Evaluation Summary

Jinan District Heating Project

Country: **People's Republic of China** | Sector: **Energy**

Evaluator: **James J. Qin, Haijiang Chen, Jing Zhang, HJI Group Corp.**
Date of the evaluation: **12/ 2021**

Key data on AFD's support

Projet numbers: CCN 1042

Amount: EUR 40 Million

Disbursement rate: 100%

Signature of financing agreement: June 2012

Completion date: November 2016

Total duration: 53 months

Context

Jinan is the capital of Shandong province, which accounts for 11% of national energy consumption. Jinan is historically an industrial city and industrial needs were given priority for heating provision, which came in the form of steam. The steam surplus produced was then distributed to meet the heating needs of homes and offices. Jinan's rapid economic development and air pollution problems have led to relocate industry to rural areas, significantly reducing the need for steam in urban area. Therefore, the heating network renovation by transforming the low efficient steam-based heating networks into hot-water based heating networks started in 2010. In addition, to satisfy local residents' demand for better heating services, the project was launched with the support of AFD to expand and improve existing heating networks and heating services.

Actors and operating method

Project implementation agency (IA) and final beneficiary is Jinan Heating Group Co. Ltd (JHG), whose previous name was Jinan District Heating Company (JDHC), a state-owned company.

The loan was on-lent by the Ministry of Finance to JDHC through the on-lending bank with the guarantee from the Department of Finance of Shandong Province.

Objectives

The overall project purpose is to combat global warming by decoupling urban growth from greenhouse gas (GHG) and air pollutant emissions; and help strengthen the France-China partnership on climate change issues.

The specific objectives are to i) improve the public district heating service in Jinan to meet growing heating demands and citizen's desire for living comfort in winter whilst consuming less coal resources; ii) improve the energy efficiency of the networks through innovative and demonstrative solutions; and iii) influence the design & practice customary in heating sector by organizing Franco-Chinese expertise exchanges.

Expected outputs

- Construct 101.8 km heat distribution network covering 9.8 million m^2 heating areas with hot water pipelines;
- Construct three initial heat exchange stations, 185 heat exchange substations, and 2 booster pump stations; and
- Construct a new control and monitoring system with an energy management center.

Performance assessment

Relevance

The project's intened and achieved objectives, outputs and outcomes are **highly relevant** to (1) the government policies on reduce carbon intensity and energy intensity as well as combat climate change; (2) heating sector development trend of energy efficiency and emission reduction; (3) AFD's Strategies with China and climate change; and (4) final beneficiaries' interest of better heating services.

Effectiveness

The project performance is rated as **very effective**. At project completion, 101.8 km pipeline, 2 initial heat exchange stations, 213 heat exchange substations, and 1 booster pump stations were constructed, covering a heating area of 10.6 million m^2. By adopting innovative equipment, high-temperature hot water-based close-loop network, and intelligent automatic energy management system, the heat losses of district heating is reduced from 30% to 5%, data transmission accuracy and efficiency is improved, and labor force is reduced.

Efficiency

The project implementation is **efficient**. The project Economic Internal Rate of Return (EIRR) is 23.5%, which is above the 12% benchmark for economic return. The sensitivity test illustrates that the project is economically strong in tackling with potential risks. The project completely utilized 100% of AFD's fund although disbursement progress was relatively slow. Comparing with planned implementation schedule, the project was delayed for 2 years due to uncontrollable urban road construction plan and overall urban heating policy.

Sustainablility

The project is **most likely be sustainable**. The project established smart, reliable, and expandable energy management system, which enables the heating network to be operated at a more efficient, sustainable and stable level. The application of energy management system enhanced JHG's team capacity and built good foundation for future company development, such as further expansion of heating area to 229 million m^2. The project is financial sustainable as the calculated Financial Internal Rate of Return (FIRR) is above its Weighted Average Cost of Capital (WACC) and higher than expected.

E&S Risk Management

The management of environment and social risks is **very satisfactory**. To prevent and mitigate the potential environmental impacts, an Environmental and Social Action Plan (EASP) was formulated and successfully implemented. A total of 29 coal-fired boilers were decommissioned. By adopting hot-water pipeline network and automatic energy management system, the project can reduce 200,000 t/year of CO_2 emission. In addition to hardware, community butler service model is also adopted to improve comfort of local residents. The project has benefited 140,000 households and 420,000 people, and they are highly satisfied with heating services provided.

