

Ex post evaluation – China

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Sector: 23620 District heating/(cooling) Grids/distribution
Programme/Project: Energy efficiency programme - District heating Qingdao, BMZ No. 2008 65 782* and Urban development programme, BMZ No. 2006 65 786*
Implementing agency: see table below



Ex post evaluation report: 2016

In EUR million actual value	Jinhong Heating Company (Qingdao) 2006 65 786	Songyuan City Heating Company 2006 65 786	Qingdao Huadian Heating Company 2008 65 782
Investment costs (total)	67.35	44.22	54.20
Composite financing			
KfW own funds + Budget funds (BMZ)	20.00	15.00	14.50
Counterpart contribution	47.35	29.22	39.70

*) Random sample 2015

Summary: As part of two programmes, district heating networks (components for coal-fired heating plants, pipes and heat exchanger stations) in the Chinese cities of Qingdao (Shandong province) and Songyuan (Jilin province) of three different operators were financed. Hot water is provided to heat households in the supply area of the implementing agencies via the district heating networks. At the same time, old, decentralised heating boilers were replaced with new centralised systems.

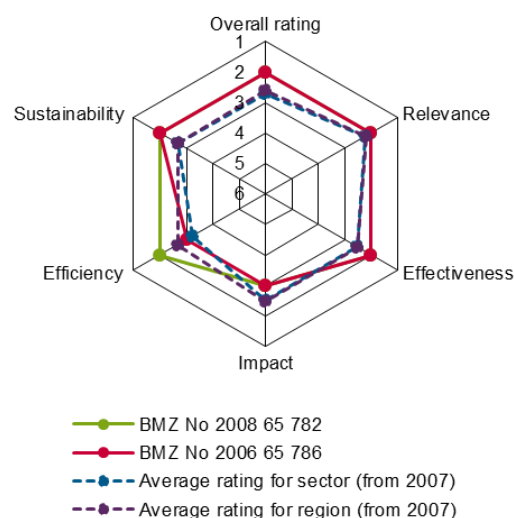
Objectives: The objective of both programmes was to ensure the efficient and eco-friendly supply and use of district heating (outcome). This was to make a contribution to ecological, social and economically sustainable urban development, and improve the living conditions of the population (impact). Finally, the programmes were designed to promote the achievement of global climate objectives.

Target group: The target group of the programmes was the urban population of the cities of Qingdao and Songyuan in the supply area of the district heating providers. In Songyuan, moreover, small and medium-sized enterprises were included in the target group.

Overall rating: 2 (both programmes)

Rationale: By replacing old and decentralised heating boilers with centralised and more efficient district heating systems as part of the two programmes, significant savings in CO2 and coal were achieved. Although there was no impetus towards more environmentally friendly energy sources, we rate both programmes as good thanks to the stable supply to households and the acceptable to good quality of the facilities financed.

Highlights: -



Rating according to DAC criteria

Overall rating: 2 (both programmes)

Breakdown of total costs

The sub-projects with BMZ no. 2006 65 786 (Jinhong Heating Company in the Licang district in Qingdao and Songyuan City Heating Company in Songyuan) were appraised in 2008 as part of an anticipated appraisal. The counterparties' own contribution of all projects was not laid down in a contract, was not sufficiently documented, and is not directly related to the facilities that were financed with FC funds; rather, it is part of the implementing agency's other fixed assets (additional pipes, boilers, etc.). The increase in total costs can be attributed in part to the appreciation of the Chinese yuan. Since the implementing agency defines its counterpart contribution in yuan, the euro equivalent increased over the period.

		Jinhong Heating Company (Licang) 2006 65 786 (Planned)	Songyuan City Heating Company 2006 65 786 (Planned)	Qingdao Huadian Heating Company 2008 65 782 (Planned)
Investment costs	in EUR m	43.30	28.80	44.00
Composite financing				
KfW own funds +				
Budget funds (BMZ)	in EUR m	20.00	15.00	14.50
Counterpart contribution	in EUR m	23.30	13.80	29.50

		Jinhong Heating Company (Licang) 2006 65 786 (Actual)	Songyuan City Heating Company 2006 65 786 (Actual)	Qingdao Huadian Heating Company 2008 65 782 (Actual)
Investment costs	in EUR m	67.35	44.22	54.20
Composite financing				
KfW own funds +				
Budget funds (BMZ)	in EUR m	20.00	15.00	14.50
Counterpart contribution	in EUR m	47.35	29.22	39.70

Relevance

China has been experiencing rapid urbanisation for a number of years. Between 2005 and 2015, the percentage of the population living in cities increased from 42.5 % to 54.4 %. As a result, and also due to the population's increasing expectations in terms of mobility and comfort, demand for energy in urban areas has increased. High demand for energy, and the resulting emissions, were already having a negative impact on both air quality and public health at the time of the programme appraisals (both in 2008).

