Efficiency, Performance, and Social Issues for Eastern European District Heating

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ABSTRACT

Many redeveloping Eastern European urban centers are plagued by significant environmental and socio-economic problems, including poor-performing district heating plants that can be a contributor. Most older systems are characterized by low central heating plant efficiencies, limited controls, poor environmental performance, and high distribution system loss rates. The effects on district heat customers are high costs, low reliability, and reduced air quality.

This paper presents a comprehensive discussion on the state of district heating in Eastern Europe based on experiences in Romania. First, we provide a general technology and operational procedure overview of district heating systems. Our discussion addresses a multitude of issues associated with typical systems: net and gross efficiency; performance, capacity, and reliability issues; hot water or steam loss rates; environmental issues; customer heat availability; and customer exodus.

We then investigate several options for system upgrades. These may include higher performance heating plants and distribution systems and conversion to cogeneration or independent heating units. Technical, environmental, and socio-economic advantages and disadvantages are discussed.

Finally, we present a case study project in Baia Mare, Romania. With funding from USAID, this problem-plagued system was studied and relevant options were assessed. Baia Mare's system, typical of Romanian district heating, had low efficiency, high distribution heat and direct hot water losses, and poor reliability. The assessment addressed numerous options and contended with a concurrent customer exodus to low quality, poorly installed independent systems. The local heating utility is currently attempting to implement recommended solutions, while trying to reconnect customers who left the system.

Introduction

The United States Agency for International Development (USAID) has developed an initiative that seeks practical, market-based solutions to industrial and urban environmental problems in Central and Eastern Europe Countries (CEEC) and Former Soviet Union Countries (FSUC). The program name is ECOLINKS (www.ecolinks.org) and promotes partnerships by linking businesses, local governments, and associations from the countries in the region with US businesses and other organizations.

Under an ECOLINKS project grant, a local utility company from Baia Mare, Romania, Energoterm SA, obtained funding for an energy efficiency study addressing their

District Heating (DH) system. For this project, they established a partnership with two energy engineering and consulting firms: Trapec Bucharest, a Romanian based company, and Energy & Resource Solutions from Haverhill, Massachusetts.

The scope of this project was to assess available options for technical and economic improvements to the Baia Mare DH system operation, and to define a global strategy for developing a DH system confronting market loss in favor of independent heating solutions.

In this paper we will discuss the study findings, including detailed descriptions of the technological, economic, and environmental benefits of the proposed solutions. We will also discuss significant factors in assessing DH systems in redeveloping Eastern European countries.

Overview of District Heating System in Baia Mare, Romania

Baia Mare is a city located in the Maramures region of northwestern Romania. This area is often referred to as “the ancestral memory of Europe” and is famous for its traditional domestic industries such as woodcarving, painting using vegetable colors, pottery, sacred icon painting, and wool carpet weaving. The famous wooden churches, some of them 400 years old, are some of the main tourist attractions in the region. The city also has a significant mining history, and some of the oldest gold mines in Europe are located here. The city (population 150,000) is one of the important urban and industrial centers in Romania.

As with many other cities in Romania, Baia Mare has a district heating system, which is currently operated by ENERGOTERM SA, the local utility. The DH system customers include the following.

1. Residential – Domestic Hot Water (DHW) and Space Heat (SH);
2. Businesses and Public Buildings – Domestic Hot Water (DHW) and Space Heat (SH).

The system was originally designed to include both a central plant, transport, and distribution system (with a large heating plant, transport networks, thermal distribution substations and distribution networks); and a distributed solution with smaller central plants and distribution networks.

Due to the low efficiency of the centralized plant, the thermal distribution substations have been transformed into heating plants by adding boilers over time. Beginning in 1994, a campaign was started to install small heating plants for each building or for two or three supplied buildings. One reason this situation occurred was because the old distribution networks suffered from low efficiency, especially for buildings near the ends of the network (down to 65-70%).

