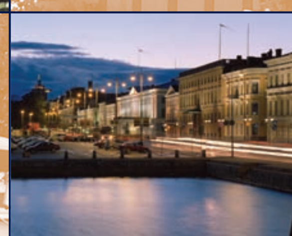
Cogeneration and District Heating



Best Practices for Municipalities

Energy Charter Secretariat

COGENERATION AND DISTRICT HEATING

Best Practices for Municipalities

Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects (PEEREA)

ENERGY CHARTER SECRETARIAT

THE ENERGY CHARTER

The work of the Energy Charter is based on the 1991 Energy Charter Declaration and the 1994 Energy Charter Treaty, signed by fifty-one countries across Europe and Asia. The Treaty provides a binding framework for energy cooperation, aimed at the following objectives:

- to strive towards open, efficient, sustainable and secure energy markets;
- to promote a constructive climate conducive to energy interdependence on the basis of trust between nations.

In the broadest terms, this mission will be achieved through:

- strengthening and extending the rule of law to facilitate market developments in the energy sector;
- establishment of rules of conduct, guidelines, standards and recommendations for open efficient and sustainable energy markets;
- developing clear, commonly-accepted rules on energy transit;
- helping countries to develop national energy efficiency policies;
- peer-group reviews of countries' progress towards their Energy Charter obligations;
- expanding the geographical coverage of the Energy Charter process.

The Energy Charter Conference, an inter-governmental organisation, is the governing and decision-making body for the Energy Charter process, and was established by the 1994 Energy Charter Treaty. The Conference is assisted by a Secretariat, based in Brussels. For information on the Charter process, please contact the Secretariat at the address provided below, or visit the Energy Charter's web site at www.encharter.org.

Energy Charter Secretariat
Boulevard de la Woluwe, 56 • B-1200 Brussels • Belgium
Tel: +32 2 775 9800 • Fax: +32 2 775 9801 • Email: info@encharter.org
www.encharter.org

PREFACE

Cogeneration (CHP) and district heating (DH) are used in many of the fifty-one countries that are signatories to the Energy Charter Treaty and the Protocol on Energy Efficiency and Related Environmental Aspects (PEEREA), but the respective shares in power and heat production vary widely across the Energy Charter constituency. The share of cogeneration in total power production varies between 10 and 50 percent and the share of district heating in total heat production varies from less than 5 to more than 60 percent. Many countries have the potential to increase their overall energy efficiency through higher shares of cogeneration and of district heating, and by reducing energy losses when upgrading district heating systems.

This report deals with the important role played by local authorities in promoting cogeneration and district heating. One conclusion reached during discussions on this issue within the Energy Charter was that successful programmes and policies are contingent on the capacity of local authorities to implement measures that are designed to meet local needs, take into account social conditions, and improve the environment, without distorting energy markets.

Delegates to the Energy Charter's PEEREA Group, which brings together energy efficiency experts from our member countries, contributed to the shaping of this report with their comments and suggestions. The main author of the report was Mr Arto Nuorkivi, acting as a consultant to the Energy Charter Secretariat. Tudor Constantinescu from the Secretariat ensured the overall coordination of the work.

The study is made publicly available under my authority as Secretary General of the Energy Charter Secretariat.

Andre Mernier
Secretary General,
Brussels, March 2006

TABLE OF CONTENTS

EXECUTIVE SUMMARY

District heating (DH) and cogeneration of heat power (CHP) are well known technologies in the energy business and are often included in municipal policies as well. Some of the major benefits of DH and CHP are less known and the barriers faced by further development of DH and CHP are substantial. The main barriers are institutional. Municipalities can play a powerful role in facilitating local DH and CHP development in order to achieve the economic and environmental benefits of DH and CHP.

This report is produced to assist municipalities in promoting efficient and environmental beneficial DH and CHP.

The focus of the report is on the economies in transition, where the institutional barriers are acute. The report addresses the issues of organisational framework, price regulation and financing, energy demand, rehabilitation of DH systems and benchmarking of DH and CHP.

The municipality may influence the DH development by a number of means. The most important means, discussed in the various chapters of the report, are:

- City planning impacts on the heat load density. A high density is an important factor for the economics of DH and city planning may promote DH in areas with high density and individual heating modes in the areas with low density;
- Managing the building stock owned by the municipality to join the DH system and paying for the heating services;
- Setting strategic goals for the District Heating Enterprise (DHE), which they usually own, regarding the quality and the costs of heating. The DHE shall be given sufficient resources to work towards such goals;
- Providing guarantees for financing DH rehabilitation and development. The DHE may not have access to commercial credits without municipal guarantees; and,
- Supporting the DHE management by giving operational independence, supervising the management performance regularly and encouraging the co-operation with other DHEs and equipment manufacturers.

Examples provided in the report of municipalities' contributions to DH development are mainly taken from countries which recently passed through or still are in a transition process. A number of examples in countries with liberalised energy markets can be found in Municipalities and Energy Efficiency in a Liberalised System (www.energie-cites.org/meels).

1. INTRODUCTION

The Secretariat and the PEEREA Working Group have already initiated work on the barriers and opportunities for cogeneration and district heating (2002), in line with the requirement in PEEREA for Contracting Parties to develop initiatives for the "support and promotion of cogeneration and measures to increase the energy efficiency of the district heat production and distribution systems to buildings and industry". The Working Group discussed the main issues and challenges faced by the cogeneration/district heating sector in the context of market liberalisation and economic restructuring.

Following a panel discussion held in June 2004 the Secretariat has further developed work in this area by producing this report on best practices for CHP/DH with focus on the role of municipal authorities. This report aims at showing how CHP and DH can be used in the best manner to address local concerns regarding the quality and extent of heat supply as well as broader national concerns relating to security of supply and environmental impacts, including green house gas emissions.

From the municipal point of view, the main concerns are:

- Subsidising DH systems is a burden to the municipal budget; and,
- Dissatisfaction of the heat customers in regard to price and technical performance of the heating services risks leading to disconnections and increased financial problems of the DH systems.