Added value of AFD's contribution

The added value brought by AFD to the project is **very satisfactory**. The JHG is satisfied with AFD's supports regarding environmental and social management and procurement, and thinks experiences gained in the AFD project are valuable for the implementation of the later ADB financed project. AFD introduced Schneider to help build the energy management platform, which not only upgraded existing heating system and service level, but also allowed further expansion that making JHG one of the pioneers in intelligent heating. The low interest rate and long duration and grace period provided JHG with sufficient funds and less financial burden.

Conclusions and lessons learnt

The project overall meet the established targets and exceed expectations in some aspects, especially for energy saving and emission reduction. By implementation of this AFD project, JHG's heating systems are much more efficient than the national standards. The excellent project technical performance leads a new trend in district heating sector in China and many companies visited JHG each year for knowledge sharing. With heating sector integration in Jinan, JHG relied on the good foundation laid by the AFD project and further expanded its service scale, which has reached 229 million m^2 heating area, 2,649 heat exchange stations, and heating pipe network of 6,753 km.

Logical framework is a key project document for project evaluation because it introduces expected project outcomes and outputs and contains important project performance indicators. However, the project owner is not familiar with it and some key indicators don't have baseline data established or detailed calculation were not well documented. In addition, key adjustments of project contents during project implementation were not reflected in the logical framework. All above factors made it difficult to track project achievement in time during implementation and accurately evaluate project performance after project completion.

Evaluation Summary

Yichun Shuangfeng Biomass Heat and Power Project

Country: **People's Republic of China** | Sector: **Energy**

Evaluator: **James J. Qin, Haijiang Chen, Jing Zhang, HJI Group Corp.**
Date of the evaluation: **12/ 2021**

Key data on AFD's support

Projet numbers: CCN 1050

Amount: EUR 35 million

Disbursement rate: 84.1% (current)/92.2% (estimated for project completion)

Signature of financing agreement: June 2014

Completion date: December 2021 (estimated)

Total duration: 90 months(estimated)

Context

Shuangfeng town and its surrounding areas, located in Yichun municipality, a cold climate region in the far northeast of China, are historically covered with forests and the main grain producing base. The project area has rich biomass resources of forest residues and agricultural residues, which can be used to generate energy. To fully utilize local biomass recourses and respond to government's renewable energy development policy, which promote the construction of biomass power plants, especially combined heat and power (CHP) plants. The project was launched with the support from AFD.

Actors and operating method

Project implementation agency (IA) and final beneficiary is Yichun Natural Resources Development Co., Ltd (YNRD) , a joint venture company of which Shuangfeng Forest Bureau (public sector) owns 52% and Beijing Natural Resources Development Corporation (private sector) owns 48%.

The loan was on-lent by the Ministry of Finance to YNRD through the on-lending bank with the guarantee from the Department of Finance of Heilongjiang Province.

Objectives

The overall purpose of the project is to reduce China's carbon intensity.

The specific objectives are to i) produce 180 GWh of electricity annually for the city's grid network, and 410,000 GJ of heat annually for district heating network; ii) reduce emissions of CO_2 and other pollutants by decommissioning coal-fired boilers; and iii) create jobs and value added in the area.

Expected outputs

- Construct a 30MW biomass CHP plant;
- Construct an electricity transmission line connecting the biomass power plant to the power grid;
- Construct a biomass collection, transport and preparation system; and
- Renovate and expend district heating system.

Performance assessment

Relevance

The project's intened and achieved objectives, outputs and outcomes are **highly relevant** to (1) government policies on reducing carbon intensity and energy intensity as well as combating climate change; (2) heating sector development trend of energy efficiency and emission reduction; (3) AFD's Strategies with China and climate change; and (4) final beneficiaries' interest of better heating services.

