily waste will be collected, transported and treated by a certificated 3rd party hazardous waste treatment company.	IA, District Sanitation Departments	EA supported by LIEC, EPB	IA operation budget
Chemical and Hazardous Materials	Inappropriate Management	- A registry of all activities that involve the handling of potentially hazardous substances will be developed, including protocols for the storage, handling and spill response. This will include all fuels, oils, grease, lubricants, and other chemicals.	IA, Licensed Contactors	EA supported by LIEC, EPB	IA operation budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		- All chemicals, toxic, hazardous, and harmful materials will be transported in spill proof tanks with filling hoses and nozzles in working order. - All chemicals, toxic, hazardous, and harmful materials will be stored in secure areas with impermeable surfaces and protective dikes such that spillage or leakage will be contained from affecting soil, surface water or groundwater systems. The area should be 110% volume of storage capacity. Their usage will be strictly monitored and recorded. - Material safety data sheets (MSDSs) will be posted for all hazardous materials. - Oil absorbents will be readily accessible in marked containers. - Good housekeeping procedures will be established to avoid the risk of spills. - Spills will be dealt with immediately, and personnel will be trained and tasked with this responsibility. - Workers will be properly trained before handling hazardous wastes and have the requisite PPE. - Hazardous waste will be temporarily stored in closed containers away from direct sunlight, wind, water and rain in secure designated areas with impermeable surfaces and protective dikes such that spillage or leakage will be contained. - Hazardous wastes including oily waste, waste			

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		chemicals and waste ion exchange resin will be collected and disposed by licensed contractors on an as needed basis. - Engineering and administrative control measures will be implemented to avoid or minimize the release of hazardous substances into the work environment keeping the level of exposure below internationally established or recognized limits. - Keep the number of employees exposed, or likely to become exposed, to a minimum to hazardous substances. - Communicating chemical hazards to workers through labeling and marking according to national and internationally recognized requirements and standards, including the International Chemical Safety Cards (ICSC), Materials Safety Data Sheets (MSDS), or equivalent. Any means of written communication should be in an easily understood language and be readily available to exposed workers and first-aid personnel. - Training workers in the use of the available information (such as MSDSs), safe work practices, and appropriate use of PPE.			
Noise	Impact on Sensitive Receptors	– Low-noise equipment will be used as far as possible, and noise reduction measures such as noise elimination, shock absorption, insulated enclosures and sound dampening materials on exterior walls will be implemented.	IA	EA supported by LIEC, EPB	IA operation budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		– All equipment will be properly maintained in order to minimize noise. – Appropriate noise PPE will be provided to the workers who are likely to be exposed to high noise level environments to meet the requirements in occupational exposure limits for hazardous agents in work place Part 2: physical agents (GBZ 2.2-2007), EHS General Guidelines and EHS Guidelines on Occupational H&S. – Layout for project site will be reasonable planned to reduce noise.			
Community and Occupational Health and Safety	Risks to Workers and Community	– Operation phase EHS plan and traffic management plan will be developed and implemented and workers will be trained regularly on their implementation. – PPE including goggles, gloves, safety shoes will be provided to workers. Noise protection equipment will be provided to workers in high-noise area. Noise areas with more than 85 dB(A) shall be marked and hearing protections shall be provided to workers. – Noise level inside control room should be no more than 60 dBA. – Provide training to workers on occupational health and safety, and emergency response. – Pipelines will be grounded and equipped with anti-lightning devices where applicable. – Vehicles transporting materials or wastes will slow down and not use their horn when passing through or nearby	Plans developed by LIEC Plans implemented by IA	EA supported by LIEC and authorities	IA operation budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		sensitive locations, such as residential communities, schools and hospitals. – Safe traffic control measures, including road signs and flag persons to warn of dangerous conditions will be taken as needed. Regular maintenance of vehicles to minimize potential accidents caused by equipment malfunction. – Energy centers and HESs will be fence with restricted public access. – Potential occupational electric and magnetic fields (EMF) exposure should be prevented/minimized through identifying potential exposure levels in the workplace, training of workers in the dentification of occupational EMF levels and hazards, implementing action plans to address potential or confirmed exposure levels that exceed reference occupational exposure levels developed by international organizations. Personal exposure monitoring equipment should be set to warn of exposure levels that are below occupational exposure reference levels (e.g., 50 percent). – Regular inspection and maintenance of pressure vessels and piping will be conducted. Adequate ventilation in work areas to reduce heat and humidity will be installed. Surfaces where workers come in close contact with hot equipment will be shielded. Warning sign will be placed in high temperature areas.			

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
	Emergency Response	A draft emergency risk and response has been established in accordance with the "National Environmental Emergency Plan" (24 January 2006), other relevant PRC laws, regulations and standards, as well as World Bank EHS Guidelines and ADB's SPS 2009, and will include measures in the World Bank EHS guidelines with respect to occupational and community health and safety. The plan must be established and in place before the component is operational. **Indicative plan requirements are as follows:** – Procedures for responding to different types of emergency situations will be identified in the response plan. – Emergency exercises will be conducted and they should include different emergency scenarios. **Training Requirements** – Appropriate operating and maintenance employees will be trained to ensure that they are knowledgeable of the requirements of emergency response plan. Training will be provided as follows: – Initial training to all employees before the gas-fired facilities are put in operation. – When new equipment, materials, or processes are introduced. – When emergency response procedures have been updated or revised. **Annual Emergency Simulation** – Simulated emergency exercises will be conducted at least annually. **Receiving Notification of a Possible Emergency**	Plans developed by PMO with support from LIEC Plans implemented by IA	EA supported by LIEC and local emergency authorities	LIEC budget and IA budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	

		– When a supervisor receives a report of a possible emergency situation, he/she should obtain at minimum the following information from the reporting person:
		  – Name of person reporting emergency;
		  – Nature of emergency - leak, fire, interruption of service if leak, odor present, etc.
		  – Details of emergency: location, amount, how long has the odor been noticed, what actions have been taken, etc.
		  – Leaks or other emergencies require prompt investigation.
		
		Immediate On-site Action
		– The first responder will assess the nature of the report. This assessment should include the status of the emergency, an estimation of how the incident might progress, and an evaluation of the manpower, equipment, and materials needed to adequately cope with the situation.
		– If there is a strong odor or any measurable reading of gas detected inside a structure:
		  – Clear the building of all occupants.
		  – Eliminate potential ignition sources.
		  – Localize or isolate the problem and shut off gas as needed.
		  – Determine the extent of the hazardous area and establish a restricted area.
		– The responding supervisor shall determine the extent of the emergency and inform the dispatcher of the condition at the site.
		– If emergency procedures are put into effect, the responding supervisor should select a location and establish an emergency command post.
		– The responding supervisor will assign one person to			

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		remain at the command post to maintain communications until the emergency is over. – When necessary, the command post will be coordinated with the local emergency responders. When local emergency responders are involved, they will be in charge of the incident. – The responding supervisor will make himself known to fire and/or police department officials, or other authority having jurisdiction, and will remain with them during the emergency. – All employees reporting to the scene of the emergency will report to the command post for identification and instructions. – Key personnel will be alerted, and it will be their responsibility to keep the emergency personnel under their supervision informed and available for emergency call out. – When a system failure cannot be made safely by normal procedures, emergency shutdown procedures should be implemented. – Reduce system pressure or segment a section before repair procedures are implemented. – Well trained and qualified personnel will be dispatched to monitor system pressure and repair work. **Communication with Public Officials** – When an emergency resulting in a hazard to the public safety occurs, the local fire department, police, the city medical emergency center and other relevant public officials should be notified. An emergency call list will be prepared and make it available at the plant control room.			

DI = design institute, EMP = environment monitoring plan, EMS = environment monitoring station, EPB = environment protection bureau, GRM = grievance redress mechanism, IA = implementing agency, LIEC = loan implementation environmental consultant.
Source: Domestic Project EIA Report (2015) and TA consultants.