The local DH/CHP industry expects from the municipality mainly:

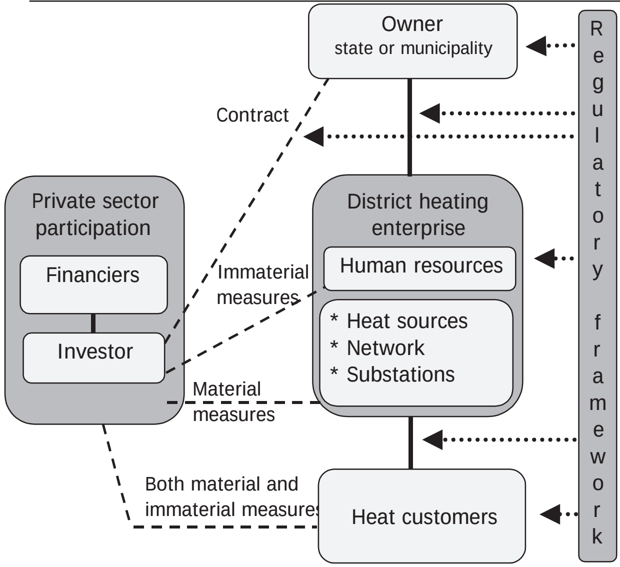
- Support to DH/CHP in city planning;
- Support to the elimination of price distortions not in line with the long term objectives of energy efficiency and environmental sustainability; and,
- Support to price increases when needed for reasons of system operation and development.

The report offers guidance to local authorities in choosing the most appropriate options. At the same time the report aims at supporting governments in initiating policies and local authorities in developing programs for consolidation of existing cogeneration and district heating systems, where sustainable, and to create a basis for an increased role of these systems.

As a rule of thumb district heating can be considered a possible viable option when the heat load density is higher than 0.5 MW/m length of the DH network. A detailed economic analysis, however, is needed to determine whether it is a least cost option. For a density higher than 3 MWh/m, DH can be considered justified.

Figure 1 below illustrates the important role of the municipality in the local DH industry in an economy in transition, where CHP usually is organised by publicly owned utilities. Private sector participation in DH system rehabilitation is important. There are a number of options for how to organise such participation but many institutional barriers as well.

Figure 1. A typical framework of DH and CHP in an economy in transition.



Large DH systems exist in the transition economies and in the northern non-transition economies. Out of the total residential and public heating market DH covers 70% in Russia and Lithuania, 68% in Latvia, 53% in Poland, 52% in Estonia, and 50% in Denmark and Finland. In EU and CEE countries DH supplies heat to more than 100 million people, thus covering a substantial share of the heating demand. Moreover, DH represents in some countries, particularly in Western Europe, important outlets for CHP plants. CHP represents 79% of DH supplies in Germany, and 75% both in Finland and Denmark. In the economies in transition the CHP share of DH supplies is generally much lower.

Usually, the DH systems in transition economies require substantial rehabilitation in order to become satisfactory for the customers and the environment. Pipelines and consumer substations need to be modernised on a large scale and heat metering to be introduced at the customer level, for instance. The local DHE, the district heating enterprise, is usually not in a position to provide sufficient guarantees in order to obtain outside finance for investments in these areas.

Both hard and soft measures are needed to improve the performance and economy of DH and CHP. Hard measures are investments in the consumer substations, the DH network and the heat sources, the CHP plant included, whereas the soft measures consist of training of staff, organising co-operation between the DHE and other DHEs, non-governmental organisations and manufacturers. The soft measures used for building the institutional capacity of the staff of a DHE comprise introducing modern management practices such as quality assurance (ISO 9002), environmental management (ISO 14000), preventive maintenance, financial planning and accounting, cost analysis of operations, economic analysis of investments, human resource management, and advanced billing and collection procedures.

The DHE has an important role in the education of heat customers to undertake energy conservation measures. The municipality should encourage, or even demand, that such information and education services are offered by the DHE.

2. Benefits of District Heating

In general, DH offers a number of benefits:

1) DH allows flexibility in the use of fuels, in this way contributing to the stability of the heat price. Local, often cheap fuels may otherwise remain unused or be used in a polluting and inefficient way;
2) DH using local fuels will create local jobs, thus providing social benefits in the municipality;
3) DH is the only sustainable way to make use of many waste heat sources for residential heating;
4) The centralised flue gas cleaning offers economics of scale;
5) DH benefits from economics of scale in the production of heat at the central plant. Unit costs of investments and operation and maintenance costs are often lower than with individual heat sources and the thermal efficiency is higher;
6) DH supply is reliable due to professional operation and continuous monitoring of heat production and distribution;
7) DH improves urban air quality while generating less pollution than some of the alternatives; and finally;
8) Combining DH and industrial heat load together with CHP offers a unique opportunity for producing electric power from fossil fuels at high efficiency. In CHP, the total efficiency ranges between 80% and 90% whereas it is between 30% and 50% in electricity only production. CHP also has a positive impact on the environment and electricity availability locally.

On the other hand, the comparable advantages of the main competitor - individual gas heating - are:

- No transmission losses;
- Lower network investments. Gas pipes are in PVC (Polyvinyl chloride) and are small and without thermal insulation. Therefore, the capital costs are lower and the economics of gas heating are less sensitive than DH to the heat density and city planning;
- Gas combustion efficiency is high and independent of the size of the combustion unit. Small boilers are relatively efficient; and,
- Gas heating has low environmental impacts, gas being a clean fuel. Natural gas combustion results in relatively low CO_2 emissions and has neither SO_2 nor dust emissions.

There are two main reasons for allowing DH and CHP to strengthen their position in the energy markets:

First, DH is a proven sustainable and least cost heating method in densely populated urban areas in northern countries. In transition economies, district heating is:

- already widespread, but needs substantial rehabilitation in order to become competitive in the market in terms of performance and price
- subject to competition of some fuels directly used at the client's premises, mainly subsidised natural gas.