Effectiveness

The biomass plant just finished its trial operation in November 2021. Considerting project implementation at current stage and design capacity of installed equipment, the project performance is rated as **effective**. Based on current estimation, each year the 30MW biomass CHP plant can produce 210 GWh electricity and 560,000 GJ heat. Due to restricted forest logging policy, the plant will only utilize crop residuals as fuel. The electricity transmission line connecting the plant to the power grid has been installed and tested. The necessary collection, storage and transportation equipment has been purchased, but the expected off-site collection and storage station has been cancelled. The heating network has been renovated, allowing the project provide heating for an area of 920,000 m^2.

Efficiency

The project implementation is **less than efficient**. The project Economic Internal Rate of Return (EIRR) is 23.5%, which is above the 12% benchmark for economic return. Currently, the project utilized 84.1% of AFD's fund and expected to reach 100% at project completion. Comparing with planned implementation schedule, the project completion will be postponed for at least 4.5 years due to different management concepts, management personal change, lengthy review and revision of preliminary design, and impact of COVID-19.

Sustainability

The project is **less likely be sustainable**. Renewable biomass fuels the CHP plan. Thus, scattered coal-fired boilers and straw burning activities are replaced, making the project environmentally sustainable. The plant adopted "One-button start-up" control system and light-weight hollow welded shaft for steam turbine, resulting in less energy consumption and low operation cost. Different management concepts between private and public sectors stagnated project implementation and frequently changes of senior managers bring uncertainty to the project. With estimated Financial Rate of Return above its Weighted Average Cost of Capital, the project is likely be financially sustainable. However, the financial sensitivity analysis indicates a rather weak risk resistance capability.

E&S Risk Management

The management of environment and social risks is **satisfactory**. To prevent and mitigate the potential environmental impacts, an Environmental and Social Action Plan (EASP) has been formulated and implemented. Once in full capacity operation, the plant will supply both heat and electricity to local areas without burning coal, contributing to 180,000 t/year of CO_2 emission reduction. In addition, a total of 1,294 people were hired for project implementation. For project operation, 127 of fixed positions in the plant will be provided. Local residents and plant workers are satisfied with how the project was implemented and no complaint received.

Added value of AFD's contribution

The added value brought by AFD to the project is **satisfactory**. The project owner is satisfied with supports provided by AFD regarding environmental and social management and procurement. AFD promoted biomass CHP project, which adopted ALSTOM's steam turbine to the project, helped the project to fight against climate change and supply both electricity and heating for local communities. The low interest rate, long duration and grace period of the loan are very attractive and the project IA's financial burden is reduced.

Conclusions and lessons learnt

The project just had trial operation. Based on the current implementation progress and its future plan, it is estimated that the project is likely to achieve most of the established targets. Yichun as the main grain producing area and forest area, biomass fuel such as crop residuals and forest residuals are abundant. Thus, it is optimal to build a biomass-fueled CHP plant to supply both heat and electricity, as well as to reduce CO_2 emission and illegal onsite crop residuals burning activities.

Logical framework is a key project document for project performance evaluation which covers expected project outcomes and outputs. . The project owner and AFD should carefully establish baseline data for indicators and well document detailed calculations for emission reduction, to facilitate the evaluation of project performance. In addition, it is recommended that the changes in project output during the implementation process be reflected in the logical framework in a timely manner.

The project has experienced significant delays due to collision of different management concepts, frequent changes of senior managers, and COVID-19. It is essential to enhance project management capacity and closely monitor future project progress to ensure project operation meets expectation.

Evaluation Summary

Qingdao High-tech Thermo Electricity CCGT Cooling, Heating and Power Project

Country: **People's Republic of China** | Sector: **Energy**

Evaluator: **James J. Qin, Haijiang Chen, Jing Zhang, HJI Group Corp.**
Date of the evaluation: **12/ 2021**

Key data on AFD's support

Projet numbers: CCN 1058

Amount: EUR 20 Million

Disbursement rate: 72.3% (current)/100% (estimated for project completion)

Signature of financing agreement: May 2017

Completion date: December 2022 (estimated)

Total duration: 79 months (estimated)

Context

Qingdao is a metropolis with 8.7 million inhabitants and Shandong's largest city in terms of GDP. One-third of CO_2 emissions of Qingdao comes from the residential sector and district heating. In 2012 the central government designated Qingdao as one of the pilot cities of the low-carbon city development program. Qingdao has been actively seeking to replace coal-fired boilers with energy efficient and low-carbon systems. Therefore, with the support from AFD, this project will construct a demonstrative gas-fired Combined Cycle Gas Turbine (CCGT) tri-generation plant, to supply electricity, heat and cold, which is the first case in Shandong Province.