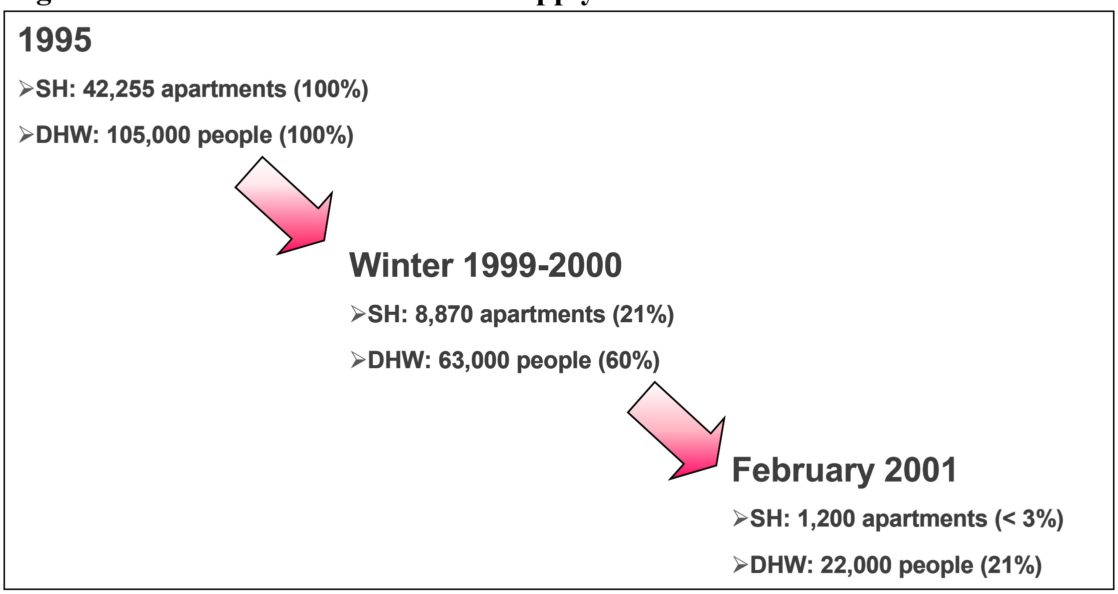
In the winter of 1999-2000, the specifications for the DH system was as follows.

1. 41 central heating plants with an installed capacity of 371.6 MW Thermal (MW_{th})
2. 230 boilers installed in central heating plants (0.7 to 5.82 MWth unit power)
3. 83 local heating plants with an installed capacity of about 40 MW_{th}
4. 114 boilers installed in small heating plants (0.2 to 0.7 MW_{th} unit power)
5. 54.7 km of distribution networks, out of which 52.7 km are insulated with mineral wool; between 1995 and 2000, there was no major pipe replacement

6. Distribution network average efficiency was approximately 80%
7. More then 68% of boilers commissioned before 1980
8. Only 79 boilers from the central heating plants were used in winter 1999 - 2000
9. Only one central heating plant was completely metered (heat meters at source and each building supplied); the balance of the central plants are not metered
10. Majority of the pumps and heat exchangers are over-sized
11. Overall efficiency of heat production and distribution in the DH system was 66%; while the average efficiency of the small heating plants was 81%

Despite the fact that the local utility has acted to improve the heat supply and to increase energy efficiency, the heating market share constantly decreased (see figure 1). Consumers are disconnecting from the DH system and opting for private heating sources.