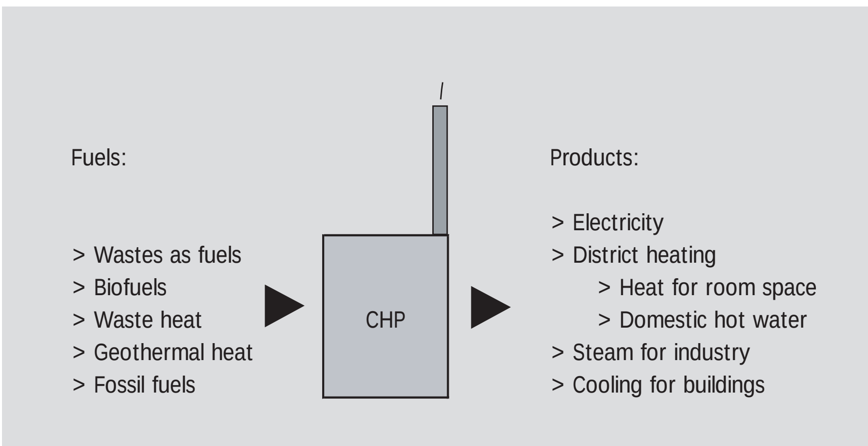
Second, CHP is a potential source for efficient production of electric power where the heat load from industrial or district heating allows it. CHP is the only way to generate electric power from the fossil fuels at an overall efficiency of 80% or higher. With CHP the total efficiency in fuel consumption is typically 30% higher than with its alternative separate production of power and heat.

Due to the local nature of district heating and CHP, the municipalities have a key role for the promotion of DH/CHP in co-operation with local industry and energy utilities.

In order to make CHP sustainable, the municipality could support the CHP development by guiding the customers located in the feasible area of CHP to join the DH network. The guidance may comprise measures such as:

- Requiring new buildings in the DH area to connect to the DH system;
- Connecting the public buildings located in the DH area to the DH system; and,
- Providing existing private buildings located in the DH area with financial support (loans, guarantees) for investments needed when joining the DH system.

Figure 2. Possible fuels and products of co-generated heat and power - CHP.



CHP is an integral approach to generate various energy products effectively from a variety of primary energy sources. CHP also offers an opportunity for centralised cooling of the nearby office buildings at high efficiency as illustrated in Figure 2 above.

3. Role of Municipalities - Organisational Framework

3.1. Municipal District Heating Enterprise

The municipality as a local governor, as large land property owner in the region, and in most cases as owner of the DHE, has a number of rights and responsibilities regarding the DH business:

1) Responsibilities of the municipalities are
   - To contribute to the strategic planning of the DHE and to ensure the operational and financial autonomy of the DHE management;
   - To prepare the town development taking the economic requirements of DH into account. A high heat load density is one of the basic requirements of cost-effective DH;
   - To prepare a heat plan for the town and, in various areas to give priority to different heating forms: DH, gas heating and electric heating;
   - To allow the DHE access to the municipality owned land and property when necessary for constructing and maintaining the DH system; and,
   - To allow expropriation of property needed for pipelines and heat-supply equipment as part of an approved heat supply plan. Compensation of expropriation shall be based on independent evaluation of the expropriated assets.

2) Guaranteed rights of the municipalities are:
   - To obtain a reasonable return on the equity invested by the municipality; and,
   - To expect DH services of sufficient quality as well as at competitive and affordable prices.

3.2. Limited Liability Company

In the municipal energy supply there is a general trend towards transforming the municipal energy enterprises to limited stock companies, which are fully responsible for their operations. The transformation clarifies the borders of the business, assigns rights and responsibilities to the DHE management and creates cost consciousness in the DHE management by giving incentives and vehicles for improving efficiency and performance.

In order to improve efficiency and performance, a DHE needs to be responsible for operation and maintenance, development, financial management including billing and collecting. The revenues collected from the customers shall be sufficient to cover not only the operation and maintenance costs but the system development costs as well.

The municipality as owner and one of the main stakeholders of the DHE shall set the strategic targets (cost effectiveness, environmental performance, social responsibility, for instance). The performance of the DHE to meet the targets shall be assessed regularly, twice a year for instance.

3.3. Municipal Utility Holding Company

The municipality may organise the basic municipal utilities under a holding company in order to gain benefits in governmental taxation, synergy in billing & collecting and field operations of network maintenance and expansion, centralised supervision of the municipal services and in strengthened co-operation between the utilities, for instance.

Example 1:

In Leipzig, Germany, the LVV (Leipziger Versorgungs- und Verkehrsgesellschaft mbH) operates as a management and a holding company since year 1997. The LVV is solely owned by the city of Leipzig. The shares of the utilities of electricity, gas and community heating (Stadtwerke Leipzig), drinking and waste water (Kommunale Wasserwerke Leipzig) and transportation (Leipziger Verkehrsbetriebe) are held by the LVV ownership. Based on the holding structure, integrated operation of electricity/gas/district heating is organized. The integrated control centre for electricity/gas/district heating/water takes care of the daily operation. In Leipzig, the city area has been divided in to gas heating and DH areas, coordinated by the city council (Contact: www.lvv.de).

Example 2:

In Krakow, Poland, the shares of the district heating enterprise MPEC have been owned by the municipal holding company, Krakowski Holding Komunalny S.A. since 1996. Two other utilities belonging to the holding company are public transportation services and water & sanitary services. Initially, the main purpose of such holding company was to reduce governmental taxes on company profits, but later on synergy benefits on a number of business areas have justified such a holding company operation. Inside the holding company, the utility specific losses and profits can be compensated and the net profit, if any achieved, will be the basis for governmental taxation (Contact: www.Krakow.pl).

3.4. Leasing DH Operations to Private Sector

A number of municipalities have leased their fixed assets of district heating and CHP to the private sector for a certain number of years.

In a leasing arrangement a private company will be responsible for running the business including, for example, investing in maintaining and developing the fixed assets as well as billing & collecting. The leasing contract will stipulate

- Rules for tariff calculation based on changes in major cost elements, which are mainly fuel prices;
- The value of the fixed assets and the depreciation rules;
- Information required from/to the energy company;
- Governing bodies, their tasks and responsibilities, representatives of each party.

At the end of the leasing period, the contract can be either renewed or discontinued. In case of discontinuation, the municipality shall pay for the increased value of the fixed assets to the investor.

The benefit of the leasing option, compared with selling the assets, is that the municipality remains the ultimate owner. At the end of the contract the municipality may either take the business back, appoint another company to run the business, or continue with a renewed contract with the former leaser.

District heating should be considered an asset, which has an increasing market value in the future, inter alia because it offers a unique opportunity for efficient CHP. The EU promotes construction of CHP capacity as a way both to reduce the dependence on energy imports, and to reduce air emissions, and greenhouse gases emissions in particular.

