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PROJECT PERFORMANCE ASSESSMENT REPORT



BULGARIA

District Heating Project

Report No. 123951

MARCH 6, 2018

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1818 H Street NW
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Telephone: 202-473-1000
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BULGARIA

**DISTRICT HEATING PROJECT
(IBRD-47030, 47040)**

March 6, 2018

*Financial, Private Sector, and Sustainable Development
Independent Evaluation Group*

Currency Equivalents (annual averages)

Currency Unit = Bulgarian Leva (Lev)

Exchange rates

January 6, 2003 (appraisal)	November 7, 2008 (closure)	October 9, 2017 (assessment)
EUR 1.00=US\$1.05	EUR 1.00=US\$1.28	EUR 1.00=US\$1.17
EUR 1.00=Lev 1.96	EUR 1.00=Lev 1.96	EUR 1.00=Lev 1.96
US\$1.00=Lev 1.87	US\$1.00=Lev 1.52	US\$1.00=Lev 1.67

Abbreviations and Acronyms

CHP	Combined Heat and Power
CPF	Country Partnership Framework
DH	District Heating
DHC	District Heating Company
EBRD	European Bank for Reconstruction and Development
ERPA	Emission Reduction Purchase Agreement
ESP	electrostatic precipitator
EU	European Union
GDP	gross domestic product
IBRD	International Bank for Reconstruction and Development (World Bank)
ICR	Implementation, Completion, and Results
IEG	Independent Evaluation Group
IMF	International Monetary Fund
Kgoe	kilogram of oil equivalent
KIDSF	Kozloduy International Decommissioning Support Fund (EU grant)
MW	megawatt
MWh	megawatt hour
NEK	National Electricity Company
NEEAP	National Energy Efficiency Action Plan
PCF	Prototype Carbon Fund
PHRD	(Japan) Professional Human Resource Development (Trust Fund)
PIU	Project Implementation Unit
PPAR	Project Performance Assessment Report
SEWRC	State Energy and Water Regulatory Commission
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development

Fiscal Year

Government: January 1 -- December 31

Director-General, Independent Evaluation	Ms. Caroline Heider
Director, Financial, Private Sector, and Sustainable Development	Mr. José Carbajo Martinez
Manager, Sustainable Development	Ms. Midori Makino
Task Manager	Ms. Victoria Alexeeva

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This report was prepared by Victoria Alexeeva who assessed the project in October 2017. The report was peer reviewed by Yanqin Song and panel reviewed by Stephen Hutton. Vibhuti Narang Khanna provided administrative support.

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Principal Ratings

	ICR*	ICR Review*	PPAR
Outcome	Moderately Satisfactory	Moderately Satisfactory	Moderately Satisfactory
Risk to Development Outcome	Low or Negligible	Moderate	Substantial
Bank Performance	Satisfactory	Satisfactory	Moderately Satisfactory
Borrower Performance	Satisfactory	Satisfactory	Moderately Satisfactory

* The Implementation Completion and Results (ICR) report is a self-evaluation by the responsible Bank global practice. The ICR Review is an intermediate IEG product that seeks to independently validate the findings of the ICR.

Key Staff Responsible

Project	Task Manager/Leader	Division Chief/ Sector Director	Country Director
Appraisal	Sudipto Sarkar	Hinderikus Busz	Andrew N. Vorkink
Completion	Sudipto Sarkar	Peter Thomson	Orsalia Kalantzopoulos

IEG Mission: Improving World Bank Group development results through excellence in independent evaluation.

About this Report

The Independent Evaluation Group assesses the programs and activities of the World Bank for two purposes: first, to ensure the integrity of the World Bank's self-evaluation process and to verify that the World Bank's work is producing the expected results, and second, to help develop improved directions, policies, and procedures through the dissemination of lessons drawn from experience. As part of this work, IEG annually assesses 20-25 percent of the World Bank's lending operations through field work. In selecting operations for assessment, preference is given to those that are innovative, large, or complex; those that are relevant to upcoming studies or country evaluations; those for which Executive Directors or World Bank management have requested assessments; and those that are likely to generate important lessons.

To prepare a Project Performance Assessment Report (PPAR), IEG staff examine project files and other documents, visit the borrowing country to discuss the operation with the government, and other in-country stakeholders, interview World Bank staff and other donor agency staff both at headquarters and in local offices as appropriate, and apply other evaluative methods as needed.

Each PPAR is subject to technical peer review, internal IEG Panel review, and management approval. Once cleared internally, the PPAR is commented on by the responsible World Bank country management unit. The PPAR is also sent to the borrower for review. IEG incorporates both World Bank and borrower comments as appropriate, and the borrowers' comments are attached to the document that is sent to the World Bank's Board of Executive Directors. After an assessment report has been sent to the Board, it is disclosed to the public.

About the IEG Rating System for Public Sector Evaluations

IEG's use of multiple evaluation methods offers both rigor and a necessary level of flexibility to adapt to lending instrument, project design, or sectoral approach. IEG evaluators all apply the same basic method to arrive at their project ratings. Following is the definition and rating scale used for each evaluation criterion (additional information is available on the IEG website: <http://ieg.worldbankgroup.org>).

Outcome: The extent to which the operation's major relevant objectives were achieved, or are expected to be achieved, efficiently. The rating has three dimensions: relevance, efficacy, and efficiency. *Relevance* includes relevance of objectives and relevance of design. Relevance of objectives is the extent to which the project's objectives are consistent with the country's current development priorities and with current World Bank country and sectoral assistance strategies and corporate goals (expressed in Poverty Reduction Strategy Papers, Country Assistance Strategies, Sector Strategy Papers, and Operational Policies). Relevance of design is the extent to which the project's design is consistent with the stated objectives. *Efficacy* is the extent to which the project's objectives were achieved, or are expected to be achieved, taking into account their relative importance. *Efficiency* is the extent to which the project achieved, or is expected to achieve, a return higher than the opportunity cost of capital and benefits at least cost compared to alternatives. The efficiency dimension is not applied to development policy operations, which provide general budget support. *Possible ratings for Outcome:* Highly Satisfactory, Satisfactory, Moderately Satisfactory, Moderately Unsatisfactory, Unsatisfactory, Highly Unsatisfactory.

Risk to Development Outcome: The risk, at the time of evaluation, that development outcomes (or expected outcomes) will not be maintained (or realized). *Possible ratings for Risk to Development Outcome:* High, Significant, Moderate, Negligible to Low, Not Evaluable.

World Bank Performance: The extent to which services provided by the World Bank ensured quality at entry of the operation and supported effective implementation through appropriate supervision (including ensuring adequate transition arrangements for regular operation of supported activities after loan/credit closing, toward the achievement of development outcomes. The rating has two dimensions: quality at entry and quality of supervision. *Possible ratings for Bank Performance:* Highly Satisfactory, Satisfactory, Moderately Satisfactory, Moderately Unsatisfactory, Unsatisfactory, Highly Unsatisfactory.

Borrower Performance: The extent to which the borrower (including the government and implementing agency or agencies) ensured quality of preparation and implementation, and complied with covenants and agreements, toward the achievement of development outcomes. The rating has two dimensions: government performance and implementing agency(ies) performance. *Possible ratings for Borrower Performance:* Highly Satisfactory, Satisfactory, Moderately Satisfactory, Moderately Unsatisfactory, Unsatisfactory, Highly Unsatisfactory.

Preface

This Project Performance Assessment Report (PPAR) prepared by the Independent Evaluation Group (IEG) evaluates the development effectiveness and sustainability of results of the World Bank–financed District Heating Project in Bulgaria (2003–08). The project development objectives were to improve the quality of district heating services in the capital city of Sofia (1.6 million people) and an adjacent town of Pernik (86,200 people), improve financial viability of the Sofia and Pernik district heating companies, and increase environmentally friendly operations in the district heating sector, through energy conservation and pollution reduction mechanisms. The project also extended funds from the World Bank–administered Prototype Carbon Fund (PCF) for the purchase of carbon emission reductions resulting from the project activities.

The project was co-financed by several development partners. In addition to the World Bank financing, other financiers included the European Bank for Reconstruction and Development (EBRD), the EBRD-administered Kozloduy International Decommissioning Support Fund (KIDSF), and the European Commission (through pre-accession support program). In addition, the United States Agency for International Development (USAID) provided a grant for project-supported activities. The overall project commitment was US\$132.7 million.

This report draws upon relevant documentation that includes the project appraisal document, legal agreements, the implementation completion and results report, supervision reports, aide-memoires, technical reports, external literature, and the EBRD/KIDSF assessment report. An IEG field mission visited Sofia and Pernik in October 2017 to follow up on the achievements and assess the sustainability of results. Meetings were held with the Sofia and Pernik district heating companies, government officials from the municipalities of Sofia and Pernik, the Ministry of Environment and Water of Bulgaria, and the Sustainable Energy Development Agency. Interviews were carried out with staff from the World Bank, EBRD, and KIDSF.

Alexander Penchev, a local energy efficiency expert, supported the PPAR mission. IEG is grateful to the World Bank Country Management Unit in Bulgaria, in particular Albena Samsonova, for support with the mission organization and logistics. Pekka Kalevi Salminen, Sudipto Sarkar, Eolina Milova, Jasneet Singh, Claudia Vasquez, Feng Lui, Yevgen Yesyrkenov, Ashna Mathema, Vladimir Mihailovski, and Migara Jayawardena provided valuable technical inputs. The PPAR team expresses appreciation for the generous time and attention given by the borrowers, government institutions, and all concerned parties (see Appendix D for a complete list of stakeholders who provided inputs for this project assessment).

Following standard IEG procedures, a copy of the report was sent to the relevant government officials and agencies for their review and feedback. No comments were received from the Borrower.

Summary

District heating (DH) is the main form of heating and hot water supply in densely populated cities in Bulgaria, serving 26.5 percent of the Bulgarian population. It is largely produced from natural gas, and about 65 percent of the national heat supply is produced by the district heating system in the capital city of Sofia, using combined heat and power (CHP) plants. Heat supply systems with the use of co-generation offer advantages over other means of heating, such as increased energy efficiency through utilization of waste heat and reduced air pollution. By using the heat output from electricity production, combined heat and power plants generally convert 75–80 percent of fuel into useful energy. The DH sector in Bulgaria has been assessed as the most economical and environmentally sustainable option for heat supply. In addition, the electricity generating capacity of CHP plants is part of Bulgaria's least-cost electricity supply strategy.

The DH sector systems in Bulgaria, built during the 1950s and 1960s, were designed to provide a collective, subsidized heat supply without consideration for individual consumer needs. Consumers were not able to adjust heat consumption on demand. The government sold heat at a fixed price below the cost of production, and the service was heavily subsidized. The increase in fuel (gas, oil) prices toward world-market levels in the mid-1990s (following the collapse of favorable trading relations with the former Soviet Union) heavily impacted the cost of heat production and put the state budget under financial pressure. The outdated design of the DH system and lack of possibilities to adjust heat consumption did not allow reduction of supply costs. Insufficient resource allocations for maintenance and investments led to gradual deterioration of the DH assets, low efficiency of operations, and poor quality of services. Many households opted to disconnect from the DH services. The decreasing customer base, along with low collection rates, further weakened the financial condition of DH companies.

In response to the government's request for assistance to address the urgent need of the district heating system modernization and revival of the district heating sector, the World Bank initiated a district heating project in the mid-90s. It prepared master plans for the DH systems in Sofia and Pernik, an adjacent industrial town with one of the most polluting DH systems in the country. The plans developed a rehabilitation schedule and a financing plan, identifying subsidy requirements and tariff increases. It was estimated that over the subsequent five years, Sofia and Pernik would need to spend about \$450 million and \$30 million, respectively, to rehabilitate their DH systems to ensure reliable and efficient heat supply. The European Bank for Reconstruction and Development (EBRD) also expressed interest in financing the sector's investment plan and the Sofia DH company.

The project was appraised in 1999 when Bulgaria was embarking on the energy sector reforms, supported by the International Monetary Fund (IMF) and the World Bank.ⁱ In July 1999, Bulgaria adopted the Energy and Energy Efficiency Act that specified key elements of the legal and institutional framework for the energy sector. It supported unbundling of the state-owned power utility, required the establishment of an independent energy regulator, and development of regulations to promote transparency and competition, and it allowed private ownership of energy assets. The IMF-supported three-year energy

sector reform program included restoring the financial viability of district heating companies, phasing out producer and price subsidies by 2001, and attracting private investment. Average heat tariffs were increased by 30 percent in September 1998 and 12 percent in July 1999.