Figure 1. Recent Transition in Heat Supply in Baia Mare

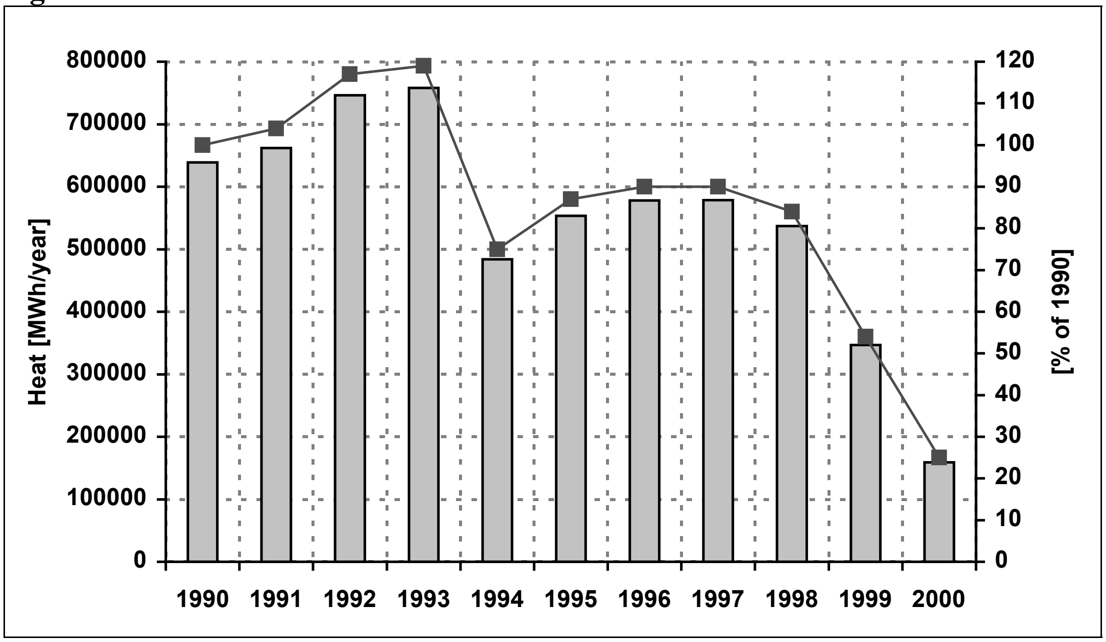


The general technical, economic, social, and political reasons for the disconnection phenomenon will be detailed later in this paper. The local reasons are the presence of natural gas; the low price of gas for residential consumers; the traffic of apartment heating units and stoves at low prices across the Hungarian border; and absence of controls on installations.

For consumers with inadequate financial resources, disconnection was a consequence of high heating bill costs. They have chosen various "domestic" solutions from gas cookers to wood stoves for heating. For this category of consumers, future re-connection is possible, provided there are lower energy rates and support for the necessary capital changes inside their apartments.

The loss of heat market is reflected in the decrease of heat sold by ENERGOTERM in recent years (figure 2).

Figure 2. Historic Heat Sales of ENERGOTERM[1]



Technical and Socio-Political Reasons for Market Share Loss

The reasons for the dramatic heating market share loss in recent years in Baia Mare must be investigated within the historical developments of the DH systems in the CEEC and FSUC. Explanations for the decline of DH systems fall in two primary categories: technical-economic and socio-political. Most of the following reasons are valid throughout the CEEC and FSUC, but there are particular factors that have aggravated the Romanian situation.

Technical-Economic Reasons for Market Loss

Over-Sizing of DH systems to accommodate future development. For many of CEEC/FSUC countries, including Romania, the DH systems have been over-sized in the design phase to address thermal demands corresponding to utopian development plans. Both heat generation capacities (many of them steam turbines with extraction and/or backpressure) and the transmission and distribution networks are designed to accommodate heat flows much higher than currently required. For this reason, equipment is operated at part load or in part-load operating regimes that lead to low overall efficiency.

Low capacity utilization due to poor understanding of load requirements. Another characteristic of CEEC DH systems is the limited full time equivalent utilization (hours per year), mainly from incorrect correlation of heat demand and outside temperatures. Most systems are designed for much lower outside temperatures than statistically recorded. The thermal inertia of buildings and thermal storage through the networks were not properly considered in the design stages. Heat storage practically does not exist in the CEEC, despite

[1] Year 2000 was unusually warm. The corrected market estimation is approximately 200,000 - 225,000 MWh/year.

the fact that it is typical in Scandinavia and other countries for comparably sized systems. Therefore, many of the systems are operated at part load, again at lower efficiency.

Difficulties in heat metering due to distribution design & fragmentation. Urban expansion in the former communist economy was based on high-rise building development. Due to the population density, complexities in apartment structures, and other factors, there is a very high heating density. The distribution system designs result in considerable challenges for accurate heat metering for each individual unit (apartment). Since district heating bills are exclusively estimates, there is never any incentive to limit usage.

Lack of technical inspections of local control systems and radiators. The regulating systems inside the apartments (valves installed on the radiators) and the radiators (which in most of the cases were not the property of the tenants) have rarely been inspected. Consequently, most of the radiators are fouled and the valves are obstructed. Temperatures inside apartments are maintained using windows. This practice persists due to the lack of tenant awareness and use-based billing, even when controls are functioning and radiators are in good condition.

Increased availability of competing heating equipment. The presence of competitors in the energy equipment market has led to increased interest by consumers who have become apartment owners. They are increasingly interested in having independence and control of their heating costs. Therefore, the number of disconnections from the DH system is increasing, with many tenants choosing individual heating units.