Example 3:

The French Dalkia has leased the district heating system and the CHP plant of Vilnius municipality for 15 years. Dalkia runs the business as if it was their own and pays an annual fee to the municipality. At the end of the contract period, the value of the assets will be determined. The municipality may need to pay Dalkia for the increased value of the assets (Contact: www.dalkia.lt).

The rights of the customer to receive heat at sufficient quality and at a reasonable price must be stipulated in the contract. The quality of heating services shall be defined by means of the three parameters as follows:

- Availability: how many hours a year available/unavailable for the customer?
- Supply temperature levels: what is the minimum supply temperature at the consumer substation received from the DH network as a function of the outdoor temperature?
- Pressure difference: what is the minimum (and maximum) pressure difference in the network connection available for the consumer substation?

Occasionally the parameters may deviate from the defined values. In such cases, the heat supplier and the customers shall have clear rules on how to address the problem. The contract shall stipulate:

- How to agree on the occurred deviation of quality;
- How to possibly compensate the deviation of quality to the customer.

The heat supplier may set contract rules to secure a sufficiently low return water temperature level at the consumer substation. The return temperature values shall be on a realistic level in order to avoid unjustified penalty fees.

The heat price adjustment shall be based on a formula, which gives incentives to the heat supplier and the customer to economic efficiency and environmental sustainability.

At the end of a leasing contract the evaluation of the fixed assets shall be made in a transparent and fair way. The depreciation of the fixed assets shall be defined taking into account:

- Expected lifetime of the existing and new assets for a variety of components, such as boilers, network, substation, automation and software;
- Replacement value of the assets per type above; and,
- Depreciation rules.

The contract shall entitle the municipality to receive reliable information about some key performance indicators on a regular basis, as for example quarterly:

- Heat sales;
- Customer basis (number and maximum demand);
- Thermal losses (% of production);
- Water losses (m^3);
- Electricity consumption;
- Number of staff;
- Availability of heating (hours a year);
- Flue gas emissions of dust, SO_2, NO_x and CO_2;
- Investments made in fixed assets (type, location, quantity and value);
- Value of the fixed assets.

The basis of the annual leasing fee payable to the municipality shall be clearly determined. The impact of inflation shall be stipulated.

Information on the heat supplier's profit may remain a business secret.

When designing the contract, the municipality shall in particular pay attention to:

- Defining the terms of establishing tariffs if the municipality is also the regulator on the local heat market;
- Establishing the value of the modernised fixed assets at the end of the leasing period: the technical lifetime of the fixed assets per category shall be determined (max. 30 years for pipelines, 20 years for heat production units and 20 years for consumer substations);
- Obtaining all technical documentation regarding the invested assets at the end of the contract period: technical specifications, drawings about location and layout, documents of commissioning testing, documents on the performance of equipment and its maintenance history;

- Defining the investments that the leasing company is bound to undertake during the contract period; and,
- The bookkeeping of the investments that should be transparent and available to the municipality. The leasing company should not be able to impute any costs to the investment account other than real investment costs.

3.5. Selling DH Operations

A number of municipalities have sold their energy supply assets to an energy company. The reasons for selling include the wish to get a professional company to run the business, but often the motivation is also to obtain cash for the municipal treasury.

In a contract for sale, there shall be stipulations about

- The rights defending the municipality in the possible role as a minority owner;
- Tariff policy if the municipality is also the regulator;
- Technical requirements and supervision of the quality of heating services; and,
- Social responsibility of the DHE comprising three components: economy, environment protection and social development, including employment.

Example 4:

In Poland, for instance, the Finnish Fortum owns 73 percent of the shares of the Polish district heating company Dolnoslaski Zaklad Termoenergetyczny S.A. (DZT). DZT produces and distributes district heating for the needs of 23 small and medium sized towns in south-western and central Poland. The net sales of the company are about € 20 million and the sales volume for heat about 500 GWh as well as for electricity about 25 GWh yearly (Contact: www.fortum.com).

3.6. Co-operation between Municipalities in Energy

A DHE may be operated geographically over a number of municipalities. A larger DH system benefits from economics of scale: larger heat production units with better feasibility of CHP, synergy in combined administration and operation and maintenance, but it is likely to have larger network losses.

Example 5:

Such a multi-municipal DHE operates in the Copenhagen capital area. Vestegnens Kraftvarmeselskab I/S, VEKS, is a transmission company supplying heat to 19 local district heating companies. VEKS was established in 1984 with the aim of utilizing surplus heat from CHP plants as well as from waste incineration plants and major industrial enterprises. Utilizing surplus heat under the VEKS system means reduces fuel consumption.

VEKS buys the main part of its heat energy from CTR, the Metropolitan Copenhagen Heating Transmission Company. In 1984 the municipalities of Frederiksberg, Gentofte, Gladsaxe, Copenhagen and Taarnby formed the CTR. The main objective for CTR is to utilize heat from waste incineration plants and CHP plants. The company is responsible for the purchase of heat from production units and for the transport of this heat through the transmission net for sale to its five owners and to VEKS - CTR's affiliated company to the west. CTR also operates back-up units and produces heat on its own account during peak load periods. (Contacts: www.veks.dk, www.ctr.dk).

3.7. Co-operation between Municipal Enterprises

Co-operation between small municipalities and between municipal enterprises will strengthen the possibilities to develop the business.

Some investment solutions may be similar in many of the cities. Often, a combined project is more cost efficient than several small ones. Attracting external capital will be easier for one combined and large project than for several small ones. Project management is simpler for a combined than for a number of small ones.

Example 6:

In Lithuania, for instance, 23 small district heating enterprises (members of the Lithuanian District Heating Association) have joined their efforts in an energy service company (JSC "Silumos ukio servisas"), which in 2001, further has established a joint venture company, NewHeat (JSC "Naujoji siluma") together with the Finnish Private Energy Market Fund.

The main goal of NewHeat is financing and implementation of renovation and development in the energy sector. Typical completed investments comprise new boilers and CHP with either natural gas or bio fuel replacing old coal and oil boilers. Also small hydropower plants are under consideration for the future. The period of the financial contract ranges from 4 to 5 years. NewHeat pays special attention to environmental projects, which reduce CO_2 emissions, save the primary energy sources and which are in compliance with EU directives.