Actors and operating method

Project implementation agency (IA) and final beneficiary is Qingdao Kaiyuan Thermal Power Co. Ltd, a state-owned subsidiary of Qingdao Kaiyuan Group Co. Ltd (QKG).

The loan was on-lent by the Ministry of Finance to QKG through the on-lending bank with the guarantee from the Qingdao Finance Bureau.

Objectives

The overall purpose is to reduce carbon intensity and help Chinese government to achieve peak coal consumption targets at the national level as well as at the regional level.

The specific objectives are to i) reduce greenhouse gas emissions and local pollutant emissions; and ii) promote innovative energy production technologies to decrease the share of electricity, heating and cold produced from coal.

Expected outputs

- Construct a gas-fired trigeneration plant that could produce 578 GWh of electricity, 87,000 tons of industrial steam, 195,000 tons of heating steam, 410,300 GJ of heat, and 202,000 GWh of cold per year;
- Construct 2 backup gas boilers for peak shaving; and
- Demolish 4 existing coal-fired boilers.

Performance assessment

Relevance

The project's intened and achieved objectives, outputs and outcomes are **highly relevant** to (1) government policies on reducing carbon intensity and energy intensity as well as combating climate change; (2) heating sector development trend of energy efficiency and emission reduction; (3) AFD's Strategies with China and climate change; and (4) final beneficiaries' interest of better heating services.

Effectiveness

Currently, the project is still being implemented and is estimated to be completed by the end of 2022. Considering project implementation at current stage and design capacity of installed equipment, the project performance is rated as **effective**. At present, the installation of the 84MW gas-fired trigeneration plant is almost complete and two 40t/h backup gas boilers have been installed. Based on design capcity, each year the plant can produce 668 GWh electricity, 49,200t industrial steam, 232,300 t heating steam, and 635,695 GJ heat supplying for 2.2 million m^2. Cooling capacity is not mentioned due to no confirmed summer cooling demand.

Efficiency

The project implementation is **efficient**. The project Economic Internal Rate of Return (EIRR) is 32.8%, which is above the 12% benchmark for economic return. The sensitivity test illustrates that the project is likely be economically strong in tackling with potential risks. Currently, the project utilized 72.3% of AFD's fund and expected to reach 100% at project completion. Comparing with planned implementation schedule, the project is delayed for at least 2 years due to slow procurement progress of gas turbine and the COVID-19 pandemic.

Sustainablility

The project is **most likely to be sustainable**. Gas-fired CCGT trigeneration plant will utilize by-product steam heat for space heating and use waste heat for cooling generation via an absorption chiller. High-pressure and medium-pressure natural gas will both be available once required infrastructures are constructed. Thus, constructing a trigeneration plant is sustainable in energy consumption and emission reduction. The project is lead by a proactive management team which arranged domestic study tours to enhance their capacity in project implementation and operation of CCGT plant. The estimated Financial Internal Rate of Return (FIRR) is above its Weighted Average Cost of Capital (WACC), so the project is likely be financial sustainable once it becomes operational.

E&S Risk Management

The management of environment and social risks is **very satisfactory**. To prevent and mitigate the potential environmental impacts, an Environmental and Social Action Plan (EASP) has been formulated and implemented. At present, 2 coal-fired boilers were deconstructed. Once in successful operation, the plant will benefit 12,000 households and 40,000 people, and reduce 310,000 t/year of CO_2 emission. Currently, the project has created 400 jobs for construction and assembling.

Added value of AFD's contribution

The added value brought by AFD to the project is **satisfactory**. The project IA is satisfied with supports provided by AFD regarding environmental and social management and procurement. AFD support of the construction of gas-fired CCGT tri-generation plant offers an overall energy efficiency of 70% which is far superior to conventional simple cycle systems. The low interest rate, long duration and grace period of the loan are very attractive and it reduced the project IA's financial burden.