Table 3: Environmental Monitoring Plan (EMoP)

Subject	Parameter/Methodology	Monitoring Location	Frequency	Implemented by	Supervised by
A. Construction Phase					
Air Pollution	Ambient dust monitoring (TSP, PM_{10}, $PM_{2.5}$) following PRC requirements	Boundaries of the construction site	Quarterly during construction season	EMS	EA, EPB
	Compliance inspection of implementation of air pollution control measures	Construction site	Daily during construction season	IA	EA, EPB
Wastewater	Wastewater sampling - COD, TSS, pH etc. following PRC requirements	Wastewater discharge point of the construction site	Monthly during construction	IA	EA, EPB
Noise	Ambient noise monitoring (day and night Leq dB(A)) using portable monitoring device following the PRC requirements	Boundaries of the construction site and sensitive receptors in 100 meters	Weekly during construction	EMS	EA, EPB
Soil	Soil contamination test following the PRC requirement	Cooling tower location	Once before construction	IA	EA, EPB
Solid Waste	Compliance inspection of implementation of solid waste management measures	Waste collection and disposal sites	Monthly during construction	IA	EA, EPB
Hazardous and Polluting Materials	Compliance inspections of implementation of hazardous materials management measures	Storage facilities for fuels, oil, chemicals and other hazardous materials. Vehicle and equipment maintenance areas.	Monthly during construction	IA	EA, EPB
Flora and	Compliance inspection of land	Construction site	Monthly during	IA	EA, EPB

Subject	Parameter/Methodology	Monitoring Location	Frequency	Implemented by	Supervised by
Fauna	clearing to ensure mitigation measures are being implemented		construction		
Socioeconomic Impacts	Compliance inspection of implementation of traffic control measures	Construction site roads. Transportation routes.	Monthly during construction season	IA	EA, EPB
	Compliance inspection of implementation of Occupational and Community Health and Safety measures including records on near miss, minor, major, fatal accidents and an Emergency Response Plan	Construction site	Monthly during construction season	IA	EA, EPB
B. Operation Phase					
Wastewater	Wastewater sampling - COD, TSS, pH etc. following PRC requirements	Discharge outlet to municipal sewer of the component site	Quarterly during none heating season and once during heating season for two weeks per year	IA	EA, EPB
Solid Waste	Compliance inspection to of operation phase solid waste management measures implementation	Component site	Semi-annually	IA	EA, EPB
CO_2 monitoring	GHG emission monitoring of the component	Component site	Semi-annually	IA	EA, EPB
Noise	Noise monitoring (day and night Leq dB(A))	Boundaries of the component site and sensitive receptors in 100 meters	Quarterly	EMS	EA, EPB

Subject	Parameter/Methodology	Monitoring Location	Frequency	Implemented by	Supervised by
Hazardous and Polluting Materials	Compliance inspection of operation phase Hazardous Materials Management Plans (HMMPs) implementation	Component site	Semi-annually	IA	EA, EPB
Health and Safety and Emergency Response	Compliance inspection of operation phase occupational and community health and safety management measures including keeping records on near miss, minor, major, fatal accidents and an Emergency Response Plan implementation	Component site	Semi-annually	IA	EA, EPB
Environmental acceptance	Compliance testing for environment acceptance	Component site	Once	IA	EA, EPB

Table 4: Institutional strengthening and training program

Training Topic	Trainers	Attendees	Contents	Times	Days	# Persons	Budget (USD)
Construction Phase Environment, Health and Safety Training	LIEC	Contractors, PMO, IA, EA	**ADB and PRC laws, regulations and policies** – ADB's Safeguard Policy Statement – Project applicable PRC environmental, health and safety laws, policies, standards and regulations – International environmental, health and safety management practice in civil irrigation and drainage construction **GRM** – GRM structure, responsibilities, and timeframe – Types of grievances and eligibility assessment **Implementation of Construction Phase EMP** – Impacts and mitigation measures – Monitoring and reporting requirements – Non-compliance and corrective actions	3 (once prior to start of construction, and then once during second and third years)	2	30	**Training Development** Fixed costs: $2000 per course delivery x 3 = $ 6,000
Operation Phase Environment, Health and Safety Plan Training	LIEC	PMO, IA, EA	**ADB and PRC laws, regulations and policies** – ADB's Safeguard Policy Statement – Project applicable PRC environmental, health and safety laws, policies, standards and regulations – International environmental, health and safety management practice in civil irrigation and drainage operation **GRM** – GRM structure, responsibilities, and timeframe – Types of grievances and eligibility assessment **Implementation of Operation Phase EMP** – Impacts and mitigation measures – Monitoring and reporting requirements – Non-compliance and corrective actions	3 (once prior to start of operation, and then once during second and third years)	2	30	**Training Development** Fixed costs: $2000 per course delivery x 3 = $6,000
			Total	**6**		**60**	**$12,000**

F. Reporting Requirements

20. **Environmental reporting.** The CSCs will submit monthly reports to the PMO on implementation and compliance with the EMP and CEMPs, including information on all spills, accidents including near miss, minor, major, fatal accidents, grievance received, and appropriate actions taken.

21. Based on the CSCs' monthly EMP progress reports and the compliance inspection and ambient monitoring results, the PMO will prepare semi-annual environmental reports including EMP implementation and monitoring results for submission to the IA and EA. The PMO ESO with the support from the LIEC will prepare semi-annual EMRs for onward submission to the IA and the PMO, and then to ADB. The reports should assess the project's compliance with the EMP and PRC environmental standards, identify any environment-related implementation issues and necessary corrective actions, and reflect these in a corrective action plan. The performance of the contractors in respect of environmental compliance will also be reported, as will the operation and performance of the project GRM, environmental institutional strengthening and training, and compliance with all safeguards covenants.

22. **Review by ADB.** ADB will review the semiannual EMRs and ADB missions will inspect the project progress and implementation on site twice a year. For environmental issues, inspections will focus mainly on (i) monitoring data; (ii) the implementation status of project performance indicators specified in the loan covenants on the environment, environmental compliance, implementation of the EMP, and environmental institutional strengthening and training; (iii) the environmental performance of contractors, CSCs and the PMO; and (iv) operation and performance of the project GRM.

23. **Environmental acceptance reporting.** Within 3 months after completion, or no later than 1 year with permission of the Jinan EPB, an environmental acceptance report shall be prepared by a licensed institute in accordance with the PRC Regulation on Project Completion Environmental Audit (MEP, 2001), approved by the relevant environmental authority, and reported to ADB. The environmental acceptance report will indicate the timing, extent, effectiveness of completed mitigation and of maintenance, and the need for additional mitigation measures and monitoring (if any) during operation at least until the project completion report is prepared.

24. The environmental reporting requirements are summarized in the **Table 5**.

Table 5: Reporting Requirements

Report	Prepared by	Submitted to	Frequency
A. Construction Phase			
EMP implementation reports	CSC	PMO	Monthly
Compliance monitoring reports	EMS	PMO, IA	Quarterly
Environmental monitoring reports	PMO with the support of LIEC	ADB	Semi-annually
B. Operation Phase			

Report	Prepared by	Submitted to	Frequency
Environmental monitoring report	PMO with the support of LIEC	ADB	Annually

G. Performance Indicators

25. Performance indicators (**Table 6**) have been developed to assess the implementation of the EMP. These indicators will be used to evaluate the effectiveness of environmental management during the component implementation.

Table 6: Performance Indicators

No.	Description	Indicators
1	Staffing	(i) PMO established with appropriately qualified staff including Environmental Officer. (ii) Appropriately qualified environmental expert recruited if needed. (iii) 3rd party environmental monitoring entity engaged.
2	Budgeting	(i) Environment mitigation cost during construction and operation is sufficiently and timely allocated. (ii) Environment monitoring cost is sufficiently and timely allocated. (iii) Budget for capacity building is sufficiently and timely allocated.
3	Monitoring	(i) Compliance monitoring is conducted by IA as per EMoP. (ii) Construction phase and operation phase ambient and effluent monitoring is conducted by EMS.
4	Supervision	(i) IA to review the implementation of EMP; (ii) ADB review missions
5	Reporting	(i) Semi-annual environmental monitoring reports during construction phase and annual reports operation phase prepared by the IA are submitted to CECEP.
6	Capacity Building	(i) Training on ADB safeguard policy, EMP implementation, and GRM is provided during component implementation.
7	Grievance Redress Mechanism	(i) GRM contact persons are designated at all IA and the PMO, and GRM contact information disclosed to the public before construction. (ii) All complains are recorded and processed within the set time framework in the GRM of this IEE.
8	Compliance with PRC standards	(i) Project complies with the PRC's environmental laws and regulations and meets all required standards.

H. Estimated Budget for EMP Implementation

26. The estimated budget for EMP implementation of the project is presented in **Table 7**. Costs are presented for mitigation implementation, ambient monitoring, capacity building, implementation support if needed, and GRM implementation. The costs do not include salaries of PMO staff.

I. Mechanisms for Feedback and Adjustment

27. The effectiveness of mitigation measures and monitoring plans will be evaluated through a feedback reporting system. If, during compliance inspections and monitoring, substantial deviation from the EMP is observed, then the PMO ESO and LIEC will consult with the PMO and Jinan EPB and propose appropriate changes to the EMP monitoring and mitigation plan.