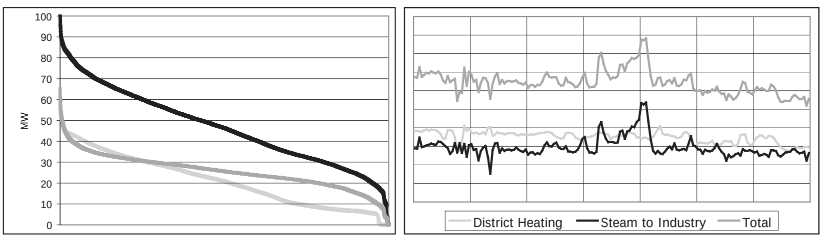
The turnover of NewHeat in 2003 was about € 3.2 million, 20 % higher than in 2002. NewHeat employs 12 regular staff (Contacts: www.newheat.lt, www.pemfund.com)

3.8. Co-operation with Local Industry

3.8.1. Opportunities

Combining local industrial and municipal heat loads offers an excellent opportunity to optimize the contribution from CHP resulting in economics of scale both in investments and in operation costs. Integration of local industrial and municipal heat loads with possible waste fuels to an efficient CHP process may provide substantial economic and environmental benefits for a region.

Figure 3. Yearly heat load duration curve and the heat load variation of a week.



Example 7:

In Figure 3 the examples of the heat load are from Kajaani (a town in northern Finland) demonstrating the combination of industrial and municipal (district heating) heat demand for joint CHP implementation. The annual heat load of the industry, the municipality and the total are presented both in the timely order (right) and in the in the descending load size order (left). (Contacts: www.upm-kymmene.com, www.kajaani.fi).

In this particular case the key benefits are as follows:

- Due to different peak load timing of industrial and municipal heat load, the total capacity of the combined CHP plant is 18% smaller than the two individual CHP plants would have been, which reduces investment costs;
- For the same reason, the peak load duration time of the combined CHP plant is 4 100 hours compared with 3 300 and 3 400 hours of the individual heat loads;
- Less staff is needed to operate and maintain one instead of two CHP plants;
- Flexibility in using available heat production capacity helps minimising the heat production costs of both the industry and the municipality.

The environmental requirements for a larger CHP unit are tighter than for smaller units. Therefore, a larger unit usually would be cleaner than two smaller ones together.

Industries with a significant heat load and having a potential for CHP, are, for instance:

- Pulp, paper and saw mills;
- Metallurgical processing;
- Dairy and other food industry;
- Glass and ceramic industry;
- Chemical industry; and
- Oil refining.

The industry may be the major fuel supplier for the joint plant utilising industrial waste products such as black liqueur, waste wood, industrial waste gases and oil residuals.

In order to implement and operate such a co-owned CHP plant, usually a separate CHP company will be established where both the municipality and the local industrial company(ies) are shareholders. In such a company, the fixed (capital and maintenance) costs can be divided amongst the shareholders according to their owner-shares, whereas the variable (energy) costs are divided according to used energy.

3.8.2. Challenges in Transition Economies

In many economies in transition the industry has collapsed or runs at low capacity. In many cases, both industrial and other (residential, public, commercial) heat consumers are connected to the same network. In some cases the residential and commercial customers have higher tariffs than the industry. Therefore, the local industry may be subsidised by other heat consumers. Such is the case in some locations in Serbia and Romania, for instance.

The high price of heat for the residential customers, connected with often poor quality of heating, may encourage customers having sufficient means for paying and investment to escape the DH system for more competitive heating forms. If the poorest customers will remain connected, the cash flow of the DHE, and thus the sustainability of DH/CHP, is even more threatened than before.

Therefore in the DH system, the heat tariff structure should be the same for all categories of heat customers, consisting of a two-part tariff with capacity and energy fee (see 4.3.3).

The costs of supplying steam to local industry and the hot water to other customers should be separated in the accounts of the DHE. The separation shall comprise all costs from capital, maintenance and operation to administration.

Example 8:

In Kragujevac, Serbia, the DHE plans to divide the accounts to an industrial and a public one in order to clarify the interface between the industrial and other sectors of heating. Such separate accounts are aimed at preventing cross-subsidies in the heating services.

3.9. Ownership of Fixed Assets

In order to efficiently operate and maintain the DH/CHP system, either ownership or control of the heating network should be in the hands of the DHE. The DHE should have full control and responsibility for optimising the use and development of the heating network. This is to have clear incentives for the DHE to target high efficiency and good quality in heating services.

Transferring the asset ownership to the DHE is one option, concluding a service contract is another one. Under a service contract, the DHE would become the "possessor" of the assets. The main difference between an "owner" and "possessor" is that a possessor does not have the right to sell the assets. But in all other aspects, he has basically the same rights as the owner.

The heat sources such as CHP plants may have other owners, but the contract between the DH operator and the heat source must be fair and accurate, taking into account a number of technical and economic relations between the CHP and district heating, as follows:

- The CHP plant sets the supply temperature, but the customer defines the water flow and the return temperature;
- The supply and return temperature set at the heat source have a linear impact on the heat losses of the heat transmission and distribution network;
- The supply and return water temperatures of the system usually have a direct impact on the power to heat ratio at the CHP plant. At low supply and return water temperatures of DH, relatively more electricity can be generated with CHP or the total plant efficiency is improved, the impact quantitatively depending on the type of the CHP plant;
- The cooling defined by the customers, as the difference between supply and return temperature, has a linear impact on the water flow needed;
- The water flow has a direct impact on the pumping need at the heat source and the size of the pipelines in the network;
- The pressure difference required by the consumer substations has a direct impact on the electricity consumption of the DH circulation pumps at the heat source; and,
- Not least, dividing the costs of the CHP to the products, heat and power, is an important instrument for promoting CHP.

The above listed issues shall be clearly stipulated in the contract in order to share the benefits (and responsibilities) of DH/CHP. In Finland, for instance, many local CHP plants and DH systems are owned and operated by the same energy company, which ensures total optimisation of the DH/CHP system operation and development, but in other owner constellations there are important contractual requirements.

The heat meter shall be owned by the DHE, because regular checking of the heat meters is necessary for reliable measuring. The heat supplier has the best possibilities to check the heat meter regularly in an appropriate manner.