At the same time, energy use for heating homes represented a non-trivial part of total energy use. Households are responsible for just over 10 % of total end-user energy use in China, and about 30 % of the energy used by households is used for heating homes.¹ Therefore, energy used for heating homes was and is responsible for a significant portion of total CO₂, particulates (fine dust particulate matter) and other emissions.

The development cooperation programme's at the time aimed at making the provision of heating energy more efficient. This approach was relevant due to its potential contribution to reducing CO₂ and other

¹ https://www.iea.org/publications/freepublications/publication/PARTNERCOUNTRYSERIESBuildingEnergy_WEB_FINAL.pdf, page 16 and China Statistical Yearbook 2014

emissions through fuel savings. Centralised heating networks, in which heating energy is generated in a central district heating plant and piped to local households, achieve 80-90 % efficiency (energy output per unit input) in China – significantly higher than decentralised heating plants, e.g. to serve a building complex (60-70 % efficiency in China), or individual furnaces for use by a single household (15-55 % for older furnaces; typically over 50 % for newer models)².

At the time of the programme appraisals, it was correctly assumed that in urban areas with high population density, many households could be reached with a district heating network. Over short distances, absolute heat losses in district heating networks are usually low.

Furthermore, the programme proposal rightfully observed that the positive effect on the efficiency of energy provision would also be present if all three project implementing agencies continued to fire the heat source with coal. The increase in efficiency could still be expected to lead to a reduction in coal and CO₂ emissions. At the same time, however, the choice of coal-fired district heating systems meant that no programmes were selected that contribute to the strengthening of renewable or alternative energy sources in China as a whole.

From today's perspective, we evaluate the relevance of the measures as good due to their large potential for reducing coal and CO₂ emissions. This is despite the failure to generate an impetus towards renewable or more environmentally friendly energy sources.

Relevance rating: 2 (both programmes)

Effectiveness

In the wake of the project, materials for 100.4 km of district heating pipe, 2 new boiler facilities in the central heating plant (2x 116 Mwh), and 82 heat transfer stations for the Jinhong Heating Company in Qingdao were financed with an Financial Cooperation (FC) loan (composite financing) of over EUR 20 million and a counterpart contribution of EUR 47.35 million. 14 old heating boilers were decommissioned in the context of the project.

In the context of the measures taken with the Songyuan City Heating Company, a total of 6 heating boilers, additional heating plant components, a modern measurement and control system, and 42 km of piping for the district heating network and 37 heat exchanger stations were financed with an FC loan (integrated composite financing) of EUR 15 million and a counterpart contribution of EUR 29.22 million. 67 old decentralised heating boilers were decommissioned in the context of the project, 11 of which have replaced even older boilers owned by another district heating operator in the city.

For the project implementing agency Qingdao Huadian Heating Company, a total of 6.3 km of steam pipes, 13 steam heat exchangers and 35.5 km of hot water pipes, 29 heat exchanger stations and control systems were financed with an FC loan (composite financing) of EUR 14.5 million and a counterpart contribution of EUR 39.7 million. The implementing agency reported that at least 66 old heating boilers were decommissioned.

The achievement of the programme objectives defined during the programme appraisal can be summarised as follows:

Indicator	Status PA, Target value PA	Ex-post evaluation (2015)
(1) Improved district heating supply (in m ² of heated area and millions of gigajoules (GJ million))	(1) Jinhong Heating Company n/a (status), 7.4 million m2 (target value) (no data on output)	(1) Jinhong Heating Company 8.2 million m2 2.3 million GJ
	(2) Songyuan City Heating Company 3.4 million m2, 7.2 million m2 (no data on output)	(2) Songyuan City Heating Company* 10.2 million m2 5.9 million GJ

² Boiling Point No. 41 - Household Energy: The Urban Dimension (ITDG - ITDG, 1998, p.44)