28. Any EMP adjustments will be subject to ADB review and approval and ADB may pursue additional environmental assessment and, if necessary, further public consultation. The revised EMP with ADB confirmation is subject to reposting on the ADB's website as the ADB public communications policy requires. The revised EMP will be passed on to the contractor(s) for incorporation into the CEMPs for implementation

J. Environmental Acceptance

29. After a three months trial operation period the Jinan EPB will conduct an environmental acceptance inspection for the component and issue environmental acceptance approvals. If the component is in compliance with all conditions for approval of the domestic EIA, the component can be put into formal operation.

Table 7: Estimated Budget for Implementing EMP

Construction Phase						
1. Ambient Monitoring	**Unit**	**Unit Cost**	**# Times**	**Cost USD**	**Cost RMB**	**Source of Funds**
Air - TSP	Quarterly	$ 300	8	$ 2,400	¥15,249	Counterpart Financing
Noise	Quarterly	$ 200	8	$ 1,600	¥10,166	
Subtotal				***$ 4,000***	***¥25,415***	
2. Capacity Building	**Unit**	**Course Cost**	**# Times**	**Cost USD**	**Cost RMB**	
Construction Phase HSE Plan Development and Training	EHS Plan Development	$ 2,000	3	$ 6,000	¥38,122	Counterpart Financing
	EHS Course Development	$ 2,000	1	$ 2,000	¥12,707	
	EHS Course Delivery	$ 4,000	1	$ 4,000	¥25,415	
Subtotal				***$ 12,000***	***¥76,244***	
TOTAL Construction Phase				***Cost USD***	***Cost RMB***	
				$ 16,000	***¥101,659***	
Operation Phase (first 2 years)						
	Unit	**Unit Cost**	**# Times**	**Cost USD**	**Cost RMB**	Counterpart
1. Ambient Monitoring	**Unit**	**Unit Cost**	**# Times**	**Cost USD**	**Cost RMB**	
Noise	Seasonal Sampling	$ 200	16	$ 3,200	¥20,332	Counterpart Financing
Wastewater	Seasonal Sampling	$ 150	16	$ 2,400	¥15,249	
Subtotal				***$ 5,600***	***¥35,581***	
2. Capacity Building	**Unit**	**Course Cost**	**# Times**	**Cost USD**	**Cost RMB**	
Operation Phase HSE Plan Development and Training	EHS Plan Development	$ 2,000	3	$ 6,000	¥38,122	Counterpart Financing
	EHS Course Development	$ 2,000	1	$ 2,000	¥12,707	
	EHS Course Delivery	$ 4,000	1	$ 4,000	¥25,415	
Subtotal				***$ 12,000***	***¥76,244***	
TOTAL Operation Phase				***Cost USD***	***Cost RMB***	
				$ 17,600	***¥111,825***	
GRAND TOTAL Construction + Operation				***Cost USD***	***Cost RMB***	
				$ 33,600	***¥213,484***	
LIEC	**Unit**	**Monthly Cost**	**# Months**	**Cost USD**	**Cost RMB**	ADB Loan
Loan Implementation EHS Consultant	Person Months	$ 6,000	9	***$ 54,000***	***¥343,100***	

APPENDIX II: EXISTING FACILITY DUE DILIGENCE ENVIRONMENTAL REVIEW – DONGXIN THERMAL POWER PLANT

A. Introduction

1. This is an environmental due diligence report of the Jinan Dongxin Thermal Power Plant (hereafter referred to as the Dongxin TPP), being conducted as part of the IEE report for East Jinan Low-Emission Combined District Heating and Cooling Component, a component of the proposed Shandong Clean Heating and Cooling Project in Shandong Province of the PRC.

2. This component will build four cooling towers in Dongxin TPP. The Dongxin TPP is therefore an existing facility for the component, and as per the SPS 2009, an environmental audit of Beijing Power Plant is required.

B. Environmental Due Diligence Review Approach

3. Audits are typically used to determine the existence of any areas where the facility has risks associated with Environmental, Health and Safety (EHS) performance. The intent is to identify any deficiencies, and to propose measures for improvement that may be necessary to minimize environmental and safety risks for the proposed ADB investment. The audit provides a baseline in terms of the company's current performance based on the management systems and controls that are in place.

4. This report is based on a site visit, consultations with Dongxin TPP managers and technical staff, and a review of plant environmental and technical documentation. The site visit was undertaken April 27th 2018, and included the following participants:

Environmental Audit Reviewers:
Dai Lei, PPTA National Environmental Specialist
Yun Zhou, ADB Environment Specialist

Jinan Heating Group:
Ms. Han Jiaying, Director of Financial Department
Mr. Sun Dapeng, Technical Engineer
Ms. Zhang Linlin, staff of Financial Department

Dongxin TPP:
Mr. Zhang Feida, Director of Production Department
Mr. Liu Feng, Engineer of Production Department

5. The audit activities included site observations, interviews with site personnel, and review of applicable documents. Time was also devoted to reviewing the environmental monitoring activities for air emissions, water discharges, and noise. The audit focused on the highest priority areas of operation EHS risks, which were already identified by Dongxin TPP based on standards on the *Identification of Hazards Installation for Dangerous Chemicals* (GB 18218-2009) and its requirements, which are: (i) chemicals storage tank areas; (ii) solid waste storage tank areas; and

(ii) hazardous waste tank. The audit team walked through the following facilities:

(i) 3x75 t/h coal fired circulating fluidized bed (CFB) boilers;

(ii) 2x 70 MW coal fired hot water coal water slurry (CWS) boilers;

(iii) 1x 15 MW back pressure turbine;

(iv) Cooling tower;

(v) Solid waste (ash and flue gas desulfurization (FGD) gypsum) storage facility;

(vi) Chemicals (hydrochloric acid, liquid caustic soda, urea and sodium hypochlorite) storage tank areas; and

(vii) Existing shaded coal storage places.

6. Documentation reviewed during and after the facility visit included:

(i) Approval of EIA Report for Dongxin TPP Phase I project (1 x75 t/h CFB boiler) by Jinan EPB High Tech Zone Branch, October 30, 2003;

(ii) Approval of EIA Report for Dongxin TPP Phase II project (1 x75 t/h CFB boiler) by Jinan EPB, June 29, 2010;

(iii) Approval of EIA Report for Dongxin TPP Phase III project (1 x75 t/h CFB boiler) by Jinan EPB, March 6, 2013;

(iv) Approval of EIA Report for Dongxin TPP Expansion project (2x 70 MW CWS boilers) by Jinan EPB, February 7, 2013;

(v) Approval of EIA Report for Dongxin TPP 1x 15 MW back pressure turbine project by Jinan EPB, December 26, 2013;

(vi) Approval of EIA Report for Dongxin TPP ultra-low emission transformation project by Jinan EPB, June 28, 2016;

(vii) Environmental acceptance of Dongxin TPP ultra-low emission transformation project by Jinan EPB, June 11, 2018;

(viii) Environmental acceptance monitoring report of Dongxin TPP ultra-low emission transformation project by Jinan Jinhang Environment Monitoring Company, March 2018.

(ix) Pollutant discharge permit;

(x) Dongxin TPP layout and technology process description;

(xi) EHS management regulation of Dongxin TPP;

(xii) Emergence response plan and drill record in 2017; and

(xiii) EHS training record in 2017.

C. Project Description

1. Type

7. The Dongxin TPP is an existing coal-fired combined heat and power plant for combined heat and power generation. Dongxin TPP was founded in December 2002 with one 75 t/h CFB

boiler and one 6 MW extraction condensing turbine. It belongs to Jinan Heating Group. The main business of Dongxin TPP includes thermal power generation and heat supply. Heat supply is Dongxin TPP's most important and core business and its heating area is 7 million m^2. All boilers and turbine only operate in heating season. In 2017, Dongxin TPP generated 4.09 million kWh of electricity and provided heat to 7 million m^2..