Disconnections lead to improperly balanced distribution system. The recent disconnections have resulted in distribution system imbalances, further reducing overall system efficiency. Consumers that still choose to be supplied through the DH systems are in a paradoxical situation, frequently receiving inadequate supply even if they are willing and able to pay for service.

Minimum investment in rehabilitation and modernization of generation, transmission, and distribution. The economic recession in the CEEC and FSUC during the 1980s, and the structural changes at the end of that decade, followed by continuing economic crises, have led to the continuous degradation of DH systems. In many cases, the systems and equipment consist of 40 – 50 year-old technologies without even basic controls, and no important upgrades have been completed in the last two decades. Basic system maintenance has also been limited. In very few cases where external financing sources were available, it was possible to carry out advanced rehabilitation and modernization projects.

Socio-Political Reasons for Market Loss

Heat was not considered a market commodity, but a government responsibility. In the past, heat from DH systems was not considered a service based on market rules, but a social good and the responsibility of the government to provide to the constituency. That perspective was associated with a lack of energy measurement and control, financial responsibility, and awareness of resource use. Now, consumers must pay for heat supply from systems with extremely high heat transmission and distribution losses, and poor management of the general heat production, transmission, and distribution facilities. These losses have become progressively higher due to system degradation.

Lack of initiative from local utilities to improve supply services. This situation is especially prevalent in countries where privatization of DH systems was delayed (as in Romania, Bulgaria, and the former Soviet Union Countries), and where the local heating utilities were able to maintain their monopolist position. Until recent years, consumers were captive, and the local utilities have done almost nothing to improve the service they offer. Only competition from the heating equipment market has led to an increased awareness by local utilities and authorities.

The absence of a national energy strategy. This reason is especially valid in countries like Romania, Moldova, and Bulgaria where the governments did not draw a coherent energy strategy with a distinct position on district heating following the structural changes of the late 1980s and early 1990s. A cogent national energy strategy could support the rehabilitation and retrofit of DH systems.

Lack of clear and transparent legal frame. Most of the CEEC and FSUC do not have specific energy regulations or have only recently adopted such regulations. The legislation that governs the energy sector is out of date and does not reflect the structural changes that took place in recent years. Absence of a clear and transparent legal frame slows the decision making process. The decisions that have a long-term impact on DH systems require clear and stable legislation. Also, the lack of environmental regulations has allowed the spread of low efficiency independent heating solutions.

Continuous increase in heat price correlated with decrease in living standard. In the last decade, heat prices have continuously increased due to service market liberalization and because the main resources are paid for in external currency. Meanwhile, most of the local economies have experienced high inflation leading to a permanent degradation of purchasing power. The continuous decrease in the living standard of citizens supplied with heat from DH systems has a major impact on their ability to pay heat bills. Tenant debts to heat suppliers are enormous in some of the CEEC and FSUC. This aspect has lead to the bankruptcy of many local DH utilities, creating an even more difficult situation for the people without alternative heat sources.

Draconian energy policy in Romania in 1980s. One political decision in the 1980s was to increase industrial production and ensure industrial energy supply by any means. As a result, many end-users were “sacrificed”, including industries considered not highly important; residential electricity use and district heating. Heat was delivered at the lowest possible levels, simply to avoid system freezing. This situation led to a permanent degradation of the systems, in addition to a profound lack of trust in district heating utilities.

Perceived low price of natural gas for residential consumers. Until recently, the policy of the Romanian government was to subsidize natural gas prices for residential consumers. This policy in conjunction with the low efficiency of the DH systems led to a situation where the price of heat produced by independent systems, even very low efficiency ones like gas cooking stoves, is lower than the price of heat delivered by the local heating utility. Disconnections were effectively motivated by this subsidization policy.

The items above provide all the necessary pieces to build an image of DH systems characterized by advanced degradation and an exponential loss of market share. Consumers have a lack of trust in DH systems, due to the inability of the suppliers to either provide high quality service or to promote the potential advantages of these systems.

Options for Improving Baia Mare System Efficiency

The problem of consumer disconnection from DH systems has a major impact on future DH system development in Romania. Assessing this process is a very difficult task, and must consider local technical, economic, social, and political aspects, as well as important international developments (such as the European market fuel price and its impact on the Romanian market, or prospects of new European energy and environmental legislation).

For the specific project in Baia Mare, this problem was addressed by developing an analysis of future district heating system development prospects and potential heat markets. Aspects considered in the analysis included: efficiency of the heat sources (heating plants); efficiency of the distribution system (networks); quality of auxiliary equipment (pumps, heat exchangers); and status of the market and market loss trends.