	(3) Huadian Heating Company 0.6 million m ² ,10.54 million m ² 0.29 million GJ, 4.4 million GJ	(3) Huadian Heating Company 20.2 million m ² 6.1 million GJ
(2) Households supplied	(1) Jinhong Heating Company 80,000 (target value)	(1) Jinhong Heating Company 70,000
	(2) Songyuan City Heating Company 50,000 (target value)	(2) Songyuan City Heating Company 85,216
	(3) Huadian Heating Company 100,000 (target value)	(3) Huadian Heating Company 290,000
(3) Yearly reduction in coal and CO ₂ emissions (in t)**	(1) Jinhong Heating Company - 40,000 t coal (target value) - 70,000 t CO ₂ (target value)	(1) Jinhong Heating Company - 65,000 t coal - 175,000 t CO ₂
	(2) Songyuan City Heating Company - 90,000 t coal (target value) - 155,000 t CO ₂ (target value)	(2) Songyuan City Heating Company - 167,000 t coal - 451,000 t CO ₂
	(3) Huadian Heating Company - 190,000 t coal (target value) - 300,000 t CO ₂ (target value)	(3) Huadian Heating Company - 170,000 t coal - 460,000 t CO ₂

*The increased demand for energy in Songyuan is mainly due to the colder climate conditions in the city.

**The calculated values for reductions in coal and CO₂ emissions refer to the total energy supplied by the implementing agency, and not to the facilities financed by the FC. For evaluation purposes, an updated conversion rate from tonnes of coal to tonnes of CO₂ was used.

The area supplied by district heating in 2015, the number of households served, and the energy supplied and used³ far exceed the target values defined at the start of the programmes. This is attributable to the continuing rapid growth of both cities participating in the programmes. All three project-executing agencies are accompanying this growth with an expansion of their networks.

In both programmes, the most obvious impact is on the efficiency with which heat is supplied. If we compare the energy use of decentralised heating boilers with the implementing agency's centralised district heating network (see Efficiency), major savings are observed which exceed the specified target values due to the rapid expansion of the service areas through 2015, the year of the ex-post evaluation (see table). The fact that improved supply also leads to increased energy consumption by households (e.g. more rooms are heated, expectations of comfort increase) is countered by increasing energy efficiency in new buildings in the area for all implementing agencies.

Most buildings in the area served by the Jinhong Heating Company are occupied by middle-income households, are so-called resettlement apartments (apartments for residents whose original houses were torn down for purposes of urban development), or, in a few cases, are high-priced apartment buildings. Most residents in the area served by the Huadian Heating Company in Qingdao are middle-income families. The proportion of non-private users of the system is small in both cases. In Songyuan, households of all income classes are served, as are a relatively large number of businesses. Neither programme has a particular focus on low-income families and related effects.

The security of the district heat supply is guaranteed and checked by the state. Suppliers must ensure an indoor temperature of at least 18 degrees. If the temperature drops below this level, a portion of the fees

³ In a circulation system, the energy used by households is equivalent to the energy supplied minus the heat lost during energy transfer.

(based on how low the temperature drops) is refunded to customers. Appropriate service centres were established at all the implementing agencies, and the supply of heat works well.

The quality of the facilities in use meets average international standards. The standard for the heating plant in Songyuan is below that of the facilities in Qingdao. However, in all cases employees are able to answer questions about technical details. Environmental standards with respect to emissions are checked by the implementing agencies and by the state. The implementing agencies report that violations of these regulations are punishable by large fines. Finally, the proper disposal of waste material (ash, sulphur) could be verified for the two implementing agencies in Qingdao, but not for the implementing agency in Songyuan.

The Chinese construction boom of recent years contributes to the fact that an appreciable number of buildings across the country are either empty or rarely used. However, the utilisation of newly constructed apartments in the catchment area of the implementing agencies appears to be acceptable. The energy drawn from the district heating networks per m² supplied is relatively stable for all implementing agencies.

Effectiveness rating: 2 (both programmes)

Efficiency

The efficiency of the project with regard to savings of coal and CO² per euro invested is high. As long as the alternative to district heating consists of decentralised heating boilers (the most modern small-scale equipment can also achieve higher efficiency), centralised district heating networks are an efficient way to reduce fuel consumption in urban areas.

The Jinhong Heating Company implementing agency's central heating plant achieves an efficiency of about 85 % (fluidised bed combustion). The efficiency of the Songyuan City Heating Company's heating plant is a few percentage points lower due to the use of simple technology (grate firing). At the Qingdao Huadian Heating Company implementing agency, the district heating network is fed with the extraction steam of a combined heat and power plant. The cogeneration of heat and power in this type of power plant leads to a significant increase in efficiency. The evaluation assumes that for all implementing agencies, the overall efficiency is increased by 30 to 40 percentage points compared to decentralised heating boilers (the exact increase in efficiency depends on which heating boilers are taken out of service, especially at the household level). The heat losses in the district heating network for all implementing agencies fall in the usual range for this technology, and show no evidence thus far of insufficient maintenance of the underground pipes.