8. By the end of 2017, Dongxin TPP had 204 staff and 29 of them were technical staff.

2. Location

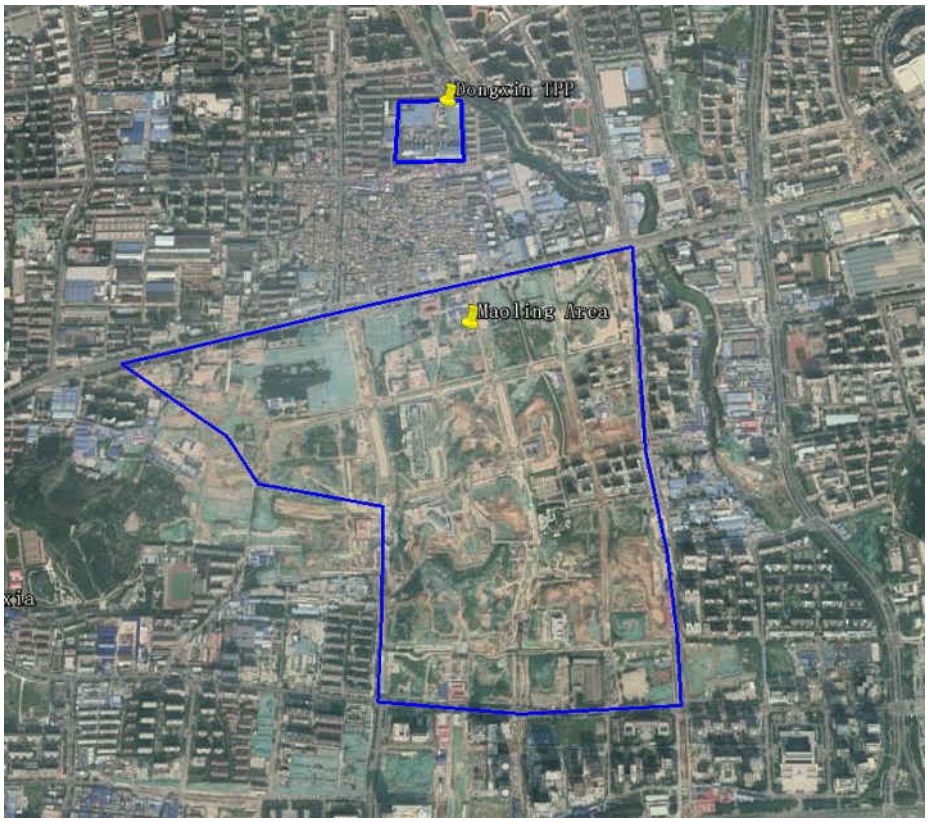
The Dongxin TPP is located on a 65,000 m^2 site in No. 8, Huaxian Road, Lixia District, Jinan (**Figure 1**). The site area is 500 m away at the north of Maoling Area where the component locates (

9. **Figure 2**). The Dongxin TPP is surrounded by residential communities and commercial buildings.

Figure 1: Dongxin TPP's location, Lixia District, Jinan

Source: Google Earth, 2018.

Figure 2: Dongxin TPP and Maoling Area



Source: Google Earth, 2018.

Figure 3: Dongxin TPP looking from the south

Source: Environment Specialist.

10. **Figure 4** shows an aerial view of the plant including the boilers, cooling tower, stack and coal storage place and railway for coal transportation and unloading.

Figure 4: Dongxin TPP layout

Source: Google Earth 2017

Figure 5: Cooling tower location in Dongxin TPP layout

3. Purpose and Capacity

11. The plant was originally built in 2002 for power generation. Now Dongxin TPP's main purpose is district heating. All the boilers and turbine only operate in heating season. The current configuration of the plant is:

(i) 3x75 t/h coal fired CFB boilers;

(ii) 2x 70 MW coal fired hot water CWS boilers;

(iii) 1x 15 MW back pressure turbine;

(iv) Chemical water treatment workshop;

(v) Limestone and gypsum FGD equipment;

(vi) Selective Catalytic Reduction (SCR) equipment; and

(vii) Electrostatic precipitator and bag filter.

12. All boilers are equipped with low-NOx burner, SCR denitration, limestone and gypsum FGD equipment, bag filters and electrostatic precipitators. Flue gases are exhausted through one 150 m high stack and inner diameter at the outlet of the stack is 15m.

13. In 2017, Dongxin TPP generated 4.09 million kWh of electricity and provided heat to 7 million m^2.

4. Fuel

14. Low sulphur (0.5-0.9%) coal is primarily sourced from Shaanxi Province and transported by train. Annual coal consumption of the Dongxin TPP in 2017 is approximately 12,879 tons. The coal was stored in coal storage room, The requirement for sulfur content in the World Bank EHS Guidelines is 0.5% or less (for projects in degraded airshed) or 1% or less for project in non-degraded airshed. Dongxin TPP uses the coal with the lowest sulfur content that can be sourced.

15. . The length of the four coal storage places are 150m and the width is 40m. The coal storage capacity was around 30,000 tons. (**Figure 6**).

Figure 6: Coal storage room, Dongxin TPP

Source: Environment Specialist

5. Water Supply and Wastewater

16. The Dongxin TPP sources domestic water and production water from municipal water.

17. Daily domestic water consumption of Dongxin TPP is around 8 m^3 per day and production water consumption is around 1,800 m^3 per day. Water for boilers is treated by filter, ultra-filtration, reverse osmosis (RO) and ion exchange in chemical water treatment workshop, and then used as boiler make-up water and circulation water. Concentrated water from chemical water treatment workshop is reused as desulfurization water, dust removal water and spray water of coal system. Water used in circulation cooling system is municipal water. The make-up water will be 1,680 m^3 per day.

18. Domestic wastewater system, production wastewater system and storm water system are

separated from each other. Domestic wastewater is collected and discharged to municipal sewer. Storm water is collected by storm water system and discharged. Production wastewater is collected and discharged to municipal sewer.

19. Wastewater generated under in-normal operation like commissioning will discharged into 1 x 1,000 m^3 emergency tanks. When operation returns to normal, water in this tank will be discharged to municipal sewer.

20. To protect groundwater and meet the anti-seepage standard, different anti-seepage are undertaken according to different places and relevant anti-seepage requirements in fuel/chemical storage areas.

Figure 7: Dongxin TPP cooling tower and office building

Source: Environment Specialist.

6. Solid Wastes

21. In 2017, the Dongxin TPP produced approximately 1,805.4 tons of fly ash, 2,408.24 tons of coal slag and 274.27 tons of desulfurization gypsum. All the desulfurization gypsum, fly ash and coal slag were sold for recycling. Domestic waste is collected, transported and treated by local sanitation department.

22. Hazardous wastes are temporarily stored on site with proper measures following the PRC Standards for Pollution Control on Hazardous Waste Storage, and then transported to a certificated company for treatment and final disposal using certificated trucks. The certificated company is Shandong Tengyue Hazardous Waste Treatment Company. The contract was presented to the audit team.

7. Noise

23. Noise sources during operation are mainly from turbines, boiler rooms, coal transportation system, fans and desulfurization equipment, and also include transformers, pumps, and cooling equipment. Because Dongxin TPP is close to residential communities, the Dongxin TPP used low-noise equipment as far as possible and also utilized noise elimination, shock absorption, insulated enclosures and sound dampening materials to mitigate noise impacts. These measures can typically reduce noise intensity. Also, appropriate personal noise protective equipment (PPE) is provided to the workers who are likely to be exposed to high noise level environment.

Figure 8: Dongxin TPP noise barrier

Source: Environment Specialist.

8. Chemicals

24. During the audit, the team reviewed the systems used by Dongxin TPP for chemicals management which emphasizes the need for obtaining and retaining a Material Safety Data Sheet (MSDS) for each chemical stored and/or used on site, and providing employee access to this information. Dongxin TPP has now installed a computerized system for keeping the MSDS records. For hazardous materials and hazardous wastes, Dongxin TPP keeps copies of permits and licenses for all handlers that deliver or remove such materials.

25. The plant has numerous tanks and vessels for storing raw materials. In 2017, annual consumption of hydrochloric acid was 0.3 tons, sodium hypochlorite was 0.3 tons, urea was 300 tons and liquid caustic soda was 0.3 tons.

Figure 9: Dongxin TPP chemical storage area

D. Compliance for Standards, Approvals, and Permits Requirements

1. EIA and environmental acceptance

26. The Dongxin TPP is in compliance with all relevant PRC EIA requirements. The Phase I Project (1 x 75t/h CFB boiler and 1x 6MW turbine) got EIA approval in October 30, 2003 and started power generation in 2004. The Phase II project (1 x75 t/h CFB boiler) got EIA approval in June 29, 2010 and Phase III project (1 x75 t/h CFB boiler) got EIA approval in March 6, 2013. Dongxin TPP Expansion project (2x 70 MW CWS boilers) got EIA approval in February 7, 2013. Dongxin TPP 1x 15 MW back pressure turbine project got EIA approval in December 26, 2013. Dongxin TPP ultra-low emission transformation project got EIA approval in June 28, 2016 and got environmental acceptance in June 11, 2018. All the EIA approvals were provided to the team for check and review.

2. Relevant Environmental Standards

27. **Table 1** presents a summary of relevant emission standards for the Dongxin TPP. **Table 2** presents the relevant ambient air quality standards for the Dongxin TPP surrounding area. **Table 3** presents ambient noise standards. **Table 4** presents groundwater standards. Because the Dongxin TPP will not discharge any wastewater to surface water body. No surface water standard is applicable.