For every heating plant, a score was compiled based on its potential to maintain the market and on its energy efficiency level. The result of the analysis showed that less than 17% of 34 total central heating plants still operating can be considered for major renovation work; 56% of plants present a high risk to lose their remaining heat market; and 27% of the central heating plants should be shut down because their energy efficiency is so low and their existing market does not justify future operation.

Considered Options

Considering probable future evolution of the heating plants and the above-mentioned background on district heating systems in Romania, the proposed options for Baia Mare's DH system are listed below.

1. Modernize and optimize existing plants and thermal networks
2. Decentralize entire system—micro-thermal plants in each end use building
3. Installation of micro-turbines and small cogeneration
4. Combination of the above options
    a. New central heat sources where most appropriate
    b. Micro-thermal plants elsewhere

Table 1. Characteristics of Considered Options

Option	Characteristic
Central District Heating Plants	- Replacement or advanced rehabilitation of boilers and distribution networks required. - Relatively high investment costs (especially distribution networks) in an uncertain market. - Requires extensive and expensive heat metering and control systems. - Secure contracts with consumers are required. - System must be designed for possible re-subscription - Boiler efficiency after rehabilitation remains relatively low. - Distribution losses can be reduced but not eliminated. - New boilers and networks have reasonably good efficiency and reduced environmental impact.
Cogeneration	- Requires major investment in equipment in an uncertain market. - Requires extensive and expensive heat metering and control systems. - Secure contracts with consumers are required. - System must be designed for possible re-subscription - Distribution losses can be reduced but not eliminated. - Improved efficiency requires consistent off season DHW demand. Heat storage is essential. - Cost of small-scale cogeneration units (micro-turbines, small gas engines) are relatively high. - High O&M costs and lack of local know-how of modern cogeneration systems.
Micro-thermal Plants	- Relatively low initial investment, even though specific price of the equipment ($/kW) is higher. - Building sited - no network distribution losses - Existing distribution network eliminated- Requires contracts only with local building group. - Consumers have better control of heating. Leads to an increased awareness of energy efficiency. - More transparent billing process - Simplified O&M - Overall efficiency relatively high, but citywide distribution may increase environmental impact.

Proposed Technical Measures

Table 2. Proposed Measures for Each Option

Solution	Proposed measures
Central District Heating Plants	- Increase generation efficiency, from an average of 81% to 87%. - Where boiler size is inadequate smaller size boilers are proposed, with efficiency up to92%. - Replacement of the shell and tube heat exchangers to plate heat exchangers. - Replacement of circulation pumps. - Installing heat metering and control systems. - Use of heat storage (where installed) to optimize operating regimes. - Advanced thermal network rehabilitation. Heat loss decrease from 20% to approx. 3-5%. - Improve out of heating season heating plant operation by connecting them. - Optimize the personnel to reduce the operation costs.
Cogeneration units	- Install gas turbine cogeneration units, efficiency of 74% & 78% for units analyzed. - Install gas engine cogeneration units, efficiency of 84% for units analyzed. - Install micro-turbines of 50 kW_e/73 kW_{th}, with net cogeneration efficiency of 73%. - Cogeneration is proposed along with rehabilitation, the above-mentioned measures apply.
Micro-Thermal Plants	- Installing small units for each building supplied by the actual heating plants - Boiler capacity 70 kW to 300 kW, single boiler with separate DHW loop, or two boilers. - Overall efficiency of the micro-thermal plants is 90%. - Proposed micro-thermal plants are completely automated, no personnel being required.

Economic Assessment Details

The economic evaluation of the proposed options was based on the specific conditions of the Romanian economy, characterized by a high inflation rate and high interest rates for capital. The proposed equipment cost was assessed based on the local market. The economic assessment details are described below:

1. New boiler equipment costs are between $32,000/MW_{th}$ and $50,000/MW_{th}$, depending on boiler size. The total investment can be highly variable depending on the scale of the associated rehabilitation. Overall plant upgrade estimates lie between $3 and $4 million depending on whether cogeneration units are installed.
2. Cogeneration units cost between $1,200/kW_e$ and $1,460/kW_e$, depending on unit type, with gas turbines slightly more expensive than gas engines. The total investment in cogeneration units can be highly variable depending on details.
3. Micro-thermal plants cost between $43,500-$71,500/MW_{th}$ (including construction, but not connection to natural gas). The total investment can be highly variable depending on the scale of system decentralization, but an estimate of a typical micro-thermal plant is approximately $4.76 million.
4. The total investment for rehabilitation of DH system thermal networks is estimated at approximately $2.95 million. This cost only addresses segments of the network where upgrades are plausible (13.3 km of distribution networks, delivering heat from the 17% of the heating plants, identified as viable for major renovation work, were proposed for rehabilitation with pre-insulated pipes).
5. Life cycle analysis period: 15 years.
6. Discount rate: 10 to 16 percent per year.
7. Model multiple scenarios for gas, heat and electric prices.
8. NPV, IRR, Discounted Payback Period (DPP) used for economic assessment.
9. For plants identified as possible to maintain their market, it was assumed that the consumers would remain connected to the DH system.

Results and Findings

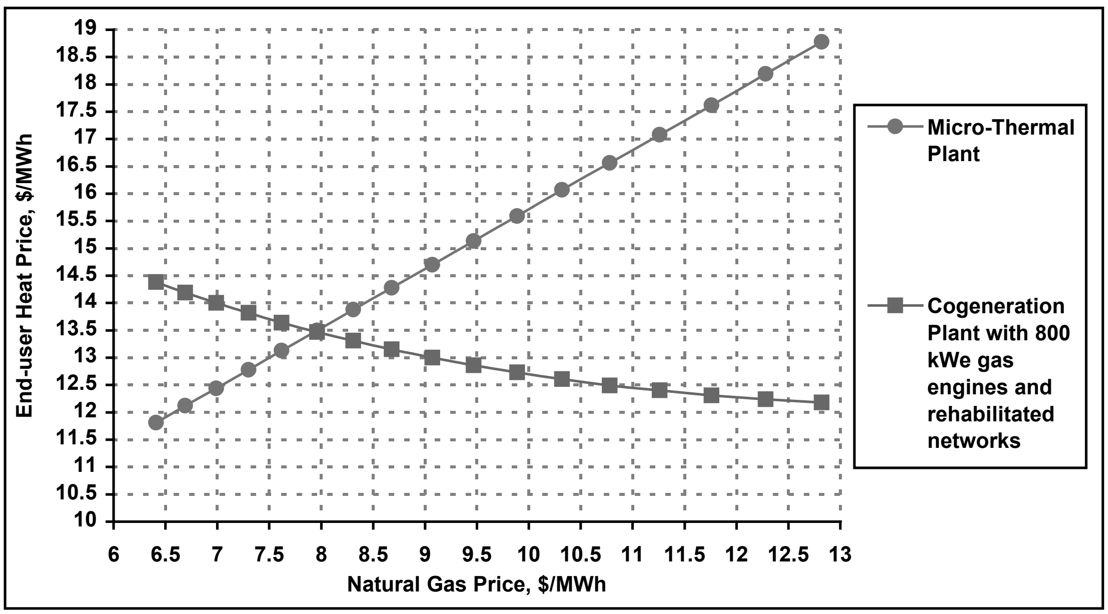
Final conclusions of the heat production cost analysis are as follows.

1. Based on the gas price in Romania at the time of the study ($6.41/MWh), micro-thermal plants (smaller-scale, building-size boilers) can produce heat at the lowest price and are the most attractive option.
2. Distribution efficiency strongly influences customer heat price. An increase in efficiency of 10% leads to a cost reduction of about 15%. For the actual energy prices in Romania, our preliminary analyses indicate that investment in distribution networks may not be cost-effective. However, a more detailed analysis of the thermal networks is essential. Such an analysis would identify the most cost-effective rehabilitation opportunities. Based on the current study, which assumes a very high thermal system upgrade cost, it is not recommended to upgrade distribution networks, unless non-reimbursable funds are obtained.
3. If the price of the natural gas increases substantially, cogeneration units with gas engines can become competitive. With increased energy prices, gas engines have better economic opportunities than gas turbines due to the higher output energy ratio (kW_e/kW_{th}). Further, larger units have economic advantages compared to small units.

4. Higher full capacity equivalent hours are essential for competitive economic performance of the proposed cogeneration solutions. Further, without heat storage, the cogeneration solutions cannot be cost-effective.
5. With lower energy prices and discount rates, the gas turbine cogeneration solutions can be economically competitive. Again, high full capacity equivalent hours and output energy ratio are essential for gas turbine competitiveness.