Either the DHE or the customer may own the consumer substation:

- Substation owned by the heat supplier: The customer shall have access to the substation to change the temperature control parameters and to supervise the overall functionality of the substation.
- Substation owned by the customer: The substation shall be built according to the technical specification of the heat supplier in order to have the substation operation co-ordinated with the integral DH/CHP system. The heat supplier shall have access to the substation room to read the heat meter regularly.

3.10. Institutional Capacity Building

In the economies in transition, in particular, soft measures to improve the institutional capacity of the DHEs have appeared to be an efficient way to further improve the DH system performance at least costs. Municipalities should encourage such measures. Soft measures consist of information technology, training, co-operation as a least-cost tool to improve economy and performance. Examples of potential training areas are:

1) Technology and economy
   - Bio fuel boilers;
   - Small-scale CHP units;
   - Frequency controlled pumping;
   - Importance and requirements of water quality;
   - Conversion of a DH system from the current supply driven mode into a modern demand driven operation mode.

How and in which order the DH system operation should be converted from the current supply driven mode (with constant water flow) into modern demand driven (with variable flow) operation mode, shall be one of the key technical topics of training.

2) Institutional capacity building
   - Heat metering and tariffs as incentives for energy conservation;
   - Corporate restructuring as a tool for creating business type operation of the energy system;
   - Marketing and customer care as a tool to keep and extend the market share under competition;
   - Cost analysis of the DHE as a way to identify the reasons for cost leakage in the system, and to identify the ways to reduce such leakage;
   - Economic analysis as a tool to assess the feasibility of investment options, identifying the priority and sustainability of the various options;
   - Modern preventive maintenance practices as a least cost measure to both reduce maintenance costs and avoid damages;
   - Advanced billing and collecting as a way to improve the financial sustainability of the heating services;

- Corporate Social Responsibility Concept (CSRC) as a way to monitor and improve performance of the energy services in terms of economic, social and environmental sustainability;
- Modern quality assurance (ISO 9000) as a means to improve organisation performance of the energy services; and,
- Modern environmental management (ISO 14000) as a way to improve environmental responsibility and sustainability of the energy supplies.

The municipality should encourage the energy utility management to use such measures, because the payback time of soft measures is likely to be shorter than for any investment. Evidence about the high economic rating of the soft measures has been collected from a wide range of district heating rehabilitation cases all over Europe. The analysis shows that one quarter of the total economic benefits of the projects were caused by soft measures. The economic rate of return of a district heating rehabilitation project usually is well above 25%. On the other hand, only 5% of the total funds were used for soft measures and 95% for the investments. It is therefore clear that the economic rate of return of the soft measures has been huge: with 5% of the total funds available was obtained a quarter of the total benefits.

4. Role of Municipalities - Price Regulation and Financing

4.1. A Regulated Environment

District heating is a local business and has substantial impacts on the living conditions of the citizens and on local business activities. Therefore, decisions on price regulation and financing of operations should take local circumstances into account and should be made locally as well.

In general, the heat and electricity prices are regulated either by the national regulator, the city council or not regulated at all and left to the decisions of the DH/CHP companies.

In Eastern Europe, there are two basic approaches to price setting responsibilities for DH: a central regulatory agency is responsible or it is the municipality. The latter is less than ideal since it means that the municipality performs several functions - it is not only the owner of the DHE, but also the regulator. Necessary checks and balances are thus not present. In Latvia, for instance, there is an attempt to build up independent municipal regulatory agencies responsible for all local communal services. In Romania, a national agency has been set up that will be in charge of the regulation of communal services, including DH supply based on heat-only-boilers (HOBs). CHP tariffs are almost always regulated together with electricity tariffs by a national regulator (ESMAP 2003).

Basically, there should be a rather complete regulation or no regulation at all. The fuel prices and end user prices of energy are often distorted, which further distorts economic development of the energy system.

Regulation of DH and CHP could be considered a temporary measure. When price distortions have been phased out and the DH system has become competitive, price regulation could be gradually phased out. The transport and distribution activities may in most cases remain regulated activities, or at a minimum be subject to detailed provisions of the competition legislation in case of complaints from the customers. The competition on the production side is an efficient way for improving the system economy and reducing the heat prices in the long term.

4.2. Better Subsidy Targeting

From the municipality point of view, the key issue in the economies in transition usually is the problem of heating related subsidies, which often are the largest individual cost component of the municipal budget, thus a heavy burden. Funding of subsidies reduces funding possibilities of other municipal development needs such as education, infrastructure and health care.

Usually the subsidies are paid to the customers proportional to the heated floor area. Thus, the customers having large apartments benefit more than those with small apartments. The owners of large apartments are usually better off than the others. Therefore, such a subsidy system benefits mostly the rich.

The subsidy system has other disadvantages as well. Subsidisation together with missing heat metering and temperature control does neither give any incentive nor means for the heat customers to save energy. Therefore, the heat consumption of the buildings often is 2-3 times higher than it should be.

Example 9:

In Poland, 78% of the heating costs countrywide were covered by subsidies in 1991 and only the balance of 22% was paid by heat customers. During the following seven years the general subsidies for heating were phased out and replaced by municipal support programs for poor families. Subsidy phase-out was achieved faster in those cities with a comprehensive DH modernisation program.

The subsidies are a social rather than a heating issue. Therefore, the subsidies should be targeted to the poorest part of the population. Municipalities should therefore gather up-to-date information on the poorest segments in order to be able to identify those being in urgent need. The municipality, perhaps with support from the central government, should be in charge of administering and funding those targeted subsidies, not the DHE.

Heat assistance payments (or earmarked cash transfer). Those households that are eligible for targeted social assistance are also eligible for support to the payments for heat (and or other energy/utility payments). The subsidy thus is in harmony with and supplements the existing benefit system. This is the typical heat support program for low-income families in Western Europe and North America. Among others, Bulgaria and Romania have adopted this support measure; see Example 10 and 11 below.

Examples 10 & 11:

Heat Assistance Payments in Bulgaria and Romania was organised as follows:

Bulgaria.