Table 1: Summary of Environmental Pollution Standards Applicable to the Dongxin TPP

Pollutant	Limit	Standards Source
Stack Emissions		
SO_2	35 mg/m^3	Ultra-low emissions standard from *Energy conservation and emission reduction upgrade and transformation Plan for coal fired power station* (2014-2020)
NOx	50 mg/m^3	
PM	10 mg/m^3	
Other		
Fugitive PM	1.0 mg/m^3 at site boundary	Table 2 of *Integrated Emission Standard of Air Pollutants* (GB 16297-1996)
Daytime Noise (06:00-22:00 h)	60dB(A) at site boundary	Class II of *Emission Standard for Industrial Enterprises at Site Boundary* (GB 12348-2008)
Nighttime noise (22:00-06:00 h)	50dB(A) (at site boundary)	

Table 2: Applicable ambient air quality standards – Class II, Ambient Air Quality Standards (GB 3095—2012) (unit: mg/m^3)

Pollutants	Annual mean (class 2)	24-hr mean (class 2)	1-hr mean (class 2)
TSP	0.200	0.300	--
PM_{10}	0.070	0.150	--
$PM_{2.5}$	0.035	0.075	--
SO_2	0.060	0.150	0.500
NO_2	0.040	0.080	0.200

Table 3: Applicable ambient environment noise standard – Class II, Environmental Quality Standards for Noise (GB3096-2008)

Item	Class II	Class III
Daytime Noise (06:00-22:00 h)	60 dB(A)	65 dB(A)
Nighttime noise (22:00-06:00 h)	50 dB(A)	55 dB(A)

Table 4: Applicable groundwater standard (Class III, *GB/T14848-2017 Quality Standard for Ground Water*)

No	Item	Unit	Limit
1	pH	-	6.5-8.5
2	Total hardness ($CaCO_3$)	mg/L	≤450
3	Fluoride	mg/L	≤1.0
4	Chloride	mg/L	≤250
5	Ammonia nitrogen	mg/L	≤0.2
6	Nitrate	mg/L	≤20
7	Nitrite	mg/L	≤0.02
8	Volatile Phenols	mg/L	≤0.002
9	Total dissolved solids	mg/L	≤1000
10	Permanganate index	mg/L	≤3.0
11	Total coliforms	/L	≤3.0

3. Environmental Monitoring

28. The Dongxin TPP is equipped with a continuous emissions monitoring system (CEMS) that monitors in real time SO_2, NOx, PM and air flow. Data is sent electronically to the Jinan EPB Data Center. Jinan EPB monitors the CEMS data, and staff indicates that Jinan EPB can be on site within as little as 1 hour if the CEMS indicates serious noncompliance. CEMS monitoring data in 2017 (**Figure 11**) shows that Dongxin TPP was in compliance with the ultra-low emission standards. The data in **Figure 11** is: annual average SO_2 concentration: 16.8 mg/m^3; annual average NO_X concentration: 41.9 mg/m^3 and annual average PM concentration: 5.07 mg/m^3

Figure 10: Dongxin TPP CEMS equipment showing real-time CEMS data

Source: Environment Specialist.

Figure 11: Dongxin TPP CEMS data in 2017

29. Manual stack emissions monitoring is also undertaken on a quarterly basis by Jinan EPB for calibration. 3rd party company is also hired by the Dongxin TPP on a quarterly basis for

calibration. Internal monitoring of stack emission operational parameters is also implemented which are used to manage operation.

30. Noise monitoring is undertaken at the site boundary on a quarterly basis and is in compliance with national standards.

4. Emission Controls and Compliance

31. All boilers are equipped with low-NOx burner, SCR denitrification, limestone and gypsum FGD equipment, bag filters and electrostatic precipitators. The plant is in full compliance with the current *Emission Standard of Air Pollutants for Thermal Power Plants* (GB 13223—2011) and ultra-low emissions standard from *Energy conservation and emission reduction upgrade and transformation Plan for coal fired power station (2014-2020)*. Jinan EPB was consulted by the consultant to identify during the site visit, no grievance received or exceedance of standards occur in the last two years.

32. Fugitive emission control measures are listed below:

(i) Coal storage site is closed and installed with spray equipment which sprays water periodically;

(ii) Fly ash and coal slag are mixed with water then transported for onsite treatment;

(iii) Fly ash, gypsum and coal slag are stored at closed storage site. This site is installed with spray equipment which sprays water periodically. In strong wind weather, water spray frequency will be increased.

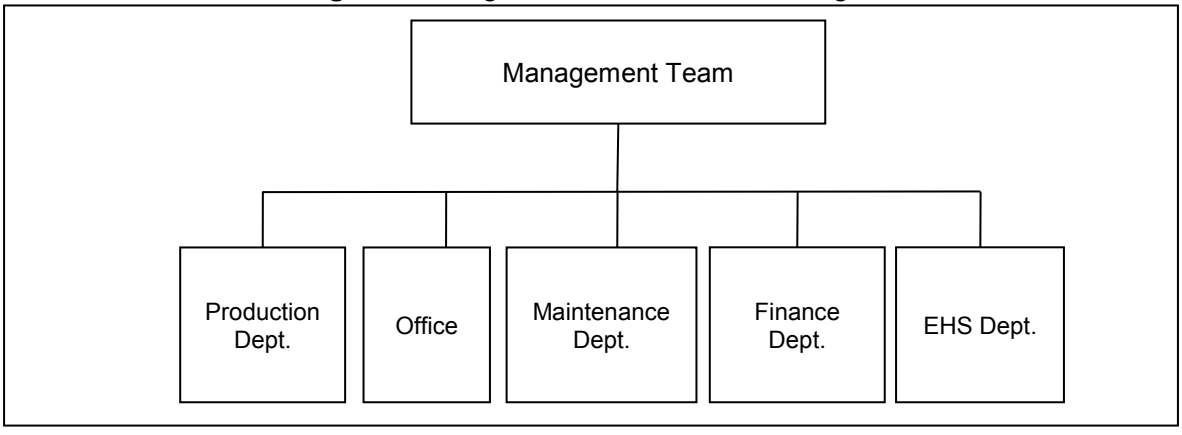
33. The noise monitoring results in environment acceptance shows that the Dongxin TPP is in compliance with the relevant standard, Class II, *Emission Standard for Industrial Enterprises Noise at Boundary* (GB 12348-2008).

E. Environmental Management

1. ISO Certification, Staffing and Environmental Management

34. The Dongxin TPP has a total of 204 staff. Environmental, health and safety (EHS) responsibilities are assigned to the EHS Department, which has a staff of 52 and 14 staff is responsible for environment engineer, 12 staff is for health and 26 is for safety. (**Figure 12**).

Figure 12: Organization structure of Dongxin TPP



35. This structural arrangement aims to ensure EHS issues are well incorporated in other aspects like technical, finance, and others. All EHS staff have regular meeting with the head of EHS department for close coordination and effective implementation of EHS management systems. The site has an EHS Committee that meets regularly to discuss progress and set targets and objectives going forward.

36. The Dongxin TPP has an EHS Management System. An EHS regulation summary (2017) was shown to the audit team. The summary refers to a series of procedural control documents for environmental, safety and occupational health management that the plant must comply with, including:

(i) Summary of laws, regulations and other requirements;

(ii) Environment policies, targets, indicators and environment management programs;

(iii) Wastewater management;

(iv) Environmental monitoring and monitoring management;

(v) Safety management system;

(vi) Safety and fire protection responsibility;

(vii) Safety training for staff;

(viii) Report and treatment procedures for accidents;

(ix) PPE management;

(x) Management of occupational hazardous factors;

(xi) Operation and management of occupational hazard factors protection facilities;

(xii) Occupational hazardous factors monitoring and management;

(xiii) Occupational hazardous factors control and prevention; and

(xiv) Emergency response plan.

37. The regulations are periodically reviewed and updated as required.

2. Staff training and PPE provision

38. Dongxin TPP organizes various types of safety education and trainings for employees. Also, external construction personnel receive EHS trainings from Dongxin TPP.

39. In 2017, Dongxin TPP provided EHS training to 657 person-times. Dongxin TPP also provided training to new employees and interns. Dongxin TPP provides employees with PPE that is essential for performing work activities safely. During the audit visit, at the entrance of the site, a full range of PPE was provided to the audit team. The workers/staff on-site were all wearing proper PPEs. Thus, the audit can confirm that PPE provision and implementation is strictly followed as designed.

40. Dongxin TPP maintains a comprehensive Emergency Response capability that includes an onsite Fire Department trained for a full range of emergencies that may occur at the plant. Dongxin TPP also has a detailed Emergency Response Plan (ERP). The ERP is tested regularly

with drills, simulations, and exercises. EHS records were reviewed. There was no incident or accident in the last 5 years.