An example for the comparative heat cost at end-users versus natural gas price is presented in Figure 3. The presented graph refers the same input hypotheses for both solutions (electricity prices, discount rate, heat production, loan conditions etc.) and for average capital costs. It must be noted that specific conditions from site to site can be significantly variable.

Figure 3. Comparative Assessment of the Micro-Thermal Plants vs. Gas Engine Cogeneration Plant



Following the economic assessment, the final recommendation was for sites that can plausibly maintain their heat market share, gas engine cogeneration can be considered for further analysis. Otherwise, micro-thermal plants are the preferred option.

Pilot Site Discussion

Following the general analysis for the entire Baia Mare DH system, a pilot site was proposed for a comprehensive feasibility study. This site was identified as one of the possible sites that could maintain their current consumers. No future re-subscription of former consumers is foreseen for this analysis.

Overview of the Current Status of the Selected Site

Initially, the heating plant under consideration supplied space heating and domestic hot water for 158 apartments and several public buildings – a health clinic, an ambulance service center, a school for disabled children, and a kindergarten. The total installed capacity of the plant was and still is 3,490 kW_{th} for SH and DHW, and 760 kW_{th} for low pressure steam needs. The heating plant has four hot water boilers (1,163 kW_{th} each) and two steam boilers (760 kW_{th} each).

In winter 2000-2001, only the health clinic, the ambulance service center and the school for disabled children used heat (other buildings in this area already had disconnected). The total peak demand of these buildings is 650.5 kW_{th} for SH, 1,163 kW_{th} for DHW, and 760 kW_{th} for low pressure steam.

Several other important factors characterize this heating plant. The boiler performance is very low due to uncontrolled combustion. Since the heat demand has dropped dramatically, the boilers operate at low part-load condition with low efficiency. Due to poor maintenance, there are very high hot water and steam losses. Pumps for the system are oversized (even at full load). Shell and tube heat exchangers used for producing DHW are in poor condition. Finally, there are installed heat storage tanks, but these are not used.

Proposed Options for the Pilot Site

Two options have been proposed for rehabilitation of the pilot site:

1. Option 1 – Combined Heat and Power (CHP): Installation of a cogeneration unit and rehabilitation of one hot water boiler, one steam boiler, and the distribution network.
2. Option 2 – Micro-Thermal Plants (MTP): Installation of a micro-thermal plant for each building or small group of buildings.

Option 1—Combined heat and power plant. Starting with DHW as the baseline demand, a gas engine cogeneration unit with 200 kW_e and 250 kW_{th} was proposed. The heat load will be covered using the gas engine, the rehabilitated 1,163 kW hot water boiler, and the rehabilitated heat storage capacities (15,000 liters). The existing steam boiler would be rehabilitated to cover the steam load.

The cogeneration unit would operate approximately 7,000 full load hours per year, including 4,200 hours during the winter and shoulder seasons, and 2,800 hours in the summer season. This full capacity equivalent utilization period considers both the daily load curve for the supplied buildings, and heat accumulation when the engine nominal thermal capacity is higher than consumer demand. Cogeneration unit net efficiency is 85 percent.

The hot water boilers will operate for 3,220 full load equivalent hours per year. The steam boiler shall effectively operate independently of the cogeneration plant. The rehabilitated boilers will have a combustion efficiency of 92 percent.

Finally, the efficiency of the upgraded distribution network will be approximately 95%. The net investment for Option 1 will be approximately $338,000.

Option 2—Micro-Thermal plants. Three micro-thermal plants have been proposed under this option: a micro-thermal plant for the Health Clinic consisting of 2 hot water boiler units with a capacity of 260 kW_{th} each and one steam boiler with an output of 760 kW_{th}; a micro-thermal plant for the Ambulance Service Center consisting of one hot water boiler rated at 170 kW_{th}; and a micro-thermal thermal plant for the School with two hot water boilers, each rated at 267 kW_{th}.

With the exception of the steam boiler for the health clinic, the equivalent full capacity utilization period will be approximately 4,700 hours per year for each system. The steam boiler shall deliver heat to serve the specific needs (not SH) of the Health Clinic, and will operate independently of that facility's SH hot water boilers. The hot water or steam production (combustion) efficiency for the upgraded boilers will now range from 88% to 92% efficiency, and the distribution efficiency will increase to approximately 98 percent. The total investment for Option 2 will be approximately $152,000.