Heat tariff increases resulted in a large-scale disconnection of consumers from the DH services in Bulgaria. A heat bill spike, combined with the poor quality of services, lack of control over heat consumption at individual level, and lack of affordability for low-income households led 30 percent of customers to disconnect from the DH services by 2000. The loss in customers, in turn, adversely affected the revenues of DH companies. The government and the World Bank recognized that increases in prevailing heat tariffs were not sufficient to put the sector on a commercial footing. It was necessary to improve the efficiency of heat consumption at the household level, which would help reduce the heat bill for the end-user. Heat demand of the average Bulgarian household was high, because of the inability to regulate heat consumption, the lack of incentives for the rational use of energy, and the low thermal resistance of buildings.

The project was put on hold for about three years, because the government and the World Bank agreed that it would be prudent to first advance the DH sector reform. It was decided to revise the DH master plans and prepare the District Heating Strategy and Action Plan for the financial recovery of the DH companies. The strategy laid out priorities for the DH sector to reduce end-user heat consumption through installation of modern, efficient substations, thermostatic valves, and cost allocators that would allow control and measurement of heat consumption; reduce supply costs through investments in the supply system (heat generation and transmission); and introduce a rational price system. These measures would be accompanied by the necessary legal framework, regulations, and policies on the provision of subsidies and on environmental emissions, and management strengthening with better accountability to customers and state/municipal authorities.

The project was approved in 2003, following implementation of several priority measures identified in the District Heating Strategy 2000-05. The energy law was amended to make cost allocators and heat regulators mandatory in apartment buildings. Private heating accounting companies were formed to install them. In addition, all DH substations in the country were equipped with heat meters. The project was approved for US\$132.7 million to be financed by loans from the World Bank and the EBRD, grants from the EBRD-KIDSF and the EU pre-accession program, and DH companies' own funds. A carbon finance operation was designed to purchase emission reductions resulting from the project-supported activities through the World Bank's Prototype Carbon Fund.

The project objectives were to improve the quality of DH services, improve financial viability, and increase environmentally friendly operations in Sofia and Pernik, through energy conservation and pollution reduction mechanisms. Investments in improving the technical performance of the DH system were to lead to reduction in heat and water losses in the system. Investments in modernizing DH substations were designed to facilitate control of heat supply at the building level that could be adjusted by households based on demand. Efficiency gains from the replacement of pipelines and substations in the DH system were to lead to energy savings and reduction in fuel consumption, thus resulting in carbon dioxide

(CO₂) emissions reduction. The improvement in DH services was expected to reverse the trend of customer disconnection, and along with the implementation of the financial recovery plans, place the DH system on a more financially sustainable path. In addition, the World Bank supported the decision of the Sofia municipality to introduce private sector participation in the Sofia DH company.

Ratings

The relevance of the project objectives is rated *high* because of their alignment with the development challenges, the government priorities in the sector, and World Bank country strategies. The relevance of the project design is rated *substantial* because of the clear linkages between the project activities, expected outcomes and objectives; however, there were no specific activities designed to support the two DHCs in improving their financial performance.

The efficacy of the project is defined by the achievement of its three objectives:

- The first objective of improving the quality of services was *substantially* achieved, as the project helped reverse the disconnection trend and more households were connected to the system than planned. There were 299,012 households using the district heating system in 2002; the number rose to 362,578 by 2008 (project closure), and continued to increase to 406,569 by 2017. At the same time, while the connection rate increase has been sustained, it is not a sufficient basis for judging the quality of services. Outages and breakdowns in DH service delivery are reported both in Sofia and Pernik during winter. No surveys to assess the level of customer satisfaction have been conducted since 2005.
- The second objective, to improve financial viability, was *modestly* achieved. The results were mixed and selected parameters, such as the improvement in bill collection and working ratios, remained below targets. The Sofia DHC, however, is no longer dependent on government subsidies, which were phased out in 2005 as planned. It is fully municipality-owned and operates on a commercial basis, but there is no private sector participation as was intended.
- The third objective, to increase environmentally friendly operations, is assessed as *substantially* achieved. The reduction in heat consumption at the household level exceeded the targets. In Sofia, the household heat consumption dropped by 40 percent at project closure, and continued to decrease by an additional 25 percent in 2016. In Pernik, heat consumption per household decreased by 22 percent by 2008, and remained at about the same level in 2016. Heat and water losses also decreased, albeit below the project targets. After project closure, water and heat losses started to increase because of the continuing deterioration of the network (only 10 percent of the DH network in Sofia was rehabilitated under the project). At present, water losses in the Sofia DH network are 3.1 million cubic meters (m³), the same level as at the start of the project in 2002. The ratio of heat loss to actual heat production has fluctuated between 17 percent and 18 percent (the target was 15.6 percent). In Pernik, heat and water losses decreased significantly at project closure, exceeding the targets. However, at present, they are higher than at project appraisal in 2002. Project investments led to the reduction of CO₂ emissions by an estimated 1,203,933 tCO₂ in

Sofia and 382,514 tCO₂ in Pernik during the project period, beyond projections. The companies were consequently able to sell the emission reductions to the Prototype Carbon Fund.

The project's efficiency in the use of funds is rated *substantial*, given the satisfactory economic rate of return and the timely completion of works. Based on the above ratings for relevance, efficacy, and efficiency, the overall project outcome rating is *moderately satisfactory*.

Lessons

IEG's review of this project's experience in Bulgaria suggests the following lessons:

Postponing an energy efficiency project until the necessary legal measures addressing demand-side management are implemented can lead to better outcomes. In Bulgaria, increases in heat tariffs led to a high rate of disconnections from the DH system in the late 1990s. The World Bank and the government recognized that increases in heat tariffs were not sufficient to achieve financial viability of the DH companies. It was necessary to improve demand-side heat consumption efficiency, which would help reduce household heating bills and encourage users to reconnect to the DH system. The project was primarily designed to rehabilitate and modernize the DH networks to improve supply efficiency (reduce heat production costs and the need for operating subsidies) but it was put on hold until policy reforms were undertaken. The DH strategies were developed and adopted, the energy law was amended to make cost allocators and heat regulators mandatory in apartment buildings, and all DH substations in the country were equipped with heat meters. Once these preconditions were met, the project was approved. Through its infrastructure investments, it helped facilitate energy conservation and contributed to a significant reduction of heat consumption at the household level.

Sustainability of benefits from infrastructure investments can be put at risk if future investment needs are unmet. The DH project carried out all the planned investments and largely achieved its objectives at the time. The investments were part of a comprehensive approach in support of the implementation of the five-year DH strategy and action plan adopted at appraisal. The benefits included the reduction in heat and water losses, reduction in heat consumption at the household level, and CO₂ emissions reduction. The government subsidies were phased out as planned by the end of the specified period in the strategy. However, the gains, for the most part, have not been sustained over time. Water and heat losses have been increasing for the past eight years after project closure and are currently at the same level as at project appraisal. The operating costs are rising for the DH companies, and the condition of the DH networks is deteriorating from a lack of investments. In addition, the related environmental benefits are being eroded. The project only covered a small fraction of the identified needs to ensure a reliable and efficient heat supply; the rest have not been subsequently addressed.

Investments in energy efficiency infrastructure alone are not enough to achieve sustained financial viability. The project's investments in rehabilitation of the DH networks helped address the DHCs' financing constraints. Technical investments yielded significant efficiency

gains in both companies (Sofia and Pernik). There was a reduction in operating costs, including fuel costs owing to reduction of heat losses, reduction in operation and maintenance costs owing to less breakdown of pipes, and a reduction of water losses. Although the project helped overcome the initial challenges in financing, it did not help put the DHCs on a financially sustainable path. In the context of a DH reform and strategy at project appraisal, the companies complied with their financial recovery plan to meet the 2005 targets; after that, their financial performance started to decline along many parameters. The World Bank covenants to the legal agreements proved insufficient to ensure the financial viability of the DHCs.

Efforts to encourage private sector participation may fail when there is no strong agreement from key stakeholders in the context of a complex and changing governance structure. Under the project, the government and the Sofia DHC worked with the World Bank and other donors (EBRD, USAID) on the satisfactory governance structure, financing arrangements, and the managerial and financial prerequisites to involve private sector in the Sofia district heating company. The ownership of the company changed several times between the state and the municipality. The stakeholders and the company planned first to select a private sector operator but then considered privatization or concession. A lack of agreement between stakeholders on the need and modality meant that no progress was made on any option. The planned private sector involvement did not materialize, and the company is fully owned by the municipality at present.

Carbon finance operation or results-based financing can have strong demonstration effects. As the first carbon finance operation in Bulgaria, it helped launch carbon finance, by demonstrating the feasibility of the instruments, by building capacity in government for managing carbon finance, and building awareness in agencies and companies that emission reductions could bring financial benefits. The carbon finance operation built the capacity of the two DHCs to measure and monitor CO₂ emissions from heat generation, transmission, and distribution. The rehabilitation works on the DH networks resulted in efficiency gains and energy savings that led to lower consumption of input fuel, thus lowering CO₂ emissions. The project helped the Sofia and Pernik DHCs to better prepare for the introduction of the EU Emission Trading System and to report on the EU requirements.

José Carbajo Martínez
Director, Financial, Private Sector, and
Sustainable Development Evaluation

ⁱ IMF-Extended Fund Facility 1998–2001; World Bank Financial and Enterprise Sector Adjustment Loans I and II.

1. Background and Context

Sectoral and Institutional context

1.1 **Although it has significantly reduced its energy intensity since the 1990s, Bulgaria remains one of the most energy-intensive economies in the European Union (EU), with significant potential for improvements in energy efficiency.** With 610 kg of oil equivalent (kgoe) per €1,000 in 2016, the energy intensity of the Bulgarian economy is about four times higher than that of the EU as a whole (142 kgoe/€1,000); at the same time, it represents a significant reduction since the 1996 levels of 1800 kgoe/€1,000 (Eurostat). The country also had strong growth in the run-up to the EU accession on January 1, 2007. Between 2000 and 2008, GDP expanded at 6 percent on average and convergence towards EU income levels accelerated from 28 percent to 45 percent. However, the growth has slowed down since 2009, following the global financial crisis, and Bulgaria remains the poorest EU member state with a per capita GDP of about 47 percent of the EU average (World Bank, 2016a).

1.2 **District heating is the main form of heating and hot water supply in densely populated cities in Bulgaria serving 26.5 percent of the Bulgarian population.** District heating (DH) in Bulgaria is largely produced from natural gas, and about 65 percent of the national heat supply is produced by the DH system in the capital city of Sofia, using combined heat and power (CHP) plants. Heat supply systems with the use of co-generation offer advantages over other means of heating: increased energy efficiency through utilization of waste heat, and reduced air pollution. By using the heat output from electricity production, CHP plants generally convert 75–80 percent of fuel into useful energy.

1.3 **DH was assessed as the least costly and most environmentally sound solution for heat supply in the country.** The World Bank's analytical work showed that rehabilitation of the existing DH systems was the most economical and environmentally sustainable means of meeting public heating needs in Bulgaria. In addition, the electricity generating capacity of CHP plants was part of the country's least-cost electricity supply strategy. Under Bulgaria's agreement with the European Bank for Reconstruction and Development (EBRD), the government agreed to close down the Kozloduy nuclear power plant (units 1–4). The electricity-generating capacity of CHP plants was to help compensate for the loss of generating capacity from nuclear fuel. The overall share of DH in electricity production is about 6 percent in Bulgaria (World Bank, 2017).

1.4 **The DH sector systems in Bulgaria, built during the 1950s and 1960s, were designed to provide a collective, subsidized heat supply without consideration of individual consumer needs.** Consumers were not able to adjust heat consumption on demand. The government sold heat at a fixed price below the cost of production, and the service was heavily subsidized. The increase in fuel (gas, oil) prices toward world market levels in the mid-1990s (following the collapse of favorable trading relations with the former Soviet Union) heavily affected the cost of heat production and put the state budget under financial pressure. The outdated design of the DH system and inability to adjust heat consumption did not allow reduction of supply costs. Insufficient resource allocations for

maintenance and investments led to the gradual deterioration of the DH assets, low efficiency of operations, and poor quality of services. Many households opted to disconnect from the DH services, and the decreasing customer base, along with low collection rates, further weakened the financial condition of district heating companies.