41. For some tank areas, such urea tank and hydrochloric acid tank, Dongxin TPP has configured spare (reserved) tanks, cofferdams and emergency accident collecting pools to timely perform relative treatments in case of leakage occurrence, which meet the World Bank EHS guidelines requirements.

F. Conclusion

42. The audit confirmed that the EHS management systems were comprehensive and there was clear evidence of continual improvement which was mainly attributed to a systematic approach to EHS implementation, driven by GB/T 24001 (equivalent to ISO 14001) Environmental Management Systems and GB/T 28001-2001 (equivalent to OSHAS 18001) Occupational Health and Safety Management Systems. The audit confirmed that senior management and employees have sincere commitment to the implementation of EHS management systems.

43. Based on this environmental audit and due diligence, it can be concluded that:

(i) the Dongxin TPP has undergone an appropriate EIA process by Jinan EPB and has received the necessary EIA approvals and environmental acceptance approvals;

(ii) EHS polices and systems are in place and the respective EHS management programs were effective;

(iii) Comprehensive environmental monitoring programs were in place;

(iv) Combustion by-products are recycled into construction materials, and wastewater is recycled on site;

(v) Hazardous waste is stored according to Standard for pollution control on hazardous waste storage (GB18599- 2001, revised in 2013), then transported and treated by certified company; and

(vi) Dongxin TPP is in full compliance with relevant ultra-low emission standards, and the CEMS monitoring data of 2017 is provided to the audit team for review.

APPENDIX III: ASSOCIATED FACILITY DUE DILIGENCE ENVIRONMENTAL REVIEW – ZHANGQIU THERMAL POWER PLANT

A. Introduction

1. This is an environmental due diligence report of the Huadian Zhangqiu Thermal Power Plant (hereafter referred to as the Zhangqiu TPP), being conducted as part of the IEE report for East Jinan Low-Emission Combined District Heating and Cooling Component, a component of the proposed Shandong Clean Heating and Cooling Project in Shandong Province of the PRC.

2. This component will utilize waste heat from Zhangqiu TPP. The Zhangqiu TPP is therefore an associated facility for the subproject, and as per the ADB Safeguard Policy Statement (SPS), an environmental audit is required.

B. Environmental Due Diligence Review Approach

3. Audits are typically used to determine the existence of any areas where the facility has risks associated with Environmental, Health and Safety (EHS) performance. The intent is to identify any deficiencies, and to propose measures for improvement that may be necessary to minimize environmental and safety risks for the proposed ADB investment. The audit provides a baseline in terms of the company's current performance based on the management systems and controls that are in place.

4. This report is based on a site visit, consultations with Zhangqiu TPP managers and technical staff, and a review of plant environmental and technical documentation. The site visit was undertaken March 20th 2018, and included the following participants:

Environmental Audit Reviewers:
Dai Lei, PPTA National Environmental Specialist
Yun Zhou, ADB Environment Specialist

Jinan Thermal Power Co., Ltd:
Mr. Zhou Qiang, Deputy Manager
Mr. Dong Linqiang, Director of Financial Department
Ms. Zhang Linlin, Financial staff

Zhangqiu TPP:
Mr. Huang Peng, Deputy Manager
Mr. Fu Guohua, Director of Production Department
Mr. Luo Yong, Director of Production Department

5. The audit activities included site observations, interviews with site personnel, and review of applicable documents. Time was also devoted to reviewing the environmental monitoring activities for air emissions, water discharges, and noise. The audit focused on the highest priority areas of operation for EHS risks, which were already identified by Zhangqiu TPP based on standards on the *Identification of Hazards Installation for Dangerous Chemicals* (GB 18218-2009) and its requirements, which are: (i) chemicals storage tank areas; (ii) solid waste storage tank areas; and (ii) hazardous waste tank. The team walked through the following facilities:

(i) 2x 145 MW turbine and 2x 435 t/h pulverized coal (pc) boilers;

(ii) 2x 335 MW turbine and 2x 1,025 t/h pulverized coal (pc) boilers;

(iii) Cooling towers;

(iv) Solid waste (ash and flue gas desulfurization (FGD) gypsum) storage facility;

(v) Chemicals (hydrochloric acid, liquid caustic soda, ammonium hydroxide and sodium hypochlorite) storage tank areas; and

(vi) Existing shaded coal storage places.

6. Documentation reviewed during and after the facility visit included:

(i) Approval of EIA Report for Zhangqiu TPP Phase I project (2 x 135 MW units) by Shandong Provincial EPB, July 15, 1999;

(ii) Approval of EIA Report for Zhangqiu TPP Phase II project (2 x 330 MW units) by former State Environmental Protection Administration, November 7, 2007;

(iii) Approval of EIA Report for Zhangqiu TPP Phase I project desulfurization transformation project by Jinan EPB, October 16, 2013;

(iv) Approval of EIA Report for Zhangqiu TPP Phase I project denitration project by Jinan EPB, July 30, 2013;

(v) Approval of EIA Report for Zhangqiu TPP Phase II project desulfurization transformation project by Jinan EPB, October 16, 2013;

(vi) Approval of EIA Report for Zhangqiu TPP Phase II project denitration project by Jinan EPB, November 21, 2011;

(vii) Approval of EIA Report for Zhangqiu TPP ultra-low emission transformation project by Jinan EPB, June 4, 2015;

(viii) Pollutant discharge permit;

(ix) Zhangqiu TPP layout and technology process description;

(x) EHS management regulation of Zhangqiu TPP;

(xi) Emergence response plan and drill record in 2017; and

(xii) EHS training record in 2017.

C. Project Description

1. Type

7. The Zhangqiu TPP is an existing coal-fired combined heat and power plant for combined heat and power generation. Zhangqiu TPP was founded in 2001. It belongs to China Huadian Group. The main business of Zhangqiu TPP includes thermal power generation and heat supply. Power generation is Zhangqiu TPP's most important and core business. In 2017, Zhangqiu TPP generated 6.72 billion kWh of electricity and provided heat to 20 million m^2.

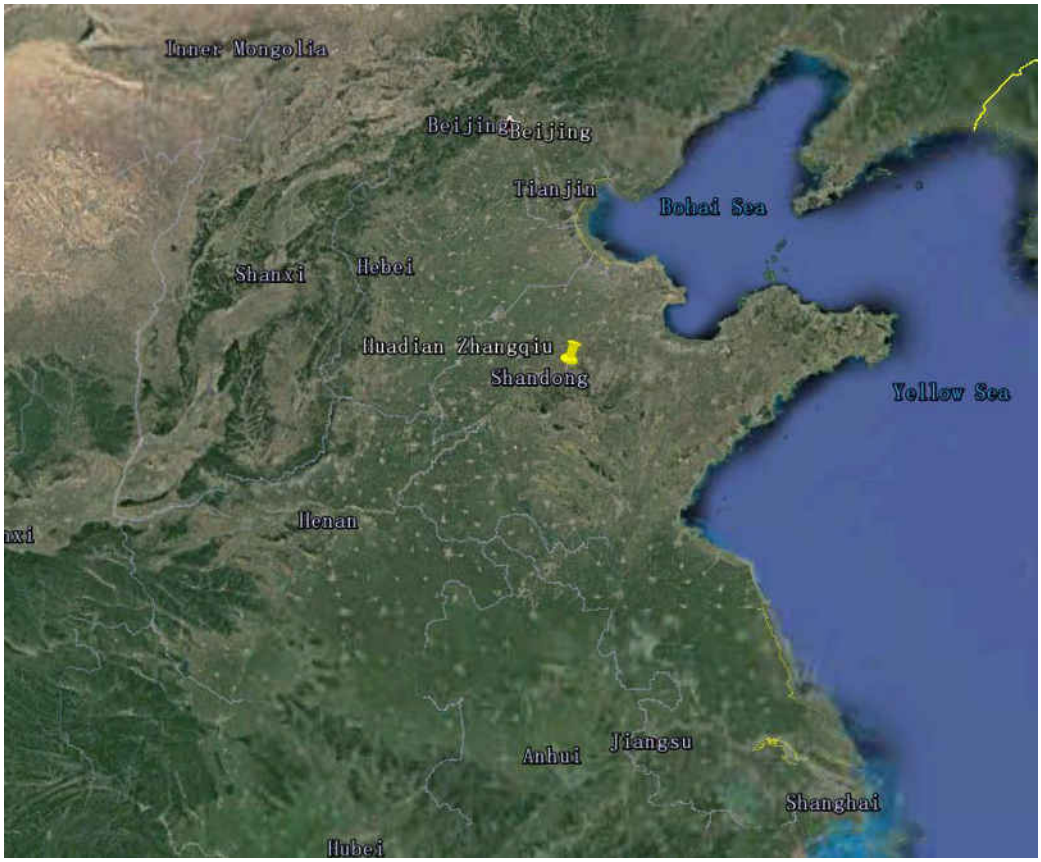
8. By the end of 2017, Zhangqiu TPP had 590 staff and 69 of them were technical staff.