Conclusions and lessons learnt

The project is still in implementation, so only part of outputs realized. Based on the current implementation progress and its future plan, it is estimated that the project is likely to achieve most of the established targets. Building a gas-fired CCGT tri-generation plant is the most energy efficient and demonstrative approach to satisfy beneficiaries' need for heat, power and cold, as well as to reduce CO2 and air pollutant emissions in Qingdao.

Logical framework is a key project document for project performance evaluation because it covers expected project outcomes and outputs. However, the outputs changed due to design update were not reflected in logical framework or the progress reports for performance tracking. Especially, the output capacity of plant has changed due to no cooling demand confirmed at current stage. It is suggested to reflect design changes in logical framework and activity seek possible cooling demand.

The project progress is relatively slow due to slow procurement progress and COVID-19. In addition, the construction of related gas supply infrastructures are also behind original schedule. It is essential to closely monitor the implementation progress to ensure successful project completion and operation.

Evaluation Summary

Zibo District Heating Comprehensive Energy Efficiency Renovation Project

Country: **People's Republic of China** | Sector: **Energy**

Evaluator: **James J. Qin, Haijiang Chen, Jing Zhang, HJI Group Corp.**
Date of the evaluation: **12/ 2021**

Key data on AFD's support

Projet numbers: CCN 1069

Amount: EUR 25.6 Million

Disbursement rate: 100%

Signature of financing agreement: September 2016

Completion date: December 2018

Total duration: 27 months

Context

Zibo, a city with over 4 million inhabitants, is a industrial hub located in Shandong province. Heating supply was primarily oriented towards the needs of industries via steam distribution networks and coal-fired heating sources. The inherent characteristics of the steam networks and coal-fired heating sources, such as significant energy loss, high risk of explosion, and air pollutants emissions, led to a sector reform launched by the authorities in 2009. Therefore, heating network renovation by transforming the low efficient steam-based heating networks into hot-water based heating networks started. Meanwhile, decommission of small coal-fired boilers and heat recovery of industrial waste heat were promoted. As a result, the project was launched with the support of AFD to expand and improve existing heating networks and heating services.

Actors and operating method

Project implementation agency (IA) and final beneficiary is Zibo District Heating Company (ZDHC), a stated-owned company.

The loan was on-lent by the Ministry of Finance to ZDHC through the on-lending bank with the guarantee from the Department of Finance of Shandong Province.

Objectives

The overall purpose of this project is to contribute to combat global warming by decoupling urban growth from GHG emissions in Zibo city and help reduce the carbon intensity of the Chinese economy.

The specific objectives are to i) improve the public district heating service in Zibo to meet growing heating demands and citizen's desire for living comfortly in winter whilst reducing energy consumption; and ii) improve the air quality by dismantle decentralized boilers and facilities and adopt more efficient and cleaner heating systems.

Expected outputs

- Construct a waste heat recovery station to recover low temperature residual heat from circulating cooling water of industrial processes to supply heat via BrLi absorption heat pumps;
- Renovate and construct 151 heat exchange sub-stations;
- Renovate heating pipelines of 2x37.96 km; and
- Create control and monitoring system with an energy management center.

Performance assessment

Relevance

The project's intened and achieved objectives, outputs and outcomes are **highly relevant** to (1) government policies on reducing carbon and energy intensity as well as combating climate change; (2) heating sector development trend of energy efficiency and emission reduction; (3) AFD's Strategies with China and climate change; and (4) final beneficiaries' interest for better heating services.

Effectiveness

The project is rated as **very effective**. At project completion, 151 heat exchange stations and 75.92 km pipeline were built. By constructing the Kaitai industrial heat recovery station, switching to high-temperature hot water-based close-loop network, and applying automatic management system, the heat losses of district heating has been reduced from 25% to 5%, and integrated automatic control of heating network is realized, which improved data transmission accuracy, ensured timely information exchange and feedback, as well as reduced and labor force.

Efficiency

The project implementation is **very efficient**. The project Economic Internal Rate of Return (EIRR) is 22.6%, which is above the 12% benchmark for economic return. The sensitivity test illustrates that the project is economically strong in tackling with potential risks. The project completely utilized 100% of AFD's fund. Comparing with planned implementation schedule, the project moved at a very quick pace and completed earlier than expected.