The state's regulation of district heat suppliers emphasises a stable supply rather than maximum efficiency. The number of employees exceeds the number needed to operate the facilities, and key positions are filled by the state. There is no inherent monetary incentive to increase the efficiency of energy production or energy supply. Tariffs for heating are set by the state (and are lower than the cost covering price), and the losses incurred by all implementing agencies are either directly offset by state subsidies or borne by the state-owned parent companies or by the local community (Songyuan). At the same time, the government is attempting to create incentives to improve production efficiency, e.g. by offering prizes for the most efficient suppliers in the city of Qingdao. Although the effectiveness of these incentives is limited, the most important personnel are mostly well-educated, and because poor air quality has drawn public attention to issues of environmental protection, the implementing agencies are interested in improving existing facilities, especially in Qingdao.

Since district heating networks are generally operated by vertically integrated local monopoly holders (i.e. the implementing agencies are responsible for the generation, transport and sale of heat), this market is strictly regulated. In recent years, an increasing proportion of customers in Qingdao (e.g. 50 % of all customers for the Jinhong Heating Company and 20 % of all customers for the Huadian Heating Company in 2015) pay a base rate per m² plus a usage-dependent portion, similar to the German system.⁴ At present, however, the government is still capping the usage-dependent payments at a fixed upper limit, so users are not necessarily penalised for extremely high usage. Yet, since far from all households reach this up-

⁴ In this type of system, the supplier only has an incentive to encourage households to save energy if it can use the freed-up capacity to expand its network, for example.

per limit, this measure is not an entirely inappropriate way to increase acceptance of the new usage-based system, as long as the upper limit is eventually removed. In Songyuan, no customers pay a usage-based rate so far. Therefore, no increase in allocation efficiency could be achieved for the provision of heat energy in Songyuan through the removal of existing disincentives.

Overall, despite the fact that production efficiency could clearly be increased, we still evaluate the efficiency of the programmes as good or, in the case of Songyuan, as satisfactory because existing disincentives could not be alleviated. This is also because the implementing agencies continuously maintain and expand their networks with their own funds.

Efficiency rating: 2 (BMZ No. 2008 65 782) and 3 (BMZ No. 2006 65 786)

Overall developmental impact

Indicator	Status PA, Target value PA	Ex-post evaluation
(1) Improved air quality measured by average daily values for particulates, SO ₂ , NO ₂ in (mg/m ³)	(1) Qingdao (Status 2007) Particulates: 0.097 SO ₂ : 0.054 NO ₂ : 0.026	(1) Qingdao (Status 2014) Particulates: 0.107 SO ₂ : 0.037 NO ₂ : 0.043
	(2) Songyuan (Status 2008) Particulates: 0.058 SO ₂ : 0.016 NO ₂ : 0.038	(2) Songyuan (Status 2014) Particulates: 0.062 SO ₂ : 0.018 NO ₂ : 0.028

In addition to coal and CO₂ savings, both programs have a direct positive impact on public health. In centralised systems, the ash and other waste material that is generated (e.g. SO₂ through desulphurisation) is filtered out more effectively and diverted to further productive uses. Households' exposure to these hazardous substances is reduced. Further, the possibility of improper coal storage within the household is precluded. Coal is transported to the heating or cogeneration plants mostly by train in Songyuan, or by ship in Qingdao, and by lorry for the last few kilometres. However, the evaluation also determines that the storage and hauling of coal and/or waste materials by the Songyuan City Heating Company does not comply with modern standards (e.g. the coal is stored directly adjacent to a neighbouring residential area). The positive health effects are therefore partially cancelled out.

The positive impact of the individual programmes does not manifest itself in a general improvement in air quality in Qingdao or Songyuan. The impact of the programmes is superseded by an overall increase in energy requirements due to the rapid growth of the cities and the economy.

The innovative effects of the measures are reduced by the absence of any connection to renewable energies (despite small, isolated pilot measures by the implementing agencies). The technology used reflects the current Chinese standard (which is otherwise typically financed from local sources) for district heating networks. Although the implementing agencies claim to be interested in the exchange of information and expertise about technical advances, the accompanying measures that were offered were not carried out. As a result, the FC's knowledge in the domain of energy efficiency or renewable energy could not be put in effect through this channel either.