Everyone eligible for social assistance is automatically eligible for assistance to paying their heating bills under the “Winter Supplement Program” (WSP), although the pool of people receiving heat assistance payments is bigger than the pool of people receiving social assistance payments. In 2001 the WSP, administered by the Ministry of Labour and Social Policy, spent 75 million BGL (about US$45 million), which represents about two percent of total social protection spending by the Government that year. However, the WSP, which used to provide vouchers to households but now makes payments directly to energy suppliers, is under-funded and thus covers only a fraction of the heating costs for typical low-income households.

Romania

Heat assistance payments (HAPs) are provided to low-income households to help pay for DH, natural gas or non-network fuels during the five months of the heating season. HAPs are in addition to any other social assistance benefits that low-income households may receive. The money is paid directly to the utilities, except for households using non-network fuels who receive cash. Although the Romanian HAP system is known as the 'coupons' system locally, it is not a voucher-based system as such. The 'coupon' is an administrative document that passes between the municipality and the Owners Association of a particular building to calculate the balance of the heat or gas bill that remains payable by each beneficiary household after the total HAP subsidy for the building (deduction from the heating or gas bill) has been taken into account. The 'coupon' has no cash value, though. This is significant as voucher-based systems that produce a form of 'secondary currency' are usually considered to be undesirable. The scheme has been running since winter 2000/2001. During the first year, households applied directly to the municipality for assistance, but the mechanism changed to incorporate the Owners Associations, who collect applications for the all the low-income consumers in the building and make a single application to the municipality. HAP policy is defined within the Ministry of Labour and Social Protection. Implementation is carried on entirely at the municipal level. The public apply to the municipalities, who look at income levels, decide if the applicant meets eligibility criteria, and pay.

4.3. Retail Heat Tariff

4.3.1. A Good Heat Tariff

A DHE shall become a self-financing unit in the long term. There are a couple of lessons learned that should be considered while designing the retail heat tariff and the steps of tariff system transition.

The heat tariff should be designed according to the six principles listed below:

1. Full cost coverage: The tariff should include all justified costs predicted for the near future and a reasonable profit. The tariff should be based on predicted rather than historical costs in order to be up-dated. The tariff should cover the capital costs based on depreciation of the fixed assets evaluated on a realistic level. Often the capital values are too low, which results in insufficient depreciation levels;
2. Cost structure reflective: The tariff components should be based on the real cost structure. The variable fee should cover variable costs, such as fuel and energy purchase costs and the fixed fee capital and staffing costs. One-component tariffs risk causing financial instability for the DHE, when customers start saving energy, as will be demonstrated in Table 1;
3. Competitiveness: the heat tariff should offer a competitive option for those customers which are economically attractive for district heating;

4. Incentive to cost reduction: For the DHE, there should be an incentive to reduce costs by competing against gas/oil heating, or by regulatory means;
5. Incentive to energy conservation: For the heat customer, there should be an incentive to reduce the required water pressure, supply and return water temperature and the water flow, which all add up to energy conservation. One way is to bind the fixed charge to the ordered water flow. Thus, when the customer is motivated to reduce the water flow, he is working for saving energy and increasing cooling of the return water; and,
6. Simplicity: The heat tariff should be easily understandable to the customers: Customers not familiar with the energy business and the technology should clearly read from the tariff and how he may influence the components of his heat bill.

Sometimes it is difficult to meet all the above criteria simultaneously and, therefore, priorities must be made in the tariff design.

4.3.2. Tariff based on Heat Metering

In the course of heating system modernisation and installation of heat meters at the customers, the heat tariff has to be converted from the floor area based (payment per m^2 of heated floor area) into an energy based tariff. The tariff conversion, however, should wait until sufficient and reliable data about the metered heat consumption (sales) is available. The municipality should support the heat metering program with information campaigns and other incentives.

Before the heat customers were equipped with heat meters on the building level, the heat transmission losses were estimated. These estimates were usually lower than the real. Due to the low loss estimates, the estimated heat sales were too high, which has been demonstrated when heat metering was introduced. If the tariff system is converted from a floor area based into a metered energy based without having the metering data analysed, the new tariff system risks incurring severe financial losses to the DHE (see Example 1). Therefore, the DHE is advised to keep the floor area based tariff until more than half of the customers are equipped with heat meters and analysed data is available about the real heat sales. The real data shall be used for designing the new two-tier tariff.

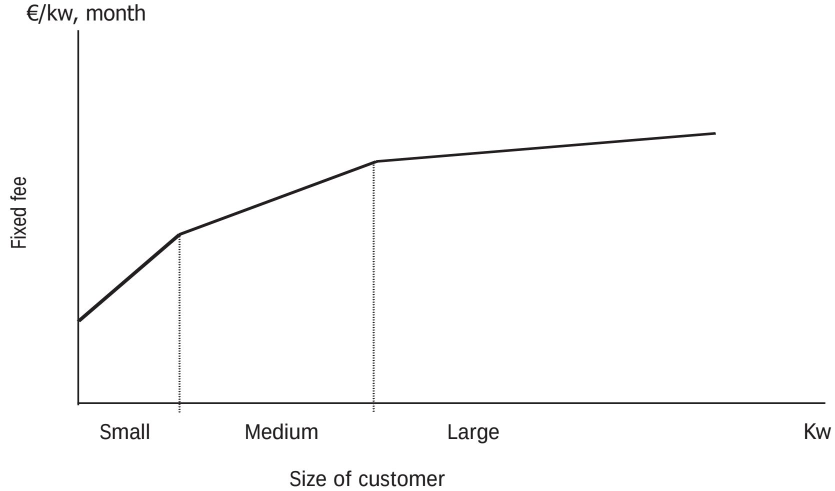
Example 12:

In a DH system, the heat supplied to the network by the boiler plant was measured as 100 GWh in year 2002. Out of this, the heat transmission losses were estimated at 5 GWh, giving the sales of 95 GWh. Based on the total costs of supply, €1.9 million, the heat price turned to be 20 €/MWh. A year later, all the customers were equipped with heat meters and the heat supply happened to be same 100 GWh again. The metered heat sales turned to be 85 GWh instead of the previous 95 GWh and the transmission losses 15 GWh instead of the estimated 5 GWh. With the same tariff, the company's revenues were €1.7 million, equal to €200,000 less than the year before. Therefore, the DHE should have been waiting until the metered data were analysed and available for tariff design in order to introduce the cost covering tariff of 22.4 €/MWh before the final tariff conversion

4.3.3. Two-tier Tariff

In almost all countries the heat tariffs based on heat metering consist of two components reflecting the costs structure of DH: (1) the fixed charge covering the costs of capital, permanent staff, a part of maintenance, and (2) the variable charge covering the costs of fuel, water, electricity and heat purchase, temporary staff and the remaining part of the maintenance costs. The two charges have to include a fair profit as well in order to enable the system operation and development in the long run.