1.5 In response to the government’s request for assistance to address the urgent need for the DH system modernization and revival of the DH sector, the World Bank initiated a DH project in the mid-90s. It prepared master plans for the DH systems in Sofia and Pernik, an adjacent industrial town with one of the most polluting DH systems in the country). The plans developed a rehabilitation schedule and a financing plan, identifying subsidy requirements and tariff increases². It was estimated that during the subsequent five years, Sofia and Pernik would need to spend about \$450 million and \$30 million respectively to rehabilitate their DH systems to ensure reliable and efficient heat supply. The EBRD also expressed interest in financing the sector’s investment plan and the Sofia DH company.

Project Context

1.6 The project was appraised in 1999, when Bulgaria was embarking on the energy sector reforms, supported by the International Monetary Fund (IMF) and the World Bank³. In July 1999, Bulgaria adopted the Energy and Energy Efficiency Act that specified key elements of the legal and institutional framework for the energy sector. It supported unbundling of the state-owned power utility, required the establishment of an independent energy regulator, develop regulations to promote transparency and competition, and allowed private ownership of energy assets. The 1990–2001 IMF-supported energy sector reform program included restoring the financial viability of DH companies, phasing out producer and price subsidies by 2001, and attracting private investment. Average heat tariffs were increased by 30 percent in September 1998 and 12 percent in July 1999 (World Bank, 1999).

1.7 Heat tariff increases resulted in a large-scale disconnection of consumers from the DH services in Bulgaria. The heat bill spike, combined with the poor quality of services, lack of control over heat consumption at individual needs, and lack of affordability to low-income households led 30 percent of customers to disconnect from the district heating services by 2000. The loss in customers, in turn, adversely affected the revenues of DH companies. The decrease in the collection rate of sold heat reached 50 percent in 1999. The government and the World Bank recognized that increases in prevailing heat tariffs were not sufficient to put the sector on a commercial footing. It was necessary to improve the efficiency of heat consumption at the household level that would help reduce heat bill for the end-user. The average Bulgarian household’s demand was high, due to inability to regulate heat, lack of incentives for rational use of energy, as well as low thermal resistance of buildings.

1.8 The project was put on hold for about three years, as the government and the World Bank agreed that it would be prudent to first advance on the DH sector reform. It was decided to revise the DH master plan and prepare the District Heating Strategy and Action Plan for the financial recovery of the DH companies. The strategy laid out priorities for the DH sector to reduce end-user heat consumption through the installation of modern,

efficient substations, thermostatic valves, and cost allocators that would allow to control and measure heat consumption; reduce supply costs through investments in the supply system (heat generation and transmission); and introduce a rational price system. These measures would be accompanied by the necessary legal framework, regulations, and policies on the provision of subsidies and on environmental emissions, as well as management strengthening with better accountability to customers and state or municipal authorities.

1.9 The project was approved in 2003, following implementation of several priority measures identified in the 2000–05 District Heating Strategy. The energy law was appended to make cost allocators and heat regulators mandatory in apartment buildings, and private heating accounting companies were formed to install them. In addition, with World Bank support, all DH substations in the country were equipped with heat meters⁴. Increases in heat prices for households planned for 2002–05 were to be undertaken as an integral part of the comprehensive approach to address legislative, infrastructure, and subsidy policy, and managerial obstacles to restoring the commercial viability of the DH companies. Government subsidies were to be phased out by the end of 2005.

2. Objectives, Design, and their Relevance

Objectives

2.1 The project development objectives, as defined in the loan agreements⁵ and the project appraisal document, were to: (a) improve the quality of DH services in Sofia and Pernik; (b) improve the financial viability of the borrower; and (c) increase environmental friendly operations in the DH sector in Sofia and Pernik, through energy conservation and pollution reduction mechanisms.

Relevance of Objectives

2.2 The project development objectives were highly relevant to the country's challenges in DH and the government priorities in the sector. In the mid-1990s, the DH sector in Bulgaria faced the following difficulties: switching to uneconomic forms of heating (such as electricity that consumes more fuel) because of deterioration of the quality of DH services and increases in heat bills; high heat consumption at the household level, as consumers could not control it; high operating subsidies; and low operational efficiency of DH companies. Routine maintenance was often deferred, leading to the increase in heat and water losses in the DH system. This in turn increased operational costs affecting the financial position of the DH companies. Among other factor, the financial situation of both DH companies steadily declined because of voluntary disconnections by consumers; low domestic tariffs that were below the unit cost of heat production; low bill collection rates; and rising operating expenses, including fuel costs.

2.3 Accession to the EU required that Bulgaria meet certain provisions, which included implementing environment-friendly practices for efficient use of energy. The main priorities in DH were to improve service quality and financial performance of DH companies, reduce the need for government subsidies, promote energy efficiency, and accelerate private sector–

led growth in the provision of infrastructure services. In 2002, Bulgaria ratified the Kyoto Protocol, making the commitment to reduce its national greenhouse gas (GHG) emissions.

2.4 The objectives remain aligned with the current government strategy in the energy sector (2020) that identifies energy efficiency as its highest priority. In line with the EU's climate and energy policy, Bulgaria adopted its third National Energy Efficiency Action Plan 2014–2020, which has set a target of increasing energy savings by 25 percent by 2020. The Plan specifically promotes efficient heating and highly efficient heat and power cogeneration plants. A new Energy Efficiency Law was introduced in 2015 in line with the EU's Energy Efficiency Directive that set an ambitious energy efficiency target of reducing total domestic energy consumption by 50 percent by 2020 in the country. Heating accounts for nearly 70 percent of household energy consumption, and the government launched the National Program for Energy Efficiency of Residential Buildings to retrofit residential buildings retrofits so as to improve energy efficiency for residents.

2.5 The World Bank Group's Country Partnership Framework (CPF) for fiscal years 2017–22 sets the specific objective of supporting Bulgaria's effort to improve its energy efficiency (World Bank 2016a). The CPF recognizes that energy efficiency in the housing sector represents a major climate change–related challenge. The residential sector accounts for about one fourth of the final energy consumption, 70 percent of which is used for space heating. A high level of heat consumption is owing in part to the poor condition of the building stock. The World Bank has pre-appraised a financing program⁶ in support of the Government's National Program for Energy Efficiency in Residential Buildings, which implements retrofitting of residential buildings to reduce households' heat consumption.

The relevance of objectives is rated *high*.

Design

COMPONENTS

Component 1- Sofia DHC (appraisal cost: US\$117.5 million; actual cost US\$116.0 million)

- Network Rehabilitation: Replacement and/or installation of transmission pipelines. Replacement of thermal insulation on above-ground pipelines. Replacement of valves and compensators in the transmission and distribution network. Installation of variable speed pumping systems at the main heat sources.
- Substation Rehabilitation: Replacement of substations in the system.
- Technical Assistance: (a) for management and implementation of the project, including audit services and a public awareness campaign to promote energy conservation; (b) to introduce private sector production and distribution of heat.

Component 2- Pernik DHC (appraisal cost: US\$13.6 million; actual cost US\$23.1 million)

- Substation Rehabilitation: Replacement of substations in the DH system.
- Network Rehabilitation: Replacement of transmission pipelines. Replacement of valves and compensators in the transmission and distribution network and in the

- network monitoring system. Installation of variable-speed pumping system at main heat source.
- **Generation Plant Rehabilitation:** Replacement of outdated electrostatic precipitator (ESP) for a boiler in the coal-fired combined heat and power plant. Rehabilitation of chemical water treatment plant. Rehabilitation of automation and control equipment for coal conveyor system.
 - **Technical Assistance -** Provision of technical assistance for project management and implementation, including audit services and a public awareness campaign to promote energy conservation.

2.6 Carbon Finance subcomponent: A carbon finance operation was linked to the project whereby the Prototype Carbon Fund (PCF), established and administered by the World Bank, would purchase emission reductions resulting from the project-supported activities. The project investments in modernization of substations and pipelines in the DH networks were expected to generate greenhouse gas emission reductions that were eligible for transfer under Article 6 of the Kyoto Protocol of the UN Framework Convention on Climate Change (UNFCCC). Bulgaria signed a PCF Umbrella Agreement with the World Bank (a trustee for the PCF). Two subprojects—Sofia District Heating (TF053790) and Pernik District Heating (TF054641)—were registered as separate Joint Implementation projects under the Kyoto Protocol and were the first such projects in Bulgaria. Emissions Reduction Purchase Agreements (ERPAs) were signed with the Sofia and Pernik DHCs. Under the ERPAs, Sofia and Pernik DHCs were required to monitor emission reductions, ensure their certification by independent third parties, and conduct periodic auditing of the reductions.

IMPLEMENTATION ARRANGEMENTS

2.7 The implementation of the project was integrated with daily operations of the DHCs. The Sofia and Pernik DHCs established a Project Implementation Unit (PIU) responsible for project management and reporting on the progress of implementation. The PIU staff, assigned to the PIU from different technical and operational areas of the companies, continued to carry out their functions in the companies. The PIUs were also responsible for managing activities related to the PCF.

Relevance of Design

2.8 The project was intended to improve the quality of DH services, improve their financial viability, and increase environmentally friendly operations in Sofia and Pernik. The project design incorporated both supply-side and demand-side measures.

2.9 On the supply side, investments in improving technical performance of the DH system were to lead to reduction in heat and water losses in the system. The project supported energy-saving technology options that included replacement of old foam concrete DH channels with pre-insulated pipes and thermal insulation of above-ground pipelines. Old district heating pipes were based on foam concrete technology that was used in 1960s and 1970s and had most of leakages and breakdowns.

2.10 On the demand side, investments in modernizing DH substations were designed to facilitate control of heat supply at the building level that could be adjusted by households based on consumer needs. These investments included the installation of flow control devices such as control valves, and installation of variable speed pumping systems at the main heat sources. Combined with project support for public awareness campaigns to promote energy efficiency measures, this was expected to facilitate energy conservation and reduce heat consumption at the household level by allowing households to directly control their own heat consumption.

2.11 Efficiency gains from the replacement of pipelines and substations in the district heating system of the two subprojects were to lead to reduction in fuel consumption, thus resulting in CO₂ emissions reduction. At the local level, replacement to a more efficient boiler in Pernik was expected to decrease particulate emissions in the air.

2.12 The above improvements in the heat transmission and distribution systems of Sofia and Pernik would translate into energy savings for the companies and help reverse the disconnection trend through improvement in the quality of services, thus increasing consumer base. This would allow the Sofia and Pernik DHCs improve their financial performance, putting them on a commercial basis with government subsidies phased out.

2.13 Technical support was largely geared towards project implementation, audit services, and private sector participation, with no specific technical assistance activities designed to support two DHCs in improving their financial viability, except for the related covenants in the legal agreements with the companies on implementation of the financial recovery plans.

2.14 The relevance of design is rated *substantial*.

3. Implementation

Planned versus Actual Expenditure

3.1 The overall investment program was estimated at US\$132.7 million equivalent. It was financed through loans to the Sofia and Pernik district heating companies from the World Bank (IBRD) and EBRD, grants from the EBRD-managed Kozloduy International Decommissioning Support Fund (KIDSF) and the EU Phare pre-accession assistance program,⁷ as well as the DHCs' own funds. A breakdown of costs is described in table 3.1.

Table 3.1. Project Financing

<i>Fund source</i>	<i>Type of Financing</i>	<i>Appraisal Estimate (US\$ million equivalent)</i>	<i>Appraisal Estimate (Euro million)</i>	<i>Actual Costs (Euro million)</i>	<i>Percentage of Appraisal</i>
SOFIA DHC (TOPLOFIKACIA SOFIA)					
Sofia DHC	Own source	27.5	26.3	18.8	72

World Bank (IBRD)	Loan	27.2	26.0	26.0	100
EBRD	Loan	31.4	30.0	14.3	48
KIDSF	Grant	31.4	30.0	30.0	100
EU Phare	Grant	1.6	1.6	1.6	100
Subtotal		119.1	113.8	90.7	80
PERNIK DHC (TOPLOFIKACIA PERNIK)					
Pernik DHC	Own source	6.6	6.3	2.0	32
World Bank (IBRD)	Loan	7.0	6.7	5.6	84 ^a
KIDSF	Grant			10.4	
Subtotal		13.6	13.0	18.0	139
TOTAL		132.7	126.8	108.7	86

^a The World Bank loan of US\$7 million for the Pernik DHC was fully disbursed; because of exchange rate differences, an 84 percent disbursement is shown in euro terms.