The impact of the sub-project on the project-executing agency in Songyuan is limited by the use of older technology and non-optimal use of waste materials. However, the overall rating for the programme with BMZ no. 2006 65 786 is improved by the better-than-average facilities at the Jinhong Heating Company implementing agency. In the end, due to the lack of an impetus towards cleaner energy sources or the most modern technology, we evaluate both programmes as satisfactory, despite clear improvements to the quality of life of households in the supplied areas.

Overall developmental impact sub-rating: 3 (both programmes)

Sustainability

During the evaluation mission, the systems at all of the implementing agencies were in operation with virtually no problems. The personnel are trained in the operation and maintenance of the facilities. Questions about technical details could be answered competently. All facilities at the Jinhong Heating Company are in an excellent state of repair. On the other hand, the condition of the Songyuan Heating Company's heating plant in the same programme could be improved. The heat exchangers at the Huadian Heating Company and the Songyuan City Heating Company are in acceptable condition.

The guarantee periods for the financed equipment are short (e.g. two years for the pumps in the heat exchangers). Therefore, any necessary repairs are performed by the implementing agencies themselves, or the equipment is replaced.

At the prices currently imposed by the state, the implementing agencies cannot cover their costs. The state therefore subsidises them directly with a contribution per unit of heat, and indirectly through their parent companies (which are also wholly owned by the state). Through this support from the state, which was specified in the 12th Five-Year Plan, the implementing agencies' financial sustainability is ensured. It is generally believed that the subject of energy efficiency will play an important role in the 13th Five-Year Plan as well. From an evaluation perspective, the risk that networks could be reduced or no longer used, or that necessary repairs might not be performed, is only a concern if the political will to promote district heating should falter. For the moment, however, all implementing agencies plan to extend their networks in the coming years.

From today's perspective, despite the implementing agencies' dependence on state subsidies and reduced maintenance quality at the Qingdao Huadian Heating Company and the Songyuan City Heating Company, we therefore evaluate the sustainability of both programmes as good.

Sustainability rating: 2 (both programmes)

Notes on the methods used to evaluate project success (project rating)

Projects (and programmes) are evaluated on a six-point scale, the criteria being **relevance**, **effectiveness**, **efficiency** and **overarching developmental impact**. The ratings are also used to arrive at a **final assessment** of a project's overall developmental efficacy. The scale is as follows:

Level 1	Very good result that clearly exceeds expectations
Level 2	Good result, fully in line with expectations and without any significant shortcomings
Level 3	Satisfactory result – project falls short of expectations but the positive results dominate
Level 4	Unsatisfactory result – significantly below expectations, with negative results dominating despite discernible positive results
Level 5	Clearly inadequate result – despite some positive partial results, the negative results clearly dominate
Level 6	The project has no impact or the situation has actually deteriorated

Rating levels 1-3 denote a positive assessment or successful project while rating levels 4-6 denote a negative assessment.

Sustainability is evaluated according to the following four-point scale:

Sustainability level 1 (very good sustainability): The developmental efficacy of the project (positive to date) is very likely to continue undiminished or even increase.

Sustainability level 2 (good sustainability): the developmental efficacy of the project (positive to date) is very likely to decline only minimally but remain positive overall (this is what can normally be expected).

Sustainability level 3 (satisfactory sustainability): The developmental efficacy of the project (positive to date) is very likely to decline significantly but remain positive overall. This rating is also assigned if the sustainability of a project is considered inadequate up to the time of the ex post evaluation but is very likely to evolve positively so that the project will ultimately achieve positive developmental efficacy.

Sustainability level 4 (inadequate sustainability): The developmental efficacy of the project is inadequate up to the time of the ex post evaluation and is very unlikely to improve. This rating is also assigned if the sustainability that has been positively evaluated to date is very likely to deteriorate severely and no longer meet the level 3 criteria.

The **overall rating** on the six-point scale is compiled from a weighting of all five individual criteria as appropriate to the project in question. Rating levels 1-3 of the overall rating denote a “successful” project while rating levels 4-6 denote an “unsuccessful” project. It should be noted that a project can generally be considered developmentally “successful” only if the achievement of the project objective (“effectiveness”), the impact on the overall objective (“overarching developmental impact”) **and** the sustainability are rated at least “satisfactory” (level 3).