Economic Assessment

Taking into consideration the changes in heat use in the last four years, an annual reference heat delivery of 5,500 MWh_{th} was used for economic assessment of the proposed options. Multiple scenarios for energy prices (gas, heat, and purchased and sold electricity), discount rate, and O&M costs have been used, with a 15-year life cycle analysis period. The investment calculation has been performed using Net Present Value (NPV), Internal Rate of Return (IRR), and Discounted Payback Period (DPP). Results are shown in Table 3.

Table 3. Economic Assessment of the Proposed Options for the Pilot Site

Indicator	Price	Value								
	Energy prices	Nat. Gas: $6.41/MWh Purchased Electric: $45/MWh Sold Electric: $37.5/MWh			Nat. Gas: $9.6/MWh Purchased Electric: $58.5/MWh Sold Electric: $48.8/MWh			Nat. Gas: $12.8/MWh Purchased Electric: $72/MWh Sold Electric: $60/MWh		
Discount rate		10%	13%	16%	10%	13%	16%	10%	13%	16%
NPV	Heat: 15 $/MWh	CHP	MTP		CHP					
	Heat: 17 $/MWh	CHP	MTP	MTP	CHP	CHP				
	Heat: 19 $/MWh	CHP	MTP	MTP	CHP	CHP	CHP	CHP	CHP	
IRR	Heat: 15 $/MWh	MTP	MTP		CHP					
	Heat: 17 $/MWh	MTP	MTP	MTP	CHP	CHP				
	Heat: 19 $/MWh	MTP	MTP	MTP	CHP	CHP	CHP	CHP	CHP	
DPP	Heat: 15 $/MWh	MTP								
	Heat: 17 $/MWh	MTP	MTP	MTP	CHP					
	Heat: 19 $/MWh	MTP	MTP	MTP	CHP	CHP	CHP			

Notes: First columns of values based on energy prices in Romania at the time when analyses were performed.
CHP – Combined Heat and Power Plant (Option 1)
MTP – Micro-Thermal Plants (Option 2)
Filled cells correspond to the preferred scenario option. Empty cells correspond to the scenarios when neither one of the options satisfies the profitability conditions: NPV > 0, IRR > a, DPP < 10 years.

The proposed options for the pilot site are not cost-effective over the 15-year period with discount rates of 10-16% if heat prices are lower than $15/MWh. For lower energy prices, as was the case in Romania at the date of analysis, Option 2 (micro-thermal plants) is generally preferred. With increased energy prices, a likely possibility for Romania, Option 1 (CHP) is preferred. Regardless, high discount rates can jeopardize rehabilitation cost-effectiveness.

Final Conclusions and Remarks

Technical and Economic Conclusions.

Primary technical and economic findings of the study demonstrate that rehabilitation of DH systems in Romania is strongly influenced by distribution network efficiency. For cities with good distribution networks, a rehabilitation of centralized sources is possible and can be cost-effective, but where networks are in poor condition, decentralization of the system is more attractive. Energy savings at the current heat prices in Romania cannot justify major rehabilitation of distribution networks, unless funds can be obtained where reimbursement is not required. Modern CHP (cogeneration) solutions can be cost-effective only if the price of energy increases to a level comparable with the market prices in Europe.

Socio-Political Conclusions

Consumer exodus from DH systems can be stopped if a coherent energy policy is adopted by the Government. This policy should establish that heat supply is a market service and must address environmental impacts of heat generation, transmission, and distribution. Currently, distrust of Government run services impedes rational solutions.

Re-subscription of consumers is essential for district heating system cost-effectiveness, but it will require a major economic incentive. Independent systems can have serious health and environment issues. The potential problems can be asphyxiation due to inappropriate exhaust venting or high emissions of pollutants due to low efficiency units. Health and safety regulations are imperative since they can limit the expansion of hazardous improvised heating systems. In conclusion, sustainable solutions that effectively address energy efficiency and environmental issues must be an integral part of the economic re-development of Romania.

The situation discussed in the above case study for Bair Mare, Romania is not unlike many other DH systems in the CEEC and FSUC. Each country, municipality, and system will have its own unique issues to address. But the situation in Baia Mare can serve as an example of the various problems and concerns that must be taken into consideration when addressing DH systems in other CEECs and FSUCs.