3.2 Other resources, not reflected in the overall costs of the project, were: (a) a United States Agency for International Development (USAID) grant financing of US\$1.0 million for consultants to assist in selecting a private operator for the Sofia DHC; and b) funds from the PCF for the purchase of carbon emission reductions resulting from the project activities.

3.3 At completion, the total project cost was €108.7 million, which was 14 percent lower than the appraisal estimate. The actual costs under the Sofia DH subproject were lower than the appraised for several reasons (a) a €15 million tranche of the EBRD loan was cancelled because it was conditional upon private sector participation in the Sofia DHC; and (b) the rehabilitation works were implemented through lower costs than anticipated because of competitive prices in procurement. The costs under the Pernik DH subproject increased because of the high cost of a boiler that was financed through an additional KIDSF⁸ grant of €10.4 million during project implementation. The Pernik DHC reduced its share of financing from €6.31 to €2.04 million.

Implementation Experience

3.4 *EU Accession.* The project was implemented during Bulgaria's transition from a European Union (EU) accession country to an EU member country. The country was strongly committed to carrying out the required reforms and pursuing energy efficiency measures in the energy sector. Bulgaria re-aligned its legal and regulatory framework with the relevant EU directives and established a suitable institutional framework to support the implementation of its energy efficiency policy. Bulgaria also took the commitment to reduce its national greenhouse gas emissions by ratifying the Kyoto Protocol in 2002. The Sofia and Pernik district heating projects were the first projects registered under the Kyoto Protocol in the country, generating the emission reductions that were sold to the Prototype Carbon Fund.

3.5 *Private sector participation in Sofia DHC.* The World Bank and the EBRD appraised the project at the same time; both institutions had a similar covenant related to the introduction of the private sector for the provision of heat in the Sofia DHC. According to the company management, it had full intentions of meeting the stipulations of the Loan Agreement to complete the bidding process and secure a private operator by December 30, 2003, in line with the decision of the municipality of Sofia to introduce the private sector. The EBRD's loan was in two phases, and the second tranche (€15 million) required the company to enter into a contract with an operator. USAID funded a consultant to provide options for private sector participation and assist with selection of an operator. A management contract was suggested as a form of private sector participation for the Sofia DHC. Based on the technical advice to proceed with a management contract, bidders were prequalified, bidding documents were prepared, a management contract was drafted, and a pre-bid meeting was held with the prequalified bidders in 2004. The final bidding to select an operator did not take place because the shareholders of the Sofia DHC started to consider a higher form of private sector participation, such as privatization or concession. The process stalled and the company has not involved the private sector as envisaged. In 2008, Sofia Municipality agreed to transfer all its shares in Sofia DHC (58 percent) to the Ministry of Economy and Energy, a move that would make the central government the only shareholder of the Sofia DHC. With the increase in gas prices, the company's payables to the stage gas company Bulgargas increased, and the transfer was considered as an option to reduce payables (World Bank 2008). In 2009, the full ownership of the company was transferred to the municipality of Sofia, where it remains.

3.6 *Heat and electricity tariffs.* During implementation, the State Energy and Water Regulatory Commission (SEWRC) allowed heat tariffs to increase but the levels were lower than the utilities proposed and there was a time lag between the increase in fuel prices and adjustments in tariffs. After project closure, heat and electricity tariffs continued to increase until 2013, when they started to decrease reflecting the decline of input (gas) prices. Heat prices are directly linked to gas prices through a formula that reflects the changes in natural gas price in DH prices. In terms of electricity tariffs, the government revised the policies for incentivizing efficient generation of electricity. Heat in Sofia and Pernik is generated together with electricity on a co-generation basis. The country set up a co-generation bonus to better incentivize its use in line with the EU Directives, which the National Electricity Company (NEK) was obliged to pay. Because of significant financial problems in the electricity sector, the amount of co-generation bonuses has been revised downwards in recent years, thus decreasing the revenues from electricity sales by the DHCs.

SAFEGUARDS COMPLIANCE

3.7 The project was subject to the World Bank's OP 4.01 on Environmental Assessment and it was rated as a category 'B' project. Project environmental impacts were to the effect of construction activities and limited to noise, dust, minor traffic disruptions, and handling of construction waste. During implementation, there were no environmental issues raised in World Bank documents, and the Environmental Management Plan was followed by the two DHCs (World Bank 2008). No other safeguards were triggered.

FINANCIAL MANAGEMENT AND PROCUREMENT

3.8 The project was implemented in compliance with fiduciary requirements. *Financial Management:* A satisfactory financial management system was maintained by the Sofia and Pernik DHCs, and the companies regularly submitted quarterly financial monitoring reports and annual audit reports to the World Bank. Project audit opinions were unqualified and no significant internal control issues were mentioned. For the Sofia DHC, the 2007 entity audit was qualified because the valuation of fixed assets, accounts receivable, and provisions for tax liabilities were not appropriate. For the Pernik DHC, in 2007, the auditors expressed an unqualified audit opinion on the entity's financial statements. *Procurement:* The project was implemented in accordance with the World Bank procurement guidelines and no major procurement-related problems occurred during implementation. The PIUs in both DHCs were supported by an international consultant (financed by EU Phare and KIDSF grants) and they managed the procurement process well and according to the planned schedules (World Bank 2008).

4. Achievement of the Objectives

Objective 1-Improving the quality of district services in Sofia and Pernik

OUTPUTS

4.1 In Sofia, about 92 km of pipes were replaced under the project, which was above the targeted 60 km, capitalizing on the lower-than-expected cost for pipes and installation works. This represented 10 percent of the total Sofia DH pipeline network of 920 km. Old foam concrete DH channels were replaced with pre-insulated pipes, and a new transmission pipe of 2 km was constructed. About 16.5 km of above-ground pipelines were thermally insulated (more than the target of 15 km).

4.2 About 2,200 valves and 1,300 compensators were procured and installed in the DH network. Variable-flow pumping systems were installed at main heat sources; these allowed the supply of heat to be adjusted based on demand.

4.3 A total of 10,330 substations were replaced under the project, above the targeted 8,030 (this was about 70 percent of the total system of about 15,000 heating substations in Sofia).

4.4 In Pernik, all 700 substations were replaced in the Pernik district heating system, with modern equipment, automation, and heat meters. 7 km of transmission pipelines were replaced against the targeted 10km (this was about 12 percent of the total network of 60 km). All 226 old leaking compensators were replaced with bellow compensators. Both pumping stations got modern variable-flow pumps in operation.

4.5 An old electrostatic precipitator was replaced for boiler No. 5 in the lignite-fired combined heat and power plant. The boiler financed by the Pernik DHC and KIDSF grant became functional after project closure.

OUTCOME

4.6 In Sofia, the rehabilitation of the DH network led to an increase in the connection rate and reversed the trend of households disconnecting from the DH services. The connection rate (a ratio of DH-connected households to all households with access to the network) of 85 percent in 2002 in Sofia increased to 96 percent by 2008,⁹ above the targeted 90 percent. The Sofia DHC informed the IEG mission that disconnection is no longer the issue. The number of customers using DH services in Sofia had increased by the time of project closure, and this increase has been sustained. DH remained a preferred source of heating. There were 299,012 households using the system in 2002, a figure which rose to 362,578 by 2008, and is 406,569 as of 2017.

4.7 In Pernik, the DH connection rates increased from 63 percent in 2002 to 85 percent by project closure. Currently, as of 2017, the connection rate is 92 percent. Overall, the number of households using the district heating system in Pernik rose from 12,410 in 2002 to 18,677 in 2017.

4.8 During the first period of project implementation, surveys were carried out to assess the level of customer satisfaction, no subsequent satisfaction surveys were done. In the last survey in Sofia, in 2005, 75 percent of the consumers reported being satisfied with DH services. In Pernik in 2004, 80 percent of the population reported satisfaction with the services provided. The Sofia DHC informed the IEG mission that no satisfaction surveys have been carried out since. Neither the municipality of Sofia nor other institutions have conducted the surveys to gauge customers' satisfaction with the quality of DH services. The officials from the municipality of Pernik informed the IEG mission that the municipality did not have relevant data on the quality of DH services in Pernik.

4.9 Overall, as a result of the modernization of substations under the project, consumers were able to regulate their consumption based on apartment-level needs and to pay for the heat they used. At the same time, although the connection rate increase has been sustained, it is not sufficient to judge the quality of services, that is, their reliability and adequacy. Outages and breakdowns in DH service delivery are reported both in Sofia and Pernik during winter.

4.10 Overall, the achievement of this objective is rated *substantial*.

Objective 2-Improving the financial viability of Sofia and Pernik DHCs.

OUTPUTS

4.11 Under covenants to the legal agreements with the Sofia and Pernik DHCs, the project required that both DHCs prepare and follow financial recovery plans acceptable to the Ministry of Finance, the Ministry of Energy, and the World Bank. The financial recovery plans outlined measures the companies had to take, including running operations efficiently and reaching certain financial and operational targets that would lead to the phase-out of operating subsidies by 2005.

4.12 It was expected that private sector involvement would help improve operational efficiency of the Sofia DHC. Consultancy services to assist in selection a private operator for the Sofia DHC were planned to be financed by the World Bank (estimated cost of US\$380,000). This was eventually financed instead through the USAID grant at a cost of US\$1 million; however, the private sector involvement did not eventuate.

4.13 Hardware was purchased for the Sofia DHC's billing system, including computers and computer networks linking bill payment offices and the DHC main office (cost of about US\$700,000). The World Bank financed the hardware, and the Sofia DHC financed the software (around US\$200,000) needed for the system. This activity was not originally planned.

OUTCOMES

4.14 There was progressive improvement in the financial performance of the companies up to 2005, but sustained financial viability has not been achieved. The companies, however, are operating on a commercial basis and the government operating subsidies were eliminated in 2005 as planned.

4.15 For the Sofia DHC, the working ratio (operating costs/revenues) improved from 1.14 in 2002 to 1 in 2003 and remained below 1 till 2005; it started worsening to 1.16 by 2008 at project closure. Operating expenditures and fuel (gas) prices continued to increase, and tariffs did not keep pace with this increase (World Bank, 2008). The working ratio improved to below 1 in subsequent years up to 2014, when it reversed and remained 1.1 till 2016 (see table 4.1 and table 4.2 below). According to the Sofia DHC, the ratio would be equal to 0.98 in 2016, if the receivables devaluation amount is subtracted; and in 2015 it would be equal to 1.

4.16 The bill collection rate increased from 80 percent (2002) to 90 percent (2004) but by project closure in 2008, the rate had dropped to 79 percent. The Sofia DHC's public image was affected by the alleged misuse of funds by the company's management (not connected with the project). In 2006, the Bulgarian press covered the dismissal of the head of the company, who was detained on charges of money laundering and using company funds for lavishly equipping his office.¹⁰ This misuse of public money may have affected public opinion; the bill collection rate sharply declined immediately afterwards (World Bank 2008). The rate continued to worsen after the project closure in 2008 and remained annually at about 74 percent till 2014 (that was lower than at the time of project appraisal). It is not clear why the rate remained so low for so many years but the country's economic downturn in 2009 could have affected the households' ability to pay as well as a relatively high vacancy rate (25 percent of apartments are vacant in Sofia, according to the World Bank's study 2016, owing to migration to other EU countries, among other factors). In 2014, the bill collection rate started to increase and reached 90 percent in 2016, following stronger enforcement through the courts and the use of sanctions for outstanding payments that help the recovery of arrears from non-paying customers.