Sustainablility

The project is **likely to be sustainable**. The project established smart, reliable, and expandable energy management system, which enables the heating network to be operated at a more efficient, sustainable and stable level. By operating the Kaitai station and new hot-water based heating network, industrial waste heat is utilized and water and heat are saved. The project was implemented by a very dynamic and competent management team. The company also built its own research and development team and established the Shandong Province Clean and Smart Heating Engineering Laboratory to further explore the clean and intelligent heating supply. The Financial Internal Rate of Return (FIRR) is above its Weighted Average Cost of Capital (WACC), making the project financial sustainable.

E&S Risk Management

The management of environment and social risks is **very satisfactory**. To prevent and mitigate the potential environmental impacts, an Environmental and Social Action Plan (EASP) was successfully implemented. 19 coal-fired boilers and many household stoves were decommissioned. By utilizing industrial waste heat, the project can reduce 99,000 t/year of CO_2 emission. By adopting hot-water pipeline network, automatic management, and community butler service model, comfort level in homes has been improved. The project has benefited 155,000 households and 465,000 people, highly satisfied with heating services provided.

Added value of AFD's contribution

The added value brought by AFD to the project is **satisfactory**. The ZDHC is satisfied with supports provided by AFD regarding environmental and social management and procurement. In addition to automatic control system, AFD promoted the utilization of industrial waste heat for heating supply via BrLi absorption heat pumps. The low interest rate, long duration and grace period of the loan are very attractive and it reduced the financial burden of ZDHC.

Conclusions and lessons learnt

The project overall meet the established targets and exceed expectations in some aspects, especially for energy saving and emission reduction. By utilizing industrial waste heat, close-loop hot-water heating network and automatic management system, ZDHC's heating system is much more clean and efficient than the national standards. The excellent project performance leads the new trend in district heating sector in China, and the project has been listed as one of the best practice cases of public heating in northern cities and towns.

Logical framework is a key project document for project performance evaluation because it includes expected project outcomes and outputs. However, the project owner is not familiar with it and some key indicators don't have baseline data or detailed calculations were not well documented. Especially, it is suggested that the documents to quantify CO_2 emission reduction regarding project's contribution to the combat of climate change should be well prepared at project appraisal and tracked during project implementation.

In addition, because the project has been implemented in a rather fast pace, some project reports were not prepared as required and project final acceptance was delayed. Thus, supervision of project implementation management can be strengthened.

Evaluation Summary

District Heating and Cooling Project based on Sewage Source Heat Pump in Jinan

Country: **People's Republic of China** | Sector: **Energy**

Evaluator: **James J. Qin, Haijiang Chen, Jing Zhang, HJI Group Corp.**
Date of the evaluation: **12/ 2021**

Key data on AFD's support

Projet numbers: CCN 1075

Amount: EUR 25 Million

Disbursement rate: 39% at the time of evaluation

Signature of financing agreement: Feburary 2017

Completion date: March 2023 (estimated)

Total duration: 61 months (estimated)

Context

Jinan is a major industrial center in Shandong requiring steam to feed its industrial processes where AFD performed a district heating project completed in 2016. To achieve the energy and carbon intensity reduction targets set in the 12th and 13th five-year plan, the province has stepped up the development of renewable energy to increase the proportion of non-fossil fuels in its total energy consumption. In addition, with economic growth, local residents are increasingly demanding for better air quality and heating service. Thus, replacing existing coal-fired boilers and diversifying energy sources by developing renewable energies, such as heat recovery from waste water, are important part of the solutions. Therefore, AFD supported the project to shift the city heat production from a high carbon mix to an increased share of renewable energy sources.

Actors and operating method

Project implementation agency (IA) and final beneficiary is Jinan Energy Construction and Development Group (JECDG), a state-owned company active in district heating, a different counterpart from the first AFD heat network project in Jinan.

The loan granted by AFD to the Chinese Ministry of Finance was on-lent to JECDG through the Shandong Provincial Department of Finance, with the guarantee from Jinan Finance Bureau.

Objectives

The overall purpose is to contribute to combat global warming by decoupling urban growth from the emissions of greenhouse gases and local pollutants in Jinan city.