2. Location

The Zhangqiu TPP is located on a 480,000 m^2 site in S102 Road, Zhangqiu District, Jinan (**Figure 13**). North of the site S102 road, west is farm land, south is Pantian Road and east is residential community (

9. **Figure 14**). The Zhangqiu TPP is about 27 km away from the Maoling Area where the component located.

Figure 13: Zhangqiu TPP's location, Zhangqiu District, Jinan



Source: Google Earth, 2018.

Figure 14: Zhangqiu TPP and surrounding area

Source: Google Earth, 2018.

10. **Figure 15** shows an aerial view of the plant including the boilers, cooling tower, stacks, primary heat exchange station to transfer waste heat from Zhangqiu TPP to east Jinan area and coal storage place and railway for coal transportation and unloading.

Figure 15: Zhangqiu TPP layout

Source: Google Earth 2017

3. Purpose and Capacity

11. The plant was originally built in 2002 for power generation. Now, Zhangqiu TPP's main purpose is combined heat and power generation. The current configuration of the plant is:

i) 2x 145 MW turbine and 2x 435 t/h pulverized coal (pc) boilers;

ii) 2x 335 MW turbine and 2x 1,025 t/h pulverized coal (pc) boilers;

iii) Chemical water treatment workshop;

iv) Limestone and gypsum FGD equipment;

v) Low NOx burners;

vi) Selective Catalytic Reduction (SCR) equipment; and

vii) Electrostatic precipitator and bag filter.

12. All boilers are equipped with low-NOx burner, selective catalytic reduction (SCR) denitration, limestone and gypsum FGD equipment, bag filters and electrostatic precipitators. Flue gases are exhausted through one 150 m high stack and inner diameter at the outlet of the stack is 15m.

13. In 2017, Zhangqiu TPP generated 6.72 billion kWh of electricity and provided heat to 20 million m^2.

Figure 16: Zhangqiu TPP one 335 MW unit and stack

Source: Environment Specialist.

4. Fuel

14. Low sulphur (0.5-0.9%) coal is primarily sourced from Shaanxi and Shanxi Province and transported by train. Annual coal consumption of the Zhangqiu TPP in 2017 is approximately 2.23 million tons. The coal was stored in coal storage room. The coal storage capacity was around 100,000 tons (**Figure 17**).

Figure 17: Closed coal storage room, Zhangqiu TPP

Source: Environment Specialist

5. Water Supply and Wastewater

15. The Zhangqiu TPP sources domestic water from municipal water and production water is reclaimed water from Zhangqiu No.1 waste water treatment plant.

16. Daily domestic water consumption of Zhangqiu TPP is around 50 m^3 per day and production water consumption is around 50,000 m^3 per day. Reclaimed water is treated by filter, ultra-filtration, reverse osmosis (RO) and ion exchange in chemical water treatment workshop, and then used as boiler make-up water and circulation water. Wastewater from chemical water treatment workshop is discharged to municipal sewer.

17. Domestic wastewater system, production wastewater system and storm water system are separated from each other. Domestic wastewater is collected and discharged to municipal sewer. Storm water is collected by storm water system and discharged. Production wastewater is collected and discharged to municipal sewer.

18. Wastewater discharge permit is presented in **Figure 18**.

Figure 18: Zhangqiu TPP Wastewater emission permit

Source: Environment Specialist.

19. Wastewater generated under in-normal operation like commissioning will discharged into 2 x 3,000 m^3 emergency tanks. When operation returns to normal, water in this tank will be discharged to municipal sewer.

20. To protect groundwater and meet the anti-seepage standard, different anti-seepage are undertaken according to different places and relevant anti-seepage requirements in fuel/chemical storage areas.

6. Solid Wastes

21. In 2017, the Zhangqiu TPP produced approximately 400,000 tons of fly ash, 95,000 tons of coal slag and 180,000 tons of desulfurization gypsum. The desulfurization gypsum is sold to Zhangqiu Yupeng Company for recycling and fly ash and coal slag are sold to Shandong Zhujin Construction Material Company for recycling. Domestic waste is collected, transported and treated by local sanitation department.

22. Hazardous wastes are temporarily stored on site with proper measures, and then sent to certificated company for treatment and final disposal by certificated trucks. The certificated company is Jinan Tianzhang Grease Company. The contracts were provided to the audit team for review.

7. Noise

44. Noise sources during operation are mainly from turbines, boiler rooms, coal transportation system, fans and desulfurization equipment, and also include transformers, pumps, and cooling equipment. Because Zhangqiu TPP is closed to residential communities, the Zhangqiu TPP used low-noise equipment as far as possible and also utilized noise elimination, shock absorption, insulated enclosures and sound dampening materials to mitigate noise impacts. These measures can typically reduce noise intensity. Also, appropriate personal noise protective equipment (PPE) is provided to the workers who are likely to be exposed to high noise level environment.

8. Chemicals

45. During the audit, the team reviewed the systems used by Zhangqiu TPP for chemicals management which emphasizes the need for obtaining and retaining a Material Safety Data Sheet (MSDS) for each chemical stored and/or used on site, and providing employee access to this information. Zhangqiu TPP has now installed a computerized system for keeping the MSDS records. For hazardous materials and hazardous wastes, Zhangqiu TPP keeps copies of permits and licenses for all handlers that deliver or remove such materials.

46. The plant has numerous tanks and vessels for storing raw materials. In 2017, annual consumption of hydrochloric acid was 220 tons, ammonium hydroxide was 11 tons and caustic soda was 260 tons.

Figure 19: Zhangqiu TPP liquid ammonia storage area

D. Compliance for Standards, Approvals, and Permits Requirements

1. EIA and environmental acceptance

47. The Zhangqiu TPP is in compliance with all relevant PRC EIA requirements. All the EIA approvals below were provided to the team for check and review.

(i) Approval of EIA Report for Zhangqiu TPP Phase I project (2 x 135 MW units) by Shandong Provincial EPB, July 15, 1999;

(ii) Approval of EIA Report for Zhangqiu TPP Phase II project (2 x 330 MW units) by former State Environmental Protection Administration, November 7, 2007;

(iii) Approval of EIA Report for Zhangqiu TPP Phase I project desulfurization transformation project by Jinan EPB, October 16, 2013;

(iv) Approval of EIA Report for Zhangqiu TPP Phase I project denitration project by Jinan EPB, July 30, 2013;

(v) Approval of EIA Report for Zhangqiu TPP Phase II project desulfurization transformation project by Jinan EPB, October 16, 2013;

(vi) Approval of EIA Report for Zhangqiu TPP Phase II project denitration project by Jinan EPB, November 21, 2011; and

(vii) Approval of EIA Report for Zhangqiu TPP ultra-low emission transformation project by Jinan EPB, June 4, 2015.

2. Relevant Environmental Standards

48. **Table 1** presents a summary of relevant emission standards for the Zhangqiu TPP. **Table 2** presents the relevant ambient air quality standards for the Zhangqiu TPP surrounding area. **Table 3** presents ambient noise standards. **Table 4** presents groundwater standards. Because the Zhangqiu TPP will not discharge any wastewater to surface water body. No surface water standard is applicable.

Table 5: Summary of Environmental Pollution Standards Applicable to the Zhangqiu TPP

Pollutant	Limit	Standards Source
Stack Emissions		
SO_2	35 mg/m^3	Ultra-low emissions standard from *Energy conservation and emission reduction upgrade and transformation Plan for coal fired power station* (2014-2020)
NOx	50 mg/m^3	
PM	10 mg/m^3	
Other		
Fugitive PM	1.0 mg/m^3 at site boundary	Table 2 of *Integrated Emission Standard of Air Pollutants* (GB 16297-1996)
Daytime Noise (06:00-22:00 h)	60dB(A) at site boundary	Class II of *Emission Standard for Industrial Enterprises at Site Boundary* (GB 12348-2008)
Nighttime noise (22:00-06:00 h)	50dB(A) (at site boundary)	

Table 6: Applicable ambient air quality standards – Class II, Ambient Air Quality Standards (GB 3095—2012) (unit: mg/m^3)

Pollutants	Annual mean (class 2)	24-hr mean (class 2)	1-hr mean (class 2)
TSP	0.200	0.300	--
PM_{10}	0.070	0.150	--
$PM_{2.5}$	0.035	0.075	--
SO_2	0.060	0.150	0.500
NO_2	0.040	0.080	0.200

Table 7: Applicable ambient environment noise standard – Class II, Environmental Quality Standards for Noise (GB3096-2008)