Table 4.1. Key Financial Parameters of Sofia DHC, Project Period 2002–08

<i>Sofi DHC- Key financial parameters</i>	<i>Unit</i>	<i>2002</i>	<i>2003</i>	<i>2004</i>	<i>2005</i>	<i>2006</i>	<i>2007</i>	<i>2008</i>
Average heat tariff	BGN/MWh	41.3	42.9	47.2	51.4	59.6	60.4	63.6
Average electricity tariff	BGN/MWh	76.0	80.0	80.0	80.0	82.0	95.0	132.0
Natural gas purchase price	BGN/000 m ³	243	235	223	245	302	325	430
Share of gas and fuel expenses in total expenses	percentage	65.6	70.7	63.8	65.2	70.7	69.3	68.4
Working ratio	Number	1.14	1.00	0.93	0.91	1.08	1.14	1.16
Annual net profit/loss	BGN million	-55.2	3.7	76.1	2.6	-10.5	-27.8	-63.3
Bill collection ratio	percentage	80	87	90	87.0	80.0	79.0	n.a.

Table 4.2. Key Financial Parameters of Sofia DHC, Post-Project Period 2009–16

<i>Sofi DHC- Key financial parameters</i>	<i>Unit</i>	<i>2009</i>	<i>2010</i>	<i>2011</i>	<i>2012</i>	<i>2013</i>	<i>2014</i>	<i>2015</i>	<i>2016</i>
Average heat tariff	BGN/MWh	65.5	69.5	76.4	84.5	81.4	80.8	77.6	67.7
Average electricity tariff	BGN/MWh	200.0	190	249	309	290	246	204	141
Natural gas purchase price	BGN/000 m ³	499	468	546	677	645	632	538	350
Share of gas and fuel expenses in total expenses	percentage	72.8	72.4	73.7	77.2	74.3	71.8	60.4	53
Working ratio	Number	1.09	1.02	0.96	1.00	1.00	1.11	1.12	1.11
Annual net profit/loss	BGN million	-43	-10	21.5	2.7	5	-58	-61.6	-42.1
Bill collection ratio	percentage	72.2	73.5	73.7	74.0	73.7	82.0	86.0	90.0

Source: Sofia DHC.

4.17 For the Pernik DHC,¹¹ the domestic bill collection rate of sold heat (without arrears) was 50 percent in Pernik in 2002; that improved to 68 percent at project closure, significantly

below the target of 84 percent. From 2008, at project closure, the bill collection rate worsened, reaching the lowest range of about 40–50 percent during 2011–13 (table 4.3 and table 4.4). These reversed to improve significantly in 2015 and 2016, to 73 percent and 70 percent respectively; this trend was like the trend observed in Sofia for heat bill collection. The vacancy rate in apartments in Pernik is 45 percent (World Bank 2017).

Table 4.3. Key Financial Parameters of Pernik DHC, Project Period 2002–08

<i>Key financial parameters</i>	<i>Unit</i>	<i>2002</i>	<i>2003</i>	<i>2004</i>	<i>2005</i>	<i>2006</i>	<i>2007</i>	<i>2008</i>
Average heat tariff	BGN/MWh	42.3	42.9	45.3	46.7	55.2	56.2	59.6
Average electricity tariff	BGN/MWh	63.8	69.7	68.2	67.6	69	79.3	101.4
Coal purchase price	BGN/tce	72.4	75	70	73.5	80	88.7	112.6
% share of coal and fuel expenses in total expenses	%	66.9	60	65.2	61.8	61.6	57.7	26
Annual net profit/loss	BGN million	-1.1	0.6	1.4	-1.5	0.2	-2.5	-8.2
Bill collection ratio	percentage	50	55	83	80	n.a.	68	46.42

Table 4.4. Key Financial Parameters of Pernik DHC, Post-Project Period 2009–16

<i>Key financial parameters</i>	<i>Unit</i>	<i>2009</i>	<i>2010</i>	<i>2011</i>	<i>2012</i>	<i>2013</i>	<i>2014</i>	<i>2015</i>	<i>2016</i>
Average heat tariff	BGN/MWh	61	65.02	69.08	71.4	75	75.63	65.86	66.34
Average electricity tariff	BGN/MWh	120	102	116.7	124.1	135.32	122.09	117.39	124
Coal purchase price	BGN/tce	140.14	145	149.8	152.6	155.12	162.14	165	165
% share of coal and fuel expenses in total expenses	%	60	50	52	61	48	54	52	52
Annual net profit/loss	BGN million	-3.7	-0.8	19.3	3.7	11.5	9.7	-10.1	-1.2
Bill collection ratio	percentage	64.4	56.8	41.3	50.9	46.3	54.2	73.2	70.0

Source: Pernik DHC.

Private Sector Participation

4.18 The project attempted unsuccessfully to support introduction of the private sector in the Sofia DHC for the provision of heating services. In 2002, the Sofia municipality, recognizing the need to bring about institutional changes and improvement in management practices of the DHC, endorsed a decision to introduce a private operator for the provision of heat. The Sofia DHC took actions to meet the stipulations of the loan agreement to complete the bidding process and secure a private operator. A decision on private sector participation was delayed and the process was not finalized. There was another attempt to revive the discussion on private sector participation when the municipality of Sofia reached out to the World Bank's International Finance Corporation (IFC) for technical advice. The municipality then decided not to pursue the technical study. According to the IEG interviews with the company and the municipality, private sector involvement may still be an option for the Sofia DHC provided it is a viable solution and would bring efficiency benefits in the delivery of DH services. Except for the Sofia DHC, all DHCs in Bulgaria are privately operated. Privatization of the Pernik DHC was done under the Government's Privatization Agency, outside the project scope.

4.19 Overall, the achievement of this project objective is rated *modest* based on mixed results for the DHCs' financial performance that fell short of targets.

Objective 3-Increase environmentally friendly operations in the DH sector in Sofia and Pernik

4.20 This objective was to be achieved through energy conservation and pollution reduction mechanisms.

OUTPUTS

4.21 The outputs are the same as described above under Objective 1. In addition to the rehabilitation and modernization works of the Sofia and Pernik DH networks, public awareness campaigns were carried out by the Sofia and Pernik DHCs, as planned, to promote energy savings. It was financed through the companies' own funds.

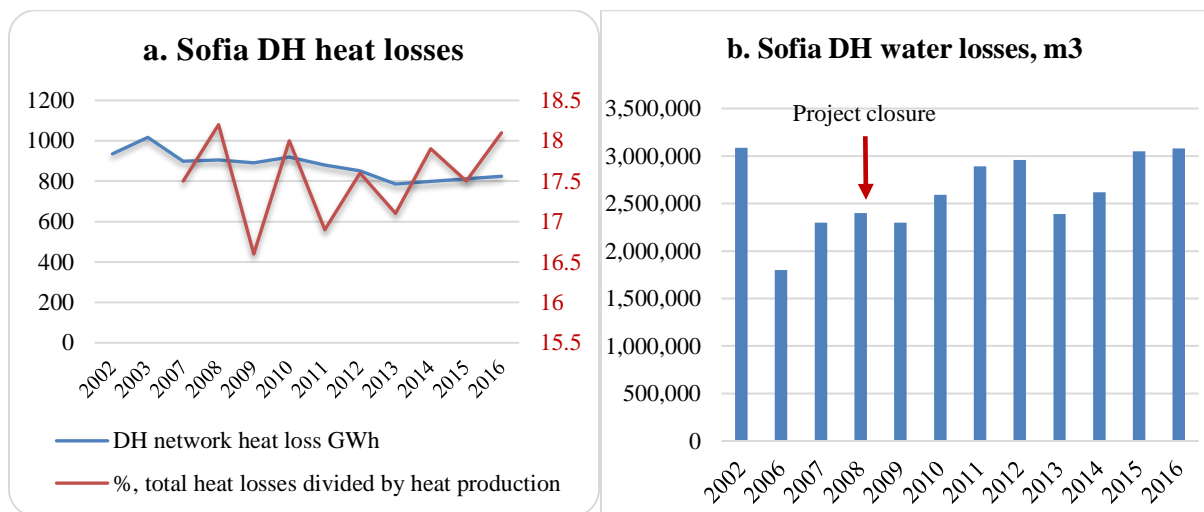
OUTCOMES

(A) Heat and water losses.

4.22 In Sofia, heat losses in the DH network decreased from 935 GWh in 2002 to 899 GWh in 2007 at project closure, with further reductions to 824 GWh in 2016. But the ratio of heat losses to the actual heat production did not reach the project target of 15.6 percent. It was 17.5 at project closure, and fluctuated between about 17 percent and 18 percent during the post-project period of 2009–16 (figure 4.1).

4.23 Water losses in the Sofia DH network reduced significantly from 3.1 million m³ in 2002 to 1.8 million m³ in 2006, but increased to 2.3 million m³ in 2007 at project closure. The target of 1,650,000 m³/year was not met. At present, water losses in the Sofia DH network are 3.1 million m³, that is, the same level as in 2002 at project start. The significant increase in water losses indicates the deteriorating condition of the Sofia DH network. The Sofia DHC informed the IEG mission that water leaks result from the deteriorating condition of the pipelines located in unpassable areas, and in many places the hydro insulation of cover slabs is compromised. The water penetrates the thermal insulation leading to local corrosion of the steel pipe, reduction of the steel pipe thickness, and DH water leakage. With support of the KIDSF funds, the company is procuring the replacement of a 100-km pipeline trunk installed in the unpassable areas most affected by water leaks.

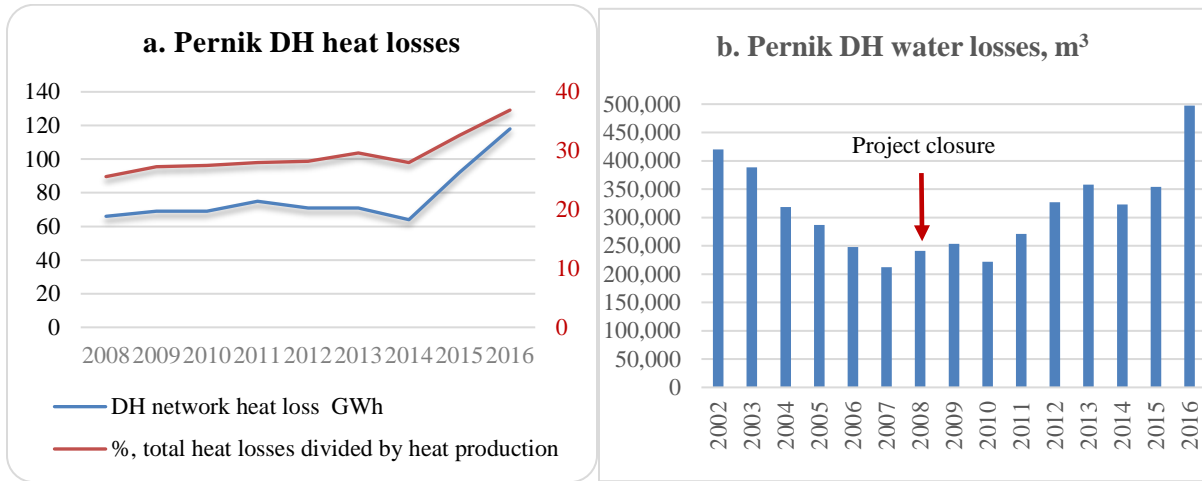
Figure 4.1. Heat and Water Losses in the Sofia DH Network, 2002–16



Source: Sofia DHC.

4.24 In Pernik, heat losses in the DH network were reduced significantly from 116 GWh in 2002 to 74 GWh by 2008. The ratio of network heat losses to the actual heat production improved from 31.9 percent to 24.4 percent during the project implementation, surpassing the target of 25.5 percent. Since 2008, the ratio of heat to the actual heat production started to worsen from 26 percent to 37 percent in 2016. In absolute terms, heat losses increased from 66 GWh in 2008 to 118 GWh in 2016 (figure 4.2). Water losses in the Pernik DH system decreased significantly from 420,000 m³ in 2002 to 212,000 m³ by 2008 at project closure, exceeding the target of 280,000 m³. They started to increase and reached 497,685 m³ in 2016, that is, higher than at project start (see figure 4.2b). The worsening heat and water losses indicate the deteriorating condition of the Pernik DH network.