The specific objectives are to :

i) satisfy growing heat demand and expected home temperature while consuming less coal resources and emitting less pollutants; and

ii) improve the efficiency of the urban heating network by adopting more efficient solutions and clean heat sources

Expected outputs

- Construct energy stations to recover heat from effluent discharge after treatment with water-water compression heat pump units;
- Construct associated heating pipeline network; and
- Install automatic control equipment in energy stations.

Performance assessment

Relevance

The project's intended and achieved objectives, outputs and outcomes are **highly relevant** to (1) government policies on reducing carbon intensity and energy intensity as well as combating climate change; (2) heating sector development trend of energy efficiency and emission reduction; (3) AFD's Strategies with China and climate change; and (4) final beneficiaries' interest of better heating services.

Effectiveness

Currently, the project is still being implemented and is estimated to be completed in 2023. Considering project implementation at the time of the evalation, the project performance is rated as **effective**. 11 energy stations have already been put into operation in Huashan district, connected to the heat network and associated with the global heat network control system. These stations have been running for the last 2 winters before evaluation. The remaining stations to be constructed have temporarily been postponed and relocated due to low occupancy rate of the new buildings and disturbance in the waste water pipeline construction plan due to a railway construction. The project heat recovery of waste water was therefore reoriented to another part of Huashan district. This reorientation led to performing a new feasibility study on the selected district and resulting in an extension of the project implementation period.

Efficiency

The project implementation is **efficient**. The estimated project Economic Internal Rate of Return (EIRR) is 48.5%, which is above the 12% benchmark for economic return. At the time of the evaluation, the project has utilized 38.9% of AFD's loan and is expected to reach 100% at project completion. Comparing with planned implementation schedule, the project completion will be postponed for at least 3 years due to relatively slow bidding process, delayed real estate development, as well as design changes.

Sustainablility

The project is **likely be sustainable**. According to the new feasibility study report, in addition to heat recovered from reclaimed water, other waste heat sources such as air, geothermal and flue gas can also be harnessed via heat pumps. Since the whole heating process has no combustion of fuel, no air pollutant, and less carbon footprint, the project is still sustainable in terms of environment. The estimated project Financial Internal Rate of Return (FIRR) is above its WACC (Weighted Average Cost of Capital), so the project is likely be financial sustainable in future operation.

E&S Risk Management

The management of environment and social risks is **satisfactory**. To mitigate the potential environmental impacts, an Environmental and Social Action Plan has been formulated and implemented for the part of the project already performed. The emission reduction target updated with the new feasibility study for the entire project is 100,000 t/year of CO_2 emission, less than expected at appraisal time (105,198CO_2). The 11 energy stations already constructed have benefited 9,500 households and 28,500 people. Local residents are satisfied with heating services provided. The only boiler to decommission was in Dawei district which cannot be addressed anymore.

Added value of AFD's contribution

The added value brought by AFD to the project is **satisfactory**. The JECDG is satisfied with supports provided by AFD regarding environmental and social management and procurement. Instead of using coal and natural gas, heat pumps are used to recover energy from reclaimed water for heating supply, to reduce carbon footprint and operation cost. The low interest rate, long duration and grace period are very attractive which recedes JECDG's financial burden.

Conclusions and lessons learnt

The project is still being implemented, so only part of outputs realized. Based on the current implementation progress and its future plan, it is estimated that the project is likely to achieve most of the established targets. The project provide heat to new communities utilizing water source heat pumps to recover heat of reclaimed water from a nearby large wastewater treatment plant, which is more optimal and cost-effective than using natural gas and coal. As a result, pollutant and greenhouse emissions are also reduced.

Logical framework is a key project document for project performance evaluation because it includes expected project outcomes and outputs. The project owner and AFD should carefully establish baseline data for indicators and well document detailed calculations for emission reduction, to facilitate the evaluation of project performance.

Since the FSR of the project has been revised, in addition to suggest updating the logical framework accordingly for future project monitoring, it is also recommend AFD to establish a project adjustment period during project implementation for future projects to assess and record changes.

The project progress is relatively slow due to delay in real estate development speed and the bidding process, as well as design changes. It is essential to enhance capacity building, strength supervision, and provide technical supports.