Item	Class II	Class III
Daytime Noise (06:00-22:00 h)	60 dB(A)	65 dB(A)
Nighttime noise (22:00-06:00 h)	50 dB(A)	55 dB(A)

Table 8: Applicable groundwater standard (Class III, *GB/T14848-2017 Quality Standard for Ground Water*)

No	Item	Unit	Limit
1	pH	-	6.5-8.5
2	Total hardness ($CaCO_3$)	mg/L	≤450
3	Fluoride	mg/L	≤1.0
4	Chloride	mg/L	≤250
5	Ammonia nitrogen	mg/L	≤0.2
6	Nitrate	mg/L	≤20
7	Nitrite	mg/L	≤0.02
8	Volatile Phenols	mg/L	≤0.002
9	Total dissolved solids	mg/L	≤1000
10	Permanganate index	mg/L	≤3.0
11	Total coliforms	/L	≤3.0

3. Environmental Monitoring

49. The Zhangqiu TPP is equipped with a continuous emissions monitoring system (CEMS) that monitors in real time SO_2, NOx, PM and air flow. Data is sent electronically to the Jinan EPB Data Center. Jinan EPB monitors the CEMS data, and staff indicates that Jinan EPB can be on site within as little as 1 hour if the CEMS indicates serious noncompliance. Emissions for Zhangqiu TPP comply with the ultra-low emission standards.

Figure 20: Zhangqiu TPP monitoring system showing real-time CEMS data

Source: Environment Specialist.

50. Manual stack emissions monitoring is also undertaken on a quarterly basis by Jinan EPB for calibration. 3rd party company is also hired by the Zhangqiu TPP on a quarterly basis for calibration. Internal monitoring of stack emission operational parameters is also implemented which are used to manage operation.

51. Noise monitoring is undertaken at the site boundary on a quarterly basis and is in compliance with the PRC standards..

4. Emission Controls and Compliance

52. All boilers are equipped with low-NOx burner, SCR denitrification, limestone and gypsum FGD equipment, bag filters and electrostatic precipitators. The plant is in full compliance with the current *Emission Standard of Air Pollutants for Thermal Power Plants* (GB 13223—2011) and ultra-low emissions standard from *Energy conservation and emission reduction upgrade and transformation Plan for coal fired power station (2014-2020)*. Jinan EPB was consulted by the consultant to identify during the site visit, no grievance was received or exceedance of standards happened in the last two years.

53. Fugitive emission control measures are listed below:

(i) Coal storage site is fully closed and installed with spray equipment which sprays water periodically;

(ii) Fly ash and coal slag are mixed with water then transported for onsite treatment;

(iii) Fly ash, gypsum and coal slag are stored at storage site. This site is installed with spray equipment which sprays water periodically. In strong wind weather, water

spray frequency will be increased.

54. The noise monitoring results in environment acceptance shows that the Zhangqiu TPP is in compliance with the relevant standard, Class II, *Emission Standard for Industrial Enterprises Noise at Boundary* (GB 12348-2008).

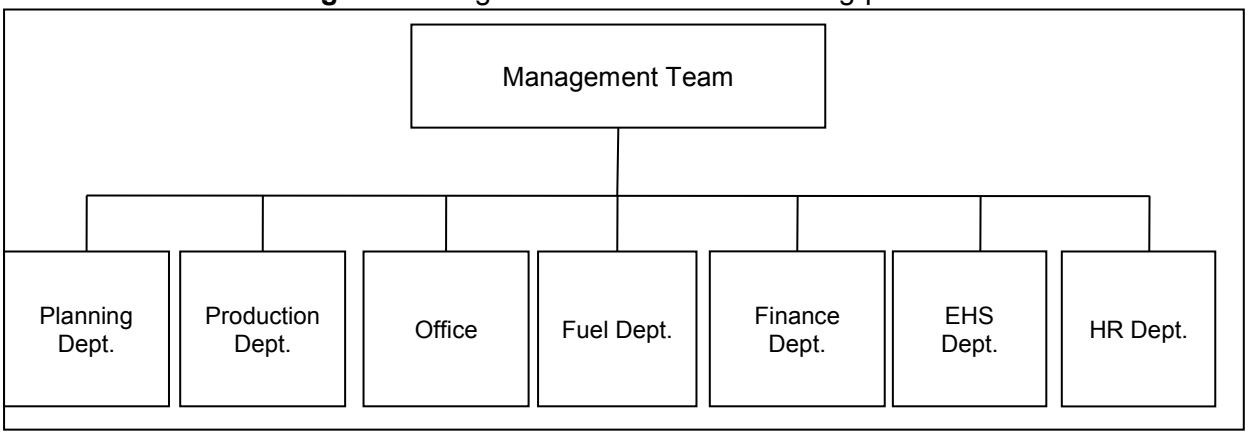
E. Environmental Management

1. ISO Certification, Staffing and Environmental Management

55. The Zhangqiu TPP has been certified for ISO 9001 (Quality Management Systems), ISO 14001 (Environmental Management Systems) and OHSAS 18001 (Occupational Health and Safety) in 2009.

56. The Zhangqiu TPP has a total of 590 staff. Environmental, health and safety (EHS) responsibilities are assigned to the EHS Department, which has a staff of 8 and includes an environment engineer, health engineer and a safety engineer (**Figure 21**).

Figure 21: Organization structure of Zhangqiu TPP



57. This structural arrangement aims to ensure EHS issues are well incorporated in other aspects like technical, finance, and others. All EHS staff have regular meeting with the head of EHS department for close coordination and effective implementation of EHS management systems. The site has an EHS Committee that meets regularly to discuss progress and set targets and objectives going forward.

58. The Zhangqiu TPP has an EHS Management System. An EHS regulation summary was provided to the audit team. The regulations include:

(i) Summary of laws, regulations and other requirements;

(ii) Waste management;

(iii) Environmental monitoring and management;

(iv) Safety management system;

(v) Safety and fire protection responsibility;

(vi) Safety training for staff;

(vii) Report and treatment procedures for accidents;

(viii) Personal Protective Equipment (PPE)management;

(ix) Management of occupational hazardous factors;

(x) Operation and management of occupational hazard factors protection facilities;

(xi) Occupational hazardous factors monitoring and management;

(xii) Emergency response plan for liquid ammonia leakage;

59. The regulations are annually reviewed and updated as required.

2. Staff training and PPE provision

60. Zhangqiu TPP organizes various types of safety education and trainings for employees. Also, external construction personnel receive EHS trainings from Zhangqiu TPP.

61. In 2017, Zhangqiu TPP provided EHS training to 1,546 person-time and the records were provided to the audit team. Zhangqiu TPP provides employees with PPE that is essential for performing work activities safely. During the audit visit, at the entrance of the site, a full range of PPE was provided to the audit team. Thus, the audit can confirm that PPE provision and implementation is strictly followed as designed.

62. Zhangqiu TPP maintains a comprehensive Emergency Response capability that includes an onsite Fire Department trained for a full range of emergencies that may occur at the plant. Zhangqiu TPP also has a detailed Emergency Response Plan (ERP). The ERP is tested regularly with drills, simulations, and exercises. EHS records were reviewed. There was no incident or accident in the last 5 years.

63. For some tank areas, such ammonium hydroxide tank and hydrochloric acid tank, Zhangqiu TPP has configured spare (reserved) tanks, cofferdams and emergency accident collecting pools to timely perform relative treatments in case of leakage occurrence, which meet the World Bank EHS guidelines requirements.

Figure 22: Emergency supplies in ammonium hydroxide storage area

F. Conclusion

64. The audit confirmed that the EHS management systems were comprehensive and there was clear evidence of continual improvement which was mainly attributed to a systematic approach to EHS implementation, driven by GB/T 24001 (equivalent to ISO 14001) Environmental Management Systems and GB/T 28001-2001 (equivalent to OSHAS 18001) Occupational Health and Safety Management Systems. The audit confirmed that senior management and employees have sincere commitment to the implementation of the EHS management system.

65. Based on this rapid environmental audit and due diligence, it can be concluded that:

(i) the Zhangqiu TPP has undergone an appropriate EIA process by Jinan EPB and has received the necessary EIA approvals and environmental acceptance approvals;

(ii) EHS polices and systems are in place and the respective EHS management programs were effective;

(iii) Comprehensive environmental monitoring programs were in place;

(iv) Combustion by-products are recycled into construction materials, and wastewater is recycled on site;

(v) Hazardous waste is stored according to *Standard for pollution control on hazardous waste storage* (GB18599- 2001, revised in 2013), then transported and treated by certified company; and

(vi) Zhangqiu TPP is in full compliance with relevant ultra-low emission standards, and the CEMS monitoring data of 2017 is provided to the audit team for review.