Figure 4.2. Heat and Water Losses in the Pernik DH Network, 2002–16

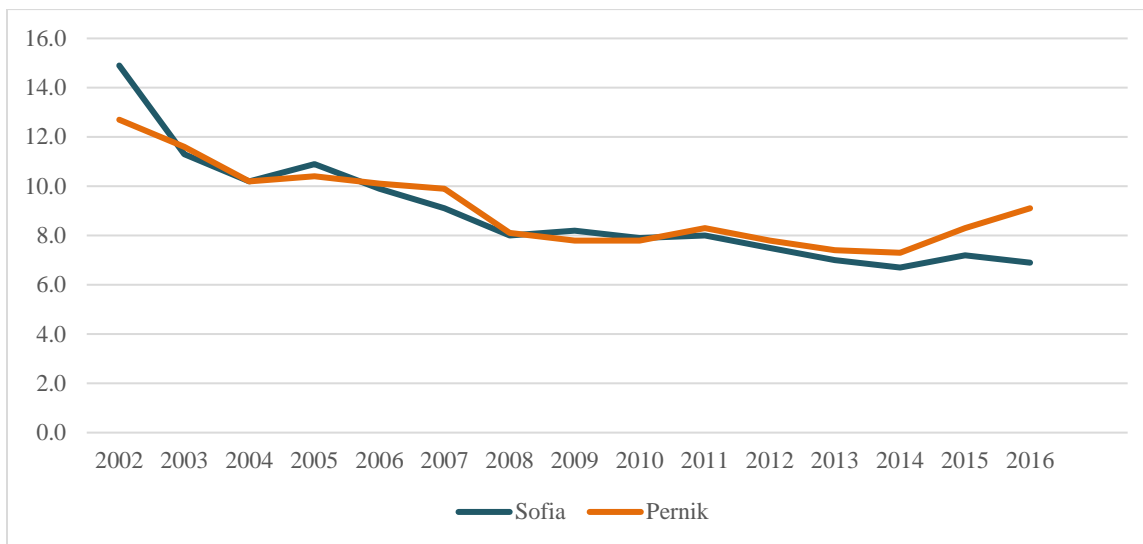


Source: Pernik DHC.

(B) Heat consumption

4.25 The annual heat consumption of 14.9 MWh per household in Sofia and 12.7 MWh in Pernik in 2002 was expected to drop to 10.6 MWh year/household at project closure. The target was exceeded. The average heat consumption per household in Sofia was reduced by 40 percent to 9.1 MWh by 2008, and during the post-project period was reduced by an additional 25 percent to 6.9 MWh in 2016. In Pernik, the average household heat consumption fell by 22 percent to 9.9 MWh by 2008 and had an overall downward trend till 2015, when it reversed and reached 9.1 MWh in 2016, which is still slightly lower than at the end of 2007 (figure 4.3).

Figure 4.3. Heat Consumption per Household in Sofia and Pernik, 2002–16



Source: Sofia and Pernik DHCs.

The project-supported modernization of DH substations that transfer heat to individual buildings helped adjust heat on demand and facilitate savings in the average heat

consumption at the household level in Sofia and Pernik. The significant reduction in heat consumption was overall to the result of a combination of measures in the DH sector. These included prior measures to equip substations with heat meters, and installation of cost allocators and heat regulators (thermostatic valves) in radiators, and metering of consumption.

(C) Reduction in emissions of carbon dioxide in Sofia and Pernik, and reduction in particulate emissions in Pernik

4.26 The rehabilitation works on the DH networks resulted in efficiency gains and energy savings that led to lower consumption of input fuel, thus lowering CO₂ emissions. CO₂ emissions were verified in both companies by an independent auditor company accredited by the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC). The project generated more emission reductions than was expected. The Sofia DH subproject reduced emissions on 1,203,933 tCO₂, and the Pernik district heating subproject reduced emissions on 382,514 tCO₂ during 2004–08¹². Both DHCs sold the emission reductions to the World Bank–administered Prototype Carbon Fund, as per the contracted volume of 1,084,000 emission reductions from the Sofia DHC and 157,000 emission reductions from the Pernik DHC.

4.27 Overall, according to the assessment of CO₂ emissions in 2015, the consumption of heat had a 21.2 percent share in the total emissions in the municipality of Sofia. Compared to 2007, the consumption of heat decreased by 7.1 percent, and CO₂ emissions were reduced by an estimated 12.4 percent in 2015. CO₂ emissions in DH were estimated at 1,242,573 tCO₂ in 2007; 1,206,948 tCO₂ in 2011, and 1,088,486 tCO₂ in 2015 (Bulgaria 2017, page 43, table 55).

4.28 The project also helped the two DHCs better prepare for introduction into the EU Emission Trading System of the Bulgarian district heating sector in 2007. The Bulgarian government allocated 158,538 emission reduction units to the Sofia DH company in the final National Allocation Plan for 2008–12 in the frame of the European Union Emission Trading System. Overall, the World Bank, through the PCF, was a pioneer in carbon finance in Bulgaria through these two DH sub-projects and a third, the Sviloza biomass project. The Bulgarian Ministry of Environment and Water acknowledged that these projects constituted an important step toward the country’s active participation in the UNFCCC. They gave Bulgaria experience in conducting Joint Implementation projects under Article 6 of the Kyoto Protocol to the UNFCCC; Bulgaria has approved a total of 28 such projects.

4.29 The reduction in particulate emissions in Pernik was achieved through the replacement of an old and outdated electrostatic precipitator for a boiler in the lignite-fired CHP plant, which had been in operation since the 1960s. At appraisal, Pernik was classified as one of the most critical points in the country in terms of industrial pollution. The combined heat and power plant of the Pernik DHC was ranked first in the list of the largest sources of pollution in the town, particularly because of its dust emissions, which are more 17 times the admissible level by Bulgarian standards. Project-financed new boiler No. 5

became operational after project closure, exceeding the target of 100 mg/m³ and reducing particulate emissions from 1,600 mg/m³ to 50 mg/m³.

5. Efficiency

5.1 Economic and financial rates of return and net present values were estimated at appraisal in 2002 and re-estimated at project completion in 2008 using the same methodology. The results are shown in table 5.1.

Table 5.1. Economic and Financial Analysis for Sofia and Pernik DHCs.

<i>Indicator</i>	<i>Sofia</i>		<i>Pernik</i>	
	APPRAISAL (2002)	PROJECT CLOSURE (2008)	APPRAISAL (2002)	PROJECT CLOSURE (2008)
ERR	23.5%	49.0%	18.3%	25.3%
ENPV	BGN 146 million	BGN 214 million	BGN 9.5 million	BGN 12 million
FRR	18%	17%	11%	13%
FNPV	BGN 65 million	BGN 53 million	BGN 0.5 million	BGN 3.5 million

Source: Project's Implementation Completion and Results report (2008).

5.2 At closure, a high ex post economic rate of return, particularly in Sofia, was to the result of energy savings and reduction in energy consumption from the project-supported improvement of the DH networks and modernization of DH substations (variable flow pumping). As reported in the project's implementation completion and results report (ICR), savings in operational costs comprised savings in pumping costs that were reduced to 90 percent of pre-project levels in Sofia and to 40 percent in Pernik; savings from reduction of water losses; reduction in operations and maintenance costs from less breakdown of pipes; and savings in fuel consumption from reduction of heat losses and household energy consumption. The analysis also estimated savings to the economy as consumers switched from electricity to DH, which was the most economical way to provide heat. The environmental benefits of the project were not quantified in the above calculations (World Bank 2008).

5.3 The ex-post financial rate of return at project completion was close to the ex-ante estimate in Sofia, but for Pernik it was higher owing to greater savings on coal expenditures, because coal prices were higher than projected. In addition, revenues received from the sale of emission reductions to the PCF amounted to an additional US\$5 million for both companies, but these were not factored into the financial analysis.

5.4 On balance, the efficiency of the project is rated *substantial*, reflecting satisfactory economic and financial rates of return at project closure, and timely completion of the upgrade and rehabilitation works. Current data for 2016 show that eight years after the project closure, the gains are eroding because of the deteriorating DH networks in both cities.

6. Ratings

Outcome

6.1 The project objectives were highly relevant to the government's development needs and priorities in DH in Bulgaria and to the World Bank country strategies. The relevance of design is rated *substantial* owing to the clear linkages between the project activities, expected outcomes, and objectives; however, there were no specific activities designed to support the two DHCs in improving their financial performance.

6.2 The first objective of improving the quality of DH services was *substantially* achieved. The project helped reverse the disconnection trend, and more households were connected to the system than expected at project closure. There were 299,012 households using the DH system in 2002; this number rose to 362,578 by 2008 (project closure), and continued to increase, to 406,569 by 2017. The second objective of improved financial viability was *modestly* achieved. The results were mixed, and selected parameters such as the improvement in bill collection and working ratios remained below targets. The Sofia DHC, however, is no longer dependent on government subsidies, which were phased out as planned in 2005. The Sofia DHC is fully municipality-owned and operating on a commercial basis but did not involve the private sector as intended.

6.3 The third objective of increasing environmentally friendly operations is assessed as *substantially* achieved. The reduction in heat consumption at the household level exceeded the targets. Heat and water losses were also reduced, but below the targets. After project closure, these started to increase because of the continuing deterioration of the network (only 10 percent of the DH network in Sofia was rehabilitated under the project). The ratio of heat loss to actual heat production has fluctuated between 17 percent and 18 percent (the target was 15.6 percent). In Pernik, heat and water losses were reduced significantly at project closure, exceeding the targets. Project investments led to the reduction of CO₂ emissions by an estimated 1,203,933 tCO₂ in Sofia and 382,514 tCO₂ in Pernik during the project period.

6.4 The project's efficiency in the use of funds is rated *substantial*, given the satisfactory rates of return and timely completion of works. The overall project outcome rating is *moderately satisfactory*.

Risk to Development Outcome

6.5 *Institutional*. Government commitment to the DH sector remains strong in support of the DH sector to ensure the delivery of this important basic public service. Institutional capacity is high, and the Sofia and Pernik DHCs have high technical capacity to perform their operations and carry out civil works.

6.6 *Environmental*. As an EU member country, Bulgaria is obliged to abide by EU regulations and to continue its focus on addressing environmental issues. The companies need to address the government requirements for carbon emissions reduction in Bulgaria.

Compliance with the CO₂ reduction will be a challenge if investments are not made in the rehabilitation and modernization of the DH system.

6.7 *Financial.* The DH networks are deteriorating, as evidenced by the significant increase in heat and water losses. The Sofia and Pernik DHCs are financially constrained to ensure the adequate level of maintenance and necessary investments into the DH assets. The risk to development outcome is rated *substantial*.

Bank Performance

QUALITY AT ENTRY

6.8 The project was pre-appraised in 1999 but then re-appraised in 2003 to ensure that the government implemented certain policy and regulatory measures that would be conducive to the project's success. The project design was underpinned by the energy sector reforms and engagement of the World Bank in the sector since 1992. Detailed technical, economic, and financial reviews were conducted. Technical assistance was provided to develop master plans for the rehabilitation of the Sofia and Pernik DH companies under the Japan PHRD fund. In 1999, a survey was carried out for both Sofia and Pernik to determine consumers' willingness and ability to pay for DH services. A follow-up survey was done in 2002 that sought the public's opinion of the quality of service. The World Bank supported the government in developing a set of District Heating Strategies that were adopted in 2002. A pilot DH subproject was added under another World Bank project¹³ to install heat meters in the DH systems. The project was prepared in close coordination with the European Bank for Reconstruction and Development (EBRD), a co-financer.

6.9 A detailed analysis of risks and mitigation measures was carried out at appraisal; it included such risks as affordability of tariffs, timeliness of private sector participation in the Sofia DHC, implementation of financial recovery plans, possible delays in policy reforms and project implementation, and fluctuation in fuel prices. The overall risk rating was high. Some risks did not materialize the government's sustained commitment to the sector reform and the technical capacity of the DH companies. The risk to private sector involvement in the Sofia DHC was underestimated.

Quality at entry is rated *satisfactory*.

QUALITY OF SUPERVISION

6.10 Supervision was carried out regularly and frequently: 10 missions were conducted during a five-year project implementation period. The supervision teams were composed mainly of technical, financial, and procurement specialists based in the region, allowing frequent supervision at a relatively lower cost. The World Bank team maintained regular contact with the co-financer of the project, EBRD, which was implementing its part of activities and managing the EU KIDSF grant. The team also coordinated with USAID on private sector involvement and with the PCF to facilitate the sale of emission reductions following the implementation of works. There were no issues in compliance with the World Bank fiduciary requirements and safeguards.

6.11 The borrowers (Sofia and Pernik DHCs) and their staff involved in different aspects of the project preparation and implementation informed the IEG mission that they were highly appreciative of the World Bank support and technical guidance throughout the process.

6.12 The World Bank project supervision team focused on the development objectives and provided guidance to the Sofia and Pernik companies to meet the key indicators. Aide memoires outlined findings and areas for the DHCs and World Bank follow-up actions. Though the World Bank implemented its responsibilities in ensuring that the main project outputs were produced, it did not take any significant action to address worsening financial viability after the first few years. The quality of World Bank supervision is rated moderately satisfactory, because its support of the two DHCs proved insufficient on matters of financial viability and involvement of the private sector in the Sofia DHC.

The overall rating of World Bank performance is assessed as *moderately satisfactory*.

Borrower Performance

GOVERNMENT PERFORMANCE

6.13 The government's commitment was strong through the project preparation and implementation, as evidenced by policy measures to revive the DH sector. measures, which included preparing and implementing the DH Strategy 2002–2005; phasing out operating subsidies; continuously adjusting the Energy Benefit Program to cover vulnerable groups; legislating mandatory demand-side management equipment (heat cost allocators and regulators) that helped adjust heat on demand and facilitated reduction in household heat consumption. The government also supported the sale of carbon emission reductions to the PCF.

6.14 Though there was an intent to introduce the private sector, the state and the municipality of Sofia, which shared ownership of the Sofia DHC under the project (the Sofia DHC became fully municipality-owned in 2009) could not reach agreement on private sector involvement after substantial work that included a US\$1 million USAID grant for technical studies and a bidding process initiation.

Government performance is rated *moderately satisfactory*.

IMPLEMENTING AGENCY PERFORMANCE

6.15 Project activities were integrated with regular operations in both DHCs, and staff for the project implementation unit were drawn from the companies' technical, financial, and commercial departments.

6.16 The DHCs are operated by experienced staff with adequate technical skills. Both companies had dedicated officials to plan and execute the investments, including preparing quality bidding documents, interacting with the World Bank to seek clarifications when needed, and making counterpart funds available. The teams gave regular updates and reported progress to the World Bank on meeting the project objectives and key indicators.

The staff was in place for most of the project's duration. Different sources confirmed to IEG that the effective implementation of the project was attributable to the high technical capacity and dedication of the DHC staff.

6.17 Despite some progressive improvements, particularly during the first years of project implementation, the financial performance of the DHCs did not improve as expected. There is room to increase operational efficiency to curb operational costs, and there is an urgent need for investments in the DH networks to sustain uninterrupted delivery of services.

6.18 Implementing agency performance is rated *moderately satisfactory*. This leads to an overall borrower performance rating of *moderately satisfactory*.

Monitoring and Evaluation

6.19 **Design.** Project indicators covered the financial performance, energy efficiency, and environmental impacts of the project. The outcome indicators were adequate and measurable, with baselines and targets set at appraisal. They were attributable to the project. The decrease in household heat consumption also depended on other measures that were conducted outside the project and supported by the World Bank. The linkage between outputs and outcomes was clearly made, making it possible to assess the progress.

6.20 **Implementation.** The indicators were used by the Sofia and Pernik DHCs for their business planning and operational purposes, and were well integrated with their work processes. Both companies regularly reported on technical and financial data. During the IEG mission, the two DHCs made data readily.

6.21 **Utilization.** The data for monitoring and evaluation indicators were used as the basis for corrective actions by the World Bank and the DHCs. It is part of the day-to-day business operations of both companies that is utilized for decision making. Overall, the project monitoring and evaluation are rated substantial.

7. Lessons

IEG's review of this project's experience in Bulgaria suggests the following lessons:

Postponing an energy efficiency project until the necessary legal measures addressing demand side management are implemented can lead to better outcomes. In Bulgaria, increases in heat tariffs led to a high rate of disconnections from the DH system in the late 1990s. The World Bank and the government recognized that increases in heat tariffs were not sufficient to achieve financial viability of the DHCs. It was necessary to improve demand-side heat consumption efficiency; that would help reduce household heating bills and encourage users to reconnect to the DH system. The project was primarily designed to rehabilitate and modernize the DH networks to improve supply efficiency (reduce heat production costs and the need for operating subsidies) but it was put on hold until policy reforms were undertaken. The strategies were developed and adopted, the energy law was amended to make cost allocators and heat regulators mandatory in apartment buildings, and

all DH substations in the country were equipped with heat meters. Once these preconditions were met, the project was approved. Through its infrastructure investments, the project helped facilitate energy conservation and contributed to a significant reduction of heat consumption at the household level.

Sustainability of benefits from infrastructure investments can be put at risk if future investment needs are unmet. The DH project carried out all the planned investments and largely achieved its objectives at the time. The investments were part of a comprehensive approach in support of the implementation of the five-year DH strategy and action plan adopted at appraisal. The benefits included the reduction in heat and water losses, reduction in heat consumption at the household level, and CO₂ emissions reduction. The government subsidies were phased out as planned by the end of the specified period in the strategy. However, the gains, for the most part, have not been sustained over time. Water and heat losses have been increasing for the past eight years since project closure and are currently at the same level as at project appraisal. The operating costs are rising for the DHCs, and the condition of the DH networks is deteriorating because of a lack of investments. In addition, the related environmental benefits are being eroded. The project only covered a small fraction of the identified needs to ensure a reliable and efficient heat supply, and these needs have not been subsequently addressed.

Investments in energy efficiency infrastructure alone are not enough to achieve sustained financial viability. The project's investments in rehabilitation of the district heating networks helped address financing constraints of the district heating companies. Technical investments yielded significant efficiency gains in both companies (Sofia and Pernik). There was a reduction in operating costs, including fuel costs (resulting from reductions in heat losses), operation and maintenance costs (owing to less breakdown of pipes), and water losses. Though the project helped overcome the initial challenges in financing, it did not help put the DHCs on a financially sustainable path. In the context of DH reform and strategy at project appraisal, the companies complied with their financial recovery plan to meet the 2005 targets; after that, their financial performance started to decline along many parameters. The World Bank covenants to the legal agreements proved insufficient to ensure the financial viability of the DH companies.

Efforts to encourage private sector participation may fail when there is no strong agreement from key stakeholders in a complex and changing governance structure. Under the project, the government and the Sofia DHC worked with the World Bank and other donors (EBRD, USAID) on the satisfactory governance structure, financing arrangements, and the managerial and financial prerequisites to involving the private sector in the Sofia DHC. The ownership of the company changed several times between the state and the municipality. The stakeholders and the company planned first to select a private sector operator but then considered privatization or concession. A lack of agreement between stakeholders on the need and modality meant that no progress was made on any option. The planned private sector involvement did not materialize, and the company is fully owned by the municipality at present.

A carbon finance operation or results-based financing can have strong demonstration effects. As the first carbon finance operation in Bulgaria, it helped launch carbon finance by

demonstrating the feasibility of the instruments, by building capacity in the government for managing carbon finance, and building awareness in agencies and companies that emission reductions could bring financial benefits. The carbon finance operation built the capacity of the two DHCs to measure and monitor CO₂ emissions from heat generation, transmission, and distribution. The rehabilitation works on the DH networks resulted in efficiency gains and energy savings that led to lower consumption of input fuel, thus lowering CO₂ emissions. The project helped the Sofia and Pernik DHCs prepare for the introduction of the EU Emission Trading System and report on emissions per EU requirements.

² Financed through World Bank-administered Japan Professional Human Resource Development (PHRD) Trust Fund.

³ IMF-Extended Fund Facility 1998–2001; World Bank Financial and Enterprise Sector Adjustment Loans I and II.

⁴ Under district heating component of the Water Companies Restructuring and Modernization Project (1994–2002).

⁵ Loan Agreement with TOPLOFIKACIA SOFIA (dated June 18, 2003; p.15); Loan Agreement with TOPLOFIKACIA PERNIK (dated June 18, 2003; p.13)

⁶ In support of the Government of Bulgaria's National Program for Energy Efficiency in Residential Buildings, the World Bank prepared a program-for-results that is tentatively scheduled for approval in FY2019 (P154710).

⁷ Poland and Hungary: Assistance for Restructuring their Economies (PHARE) program, subsequently extended to 10 countries, including Bulgaria and Romania.

⁸ KIDSF is a fund established at the EBRD with contributions from the European Commission and other European donors to cope with the early closure and decommissioning of the Kozloduy nuclear power plant (units 1–4) in Bulgaria that resulted in the loss of 1,760 MW of installed generating capacity. The KIDSF provided grants for projects in restructuring, upgrading, and modernization of the energy production, transmission, and distribution, as well as improving energy efficiency in the country. The rehabilitation and modernization of the district heating plants in Sofia and Pernik was required under Bulgaria's Agreement with the Nuclear Safety Account of the EBRD before units 3 and 4 of Bulgaria's nuclear power plant at Kozloduy were closed.

⁹ The results at project closure are measured as of December 31, 2007; the project closed on June 30, 2008.

¹⁰ <http://www.novinite.com/articles/66110/Sofia+Heating+Company+Ex-Chief+Left+Behind+Bars%2C+Says+He+is+%22Scapegoat%22>

¹¹ The results on the working ratio are not conclusive owing to apparent errors in the data received from the company.

¹² PCF's Carbon Finance Closing Memo (2008).

¹³ A district heating component was added in 1997 under the Water Companies Restructuring and Modernization Project (1994–2002).

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Appendix A. Basic Data Sheet

BULGARIA DISTRICT HEATING PROJECT (IBRD-47030, 47040)

KEY PROJECT DATA (AMOUNTS IN US\$ MILLION AND EURO MILLION)

<i>Fund source</i>	<i>Type of Financing</i>	<i>Appraisal Estimate (US\$ million equivalent)</i>	<i>Appraisal Estimate (Euro million)</i>	<i>Actual Costs (Euro million)</i>	<i>Percentage of Appraisal</i>
<i>Sofia DHC (Toplofikacia Sofia)</i>					
Sofia DHC	Own source	27.5	26.3	18.8	72
World Bank (IBRD)	Loan	27.2	26.0	26.0	100
EBRD	Loan	31.4	30.0	14.3	48
KIDSF	Grant	31.4	30.0	30.0	100
EU Phare	Grant	1.6	1.6	1.6	100
Sub-total		119.1	113.8	90.7	80
<i>Pernik DHC (Toplofikacia Pernik)</i>					
Pernik DHC	Own source	6.6	6.3	2.0	32
World Bank (IBRD)	Loan	7.0	6.7	5.6	84(a)
KIDSF	Grant			10.4	
Sub-total		13.6	13.0	18.0	139
TOTAL		132.7	126.8	108.7	86

Cumulative Estimated and Actual Disbursements

	<i>FY2004</i>	<i>FY2005</i>	<i>FY2006</i>	<i>FY2007</i>	<i>FY2008</i>	<i>FY 2009</i>
Appraisal estimate (US\$M)	8.0	20	30	34.2	34.2	34.2
Actual (US\$M)	5.41	22.2	26.5	34.5	40.5	40.7
Actual as % of appraisal	67.6	111	88.3	100.8	118.4	119
Date of final disbursement:						4/30/2010

Project Dates

	<i>Original</i>	<i>Actual</i>
Board approval	06/17/2003	06/17/2003
Effectiveness	10/31/2003	10/31/2003
Closing date	06/30/2008	06/30/2008

Appendix B. Sofia and Pernik District Heating Companies, Bulgaria

District heating serves 26.5 percent of the Bulgarian households (World Bank 2016b). About 65 percent of heat in the country is supplied by the Sofia District Heating Company (*Toplofikacia Sofia*) (Sofia DHC).

Sofia DHC

Sofia DHC is a joint stock company fully owned by the municipality of Sofia. It has four large heat sources, two combined heat and power plants (CHP Sofia and CHP Sofia East), and two large heating plants (Zemliane and Lyulin). In addition, the heating company has seven small local boiler plants. Gas is the main fuel; mazut is used as reserve fuel and in some small boiler plants where the gas network is not available.

Sofia DHC (Toplofikacia Sofia)		
	2002	2016
Length of the pipeline trunk	830 km	999 km
Installed heat capacity	3816 MW	4038 MW
Installed electric capacity	318 MW	198 MW
Sofia DH connections	299,012	406,569

Pernik DHC

Pernik DHC is a privately-owned company. The DH system in Pernik consists of a CHP plant that produces heat for district heating, and steam for industry and electricity. The plant has five steam boilers and three turbines with the heat capacity of about 260 MW. The district heating system in Pernik is based on local coal. The fuel quality is poor. The local lignite has ash content up to 65 percent and the average caloric value is less than 2000 kcal/kg.

Pernik DHC (Toplofikacia Pernik)		
	2002	2016
Length of the pipeline trunk	60 km	69 km
Installed heat capacity	270 MW	256 MW
Pernik DH connections	12,410	18,677

Bulgaria District Heating Policy

The state policy is reflected in “Project of a National Program for Stabilization and Development of the DH Sector of the Republic of Bulgaria until 2020,” developed by the Ministry of Economy, Energy and Tourism.

(http://www.mi.government.bg/files/useruploads/files/proekt_programme_dht.pdf)

The main goals are focused on stabilization measures including:

- Political support;
- Contribution of DH for reduction of carbon emissions;
- Cooperation with local authority;
- Implementation of CHP technology;
- Diversification of natural gas supply.

Due to the fact, that DHC are privately owned, the state has very limited options to influence the development of the DC sector.

Tariffs

All heat and electricity tariffs are determined, after analyses from the Energy and Water Regulatory Commission (State body), on the basis of two Ordinances: “Ordinance for the Regulation of the Prices of Heat Energy,” (<http://lex.bg/laws/ldoc/2135486705>) and “Ordinance No 1/14 of March 2017, for the Regulation of Prices of Electrical Energy” (<http://www.dker.bg/uploads/2017/06/13-1/naredba-regtsenelen-24mar2017.pdf>)

Appendix C. Bulgaria Energy Efficiency Policies

Energy efficiency in the residential sector and reduction of carbon intensity

Policy and main strategy documents

The Bulgarian State provides its functions in the field of energy efficiency through the National Assembly and the Council of Ministers. The main measures for enhancing energy efficiency in the building sector are regulated in normative and strategic documents. Many of the documents, plans, programs, and mechanisms cover the entire building stock, with some sections referring to measures in the residential sector. The National Assembly adopts a National Energy Efficiency Strategy of the Republic of Bulgaria, which sets the stages, means and measures for achieving the national energy efficiency target. The national indicative target for energy savings by 2020 is 716 ktoe (8,325,650 GWh) energy savings on Final Energy Consumption (FEC) and 1590 ktoe (18488,520 GWh) for Primary Energy Consumption, of which 169 ktoe (1,965,130 GWh - 11 percent) is in the transformation, transmission and distribution processes in the energy sector.

The Council of Ministers defines state policy on energy efficiency as part of the country's sustainable development policy. National energy efficiency legislation includes the Energy Efficiency Act, the Spatial Planning Act, the Energy Act, the Renewable Energy Act, the Law on Technical Requirements for Products, the National Standardization Act, as well as the secondary legislation.

Bulgaria has developed and presented to the European Commission a National Energy Efficiency Action Plan for 2014–20 (NEEAP). It has been developed in accordance with the requirements of the Directive 2012/27/EC, in a model that ensures the inclusion of all obligations. The requirements related to Directive 2010/31/EU on the energy performance of buildings has also been taken into account. All plans and programs, including those in the building sector, are covered by the NEEAP.

Financing

Energy Efficiency Measures are funded by a variety of sources: the State Budget, credit lines, and funds. and include most of the Operational Programs funded by the European Economic Area. To finance the National Program, Bulgarian Development Bank (BDB) SC has concluded two loan agreements with external creditors in 2016: the Council of Europe Development Bank and the KfW, Germany.

Sector structure

The residential sector is the third largest energy consumer with a 2,213,000 kgoe/y.

The total building stock is 2,012,000. The attention of the authorities is focused on energy efficiency measures in multifamily buildings (part of 1,730,000 buildings) with reinforced concrete construction and massive buildings.

Currently the implemented Energy Efficiency Programs in Residential Buildings are:

A. The National Energy Efficiency Program for Multifamily Residential Buildings, shortly referred to as the “rehabilitation program,” was adopted by Decree No 18 of the Council of Ministers of 2 February 2015 (Decree of the Council of Ministers No 18/ 02.02.2015). It is an important measure for energy efficiency. The financial program is secured by BGN 2 billion from the state budget, which is exhausted today. In 2017, the work on the program continues only on projects already launched. All multifamily residential buildings designed before April 26, 1999, on three or more floors with six or more separate residential buildings are eligible to apply. Public procurement concerns the rehabilitation of only 2,022 buildings in the territory of the country, in 11,361,795 m² of built-up area, distributed in 147,761 dwellings that house 340,705 people. Up to now, 313 buildings have been completed and the rest are at different stages of execution; for example, 535 buildings are at completion. The expected energy savings of the renovated residential buildings for all 2,022 buildings is: 961,688,756 kWh/year. Estimated annual greenhouse gas emission reductions (CO₂ and equivalent), including savings for all 2,022 buildings are 314,725 tCO₂/year.

B. National Long-Term Program to Promote Investments to Implement Measures to Improve the Energy Performance of Buildings by Public and Private National Housing and Commercial Buildings. The energy performance of buildings in operation is determined by an energy efficiency audit. The investigation ends with a report and a certificate of energy performance of the building. The energy performance of a new building before commissioning is certified by a design certificate of energy performance.

C. The model of contract with guaranteed result is well known in Bulgaria, but it is not disseminated enough.

D. The Ministry of Energy has signed contracts with gas distribution companies in the country for gasification of residential buildings as an energy efficiency measure. The aim is to achieve extra savings of electricity of 70,000 MWh/year, as a result of the transition from coal, biomass, and oil to natural gas, owing to the higher incineration efficiency.

Current outcomes and benefits

The improved residential infrastructure has a total area of 2, 489, 434 m². The number of renovated dwellings is 29,915; 62,252 residents have benefited from the improved infrastructure. The main benefits for the whole society are:

- lower generation costs;
- improved environment;
- development of new financing models;
- lower bills for energy consumers;
- reduced share of households falling into the category of energy poverty.

Launched plans

A. The National Plan for Near-Zero Energy Buildings 2015–20 (NZEBS) aims to make the concept of nearly zero-energy buildings a practical alternative to the future construction of new buildings in Bulgaria after 2018, with proven cost effectiveness and when renovating existing buildings for different sub-categories of buildings. Field of application: Private and State/Municipal Property. By December 2020, all new buildings should have close to zero net energy consumption. The energy efficiency requirements for new buildings in Bulgaria are provided at the stage of investment design; at the stage of assessing the conformity of investment projects of new buildings before issuing a building permit; at construction stage and at the stage of entering a new building in operation. By December 21, 2020, all new buildings will have close to zero energy consumption.

It is expected that the implementation of the national NZEBs plan will contribute final energy savings of 23.1 ktoe (267.7 GWh) to 46.2 ktoe (535.4 GWh) of primary energy, representing 10.04 percent of the national 2020 energy savings target. It is expected to contribute savings of 36 685 tons of CO₂ emissions by 2020. The assessment is for all measures applied in state and residential buildings. Achieving the targets for the residential buildings only by 2020 will achieve savings of 8.1 ktoe (93.7 GWh) of final energy, representing 3.52 percent of the national 2020 energy saving target without energy traders.

B. Introducing a Financial Mechanism for Trade in Energy Savings - the so-called “Trade with White Certificates.”

Energy Efficiency Programs in State Buildings

A. National Plan for improvement of the energy performance of heated and/or cooled Buildings - State property, used by the State administration. The summary list of government buildings, owned by the ministries in the country is published in the National Energy Efficiency Action Plan.

All public buildings in operation with a total built-up area of over 250 m² are subject to mandatory auditing and certification and they are required to manage energy efficiency. Installations with hot water boilers are subject to mandatory periodic inspection depending on the installed capacity and the type of energy used.

It is planned to take measures annually to improve the energy performance of at least 5 percent of the total built-up area. In 2015, a total of 213 buildings owned by the state administration were surveyed, with a total built-up area of 1 005 268 m², representing 11.7 percent of the total building area of all buildings owned by the state administration.

The analysis of the existing buildings, state and municipal property shows that, by 2015, 5,660 buildings (with a total built-up area of more than 250 m²) with a total built-up area of 9,162,308 m² have outstanding energy saving measures and do not meet the minimum requirements for energy efficiency.

The expected effects are:

- Energy savings of 72 GWh/y;
- Emission savings of 24 CO₂ t/y;

- Savings of 11 mill/y.

The overall goal of the owners of state and municipal buildings by 2020 is 1015.3 GWh of saved energy.

The Forecast to 2020 for annual electricity generation is 520 GWh/y from CHP installations in residential and public buildings.

B. Program BG04 “Energy Efficiency and Renewable Energy,” Procedure BG04-02-03: “Improving Energy Efficiency and Renewable Energy in Municipal and State Buildings.” Beneficiaries of the scheme are state or municipal institutions. The procedure has two components: 1. Energy efficiency measures; 2. Measures to use energy from renewable sources.

The expected results of the procedure are:

- GHG savings of 5655.60 tons CO₂ eq./d;
- Installed energy from renewable sources in buildings - 10,152 MW.

After December 31, 2018, new buildings occupied or owned by public authorities will have close to zero energy consumption. Achieving these targets in the existing public service buildings by 2020 will deliver savings of 15 ktoe (174 GWh) of final energy, representing 6.52 percent of the national 2020 energy savings target without energy traders.

Appendix D. List of Persons Met

Sofia District Heating Company (Toplofikacia Sofia)

Mr. Ljuben Paralanov, Chairman of Board of Directors

Ms. Maria Domuzova, Head of Project Management Department

Ms. Anastasiya Markova, former Head of Project Management Department

Mr. Petar Iliev, former Deputy Executive Director

Technical experts

Pernik District Heating Company (Toplofikacia Pernik)

Mr. Lyubomir Spassov, Executive Director

Mr. Yasen Katsarov, Head of Inspectorate Department

Mr. Ludmil Ivanov, Deputy Head of DH services

Municipality of Sofia

Mr. Doncho Barbalov, Deputy Mayor

Municipality of Pernik

Mr. Mihail Rizov, former Deputy Executive Director in the Pernik DHC

Ms. Irina Boshkova, former expert in the Pernik DHC

Experts from the municipality's environment unit

Ministry of Environment and Water (MOEW)

Ms. Boriana Kamenova, Director, Climate Change Policy Directorate

Ms. Rayna Angelova, Head of EU Policy Implementation on Climate Change Department

Sustainable Energy Development Agency (SEDA)

Ivailo Alexiev, Executive Director

Nikola Tsankov, General Secretary

Ms. Tsvetomira Kulevska, Director for Coordination and Management of EE and RES

Sofia Energy Agency- SOFENA, Bulgaria non-governmental organization (NGO)

Mr. Zdravko Georgiev, Executive Director

Ms. Nadya Nikolova, Chair of the Management Board

European Bank for Reconstruction and Development (EBRD)

Mr. Iliya Kardashliev, Principal Banker

EBRD Kozloduy International Decommissioning Support Fund (KIDSF)

Mr. Valentin Seider, EBRD/KIDSF manager

Mr. Zoltan Kiss, former EBRD/KIDSF manager

Ms. Ewa Szajner, Sr. Energy Consultant, former consultant for EBRD/KIDSF

World Bank Group

Mr. Sudipto Sarkar, Practice Manager, Task Team Leader at appraisal

Mr. Pekka Kalevi Salminen, Energy Consultant, former Sr. Energy Specialist

Mr. Jasneet Singh, Lead Energy Specialist

Ms. Claudia Ines Vasquez Suarez, Sr. Energy Specialist

Mr. Feng Liu, Sr. Energy Specialist

Mr. Yevgen Yesyrkenov, Sr. Carbon Finance Specialist

Ms. Eolina Petrova Milova, Senior Operations Officer, Sofia, Bulgaria

Ms. Vladimir Mihailovski, Country Officer, IFC, Sofia, Bulgaria

Appendix E. Borrower Comments

No comments were received from the Borrower.