Figure 4. Regressive fixed fee of district heating tariff.



The fixed charge could be regressive as indicated in Figure 4, as an incentive for large customers to connect to the DH system. Such large customers are usually more beneficial to the DHE, due to economies of scale, than a number of small ones with the same total ordered heating capacity.

Example 13:

A few towns in Poland used to consider selecting either a one-tier or a two-tier tariff. Thanks to well organized energy conservation campaigns and successful investments in modern DH technology, the heat customers have started to save energy. In Table 1 below, the billing of Holotna Street 18 customer, as an example, is demonstrated with two optional tariff systems, the one-tier and the two-tier tariff (in terms of PLN). Both tariff systems will yield the equal financial result for the DHE in year 2003. Two years later, when the customer has managed to save 10% of their heat consumption; the two-tier tariff gives a neutral financial result, whereas the one-tier tariff will yield serious financial losses to the DHE. To avoid the financial losses and keeping the one-tier tariff, the DHE is obliged to raise the tariff level in order to compensate the financial losses. In other words, the DHE has to punish the customer by means of a heat tariff increase, because the customer managed to be successful in energy conservation. The punishment for a well done work is inconsistent with the energy conservation message. Therefore, the two-tier tariff system should be introduced and applied to appropriately respond to the energy conservation measures of the customers.

Table 1. Financial impact of tariff structure related to energy conservation.

Energy Conservation : 10% a year **Case : Holotna Streat 18, Cieplo town, Poland**				
	2003	**2004**	**2005**	
Heat demand Forecast	4,115	3,704	3,333	GJ
Heat Tariff Options A. One-tier tariff Variable	24	24	24	PLN/GJ
B. Two-tier tariff Fixed variable	9.6 14.4	9.6 14.4	9.6 14.4	PLN/GJ equi PLN/GJ
Cash flow of DHE of Cieplo Town				
A. One-tier tariff Variable revenues Reduced variable costs Total cash reduced Net effect cash flow	98,760 98,760	88,884 5,926 94,810 -3,950	79,996 11,259 91,254 -7,506	PLN PLN PLN PLN
B. Two-tier tariff Fixed revenues Variable revenues Reduced variable costs Total cash flow Net effect cash flow	39,504 59,256 0 98,760	39,504 53,330 5,926 98,760 0	39,504 47,997 11,259 98,760 0	PLN PLN PLN PLN PLN

4.4. ALLOCATION OF COSTS OF COGENERATION

In cases where the municipality is an owner of the CHP plants it might have an influence on the allocation of the costs of cogeneration of heat and power - CHP - between the products, DH, industrial steam and electric power. But in many instances, municipalities do not own CHP, and therefore, CHP cost allocation and thereby bulk tariffs are determined by national power regulators.

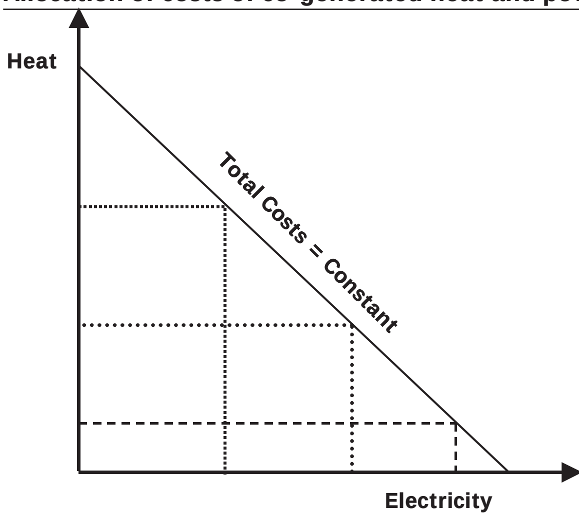
Allocation of the costs of a CHP plant has been an eternal subject for discussion, since several thermodynamic methods are available to make such an allocation. Apart from the thermodynamics, the idea is actually very simple. The cost allocation problem is analogous to any production unit, which generates two or more products from the same input, for instance, like an oil refinery which produces gasoline, oil for heating, heavy fuel oil, and asphalt for roads, etc. from the same process and all based on the same major resource: crude oil. The market defines the price of each product, not the specific differences in production costs.

Figure 5 illustrates possible cost allocation of heat and power in a CHP system. One should bear in mind that often CHP may not exist without the heat demand offered by the DH systems, and therefore the DH price should incorporate some of the benefits associated with CHP production.

There are several ways to allocate the costs of CHP plant between electric power and heat, as shown in the figure. Selection of the allocation method shall take into account the surrounding energy market as follows:

- A: Production of DH started with extracting steam from the existing condensing power plants at low incremental costs and such costing was used quite a long time to compete with gas heating (used to be in Denmark and Germany);
- B: District heating and power operate on a saturated market and the costs are allocated to power and heat in a market price based way (Finland and Sweden);
- C: Heat covers most of the costs of CHP, and electricity pricing is based on incremental costs (used to be in Poland, the Baltic countries and in Russia); and,
- D: Any method without regulation: when both the heat and power sectors are unbundled and competition works properly on both sides, no central regulation is needed but the market determines the allocation. Such allocation is currently used in some market economies on company level and the position of D in the straight line in Figure 5 is case specific and often considered a business secret.

Figure 5. **Allocation of costs of co-generated heat and power – CHP.**



In conclusion, the costs of heat must be always lower than the costs of the alternative for the DHE and the customers in order to ensure sustainable development of the local DH/CHP system.

4.5. ESCOs as Financing Mechanism

ESCO is an energy service company. Its business idea is to invest in energy conservation measures at the client premises. The client is expected to back the investment to ESCO based on the obtained savings in energy costs.

An ESCO owned and operated by a municipality – such as in Krakow, for instance – is justified only as a starter when no other ESCOs exist in the country. It is a much better solution for the customers (such as the municipality) to benefit from competition between different ESCOs in order to get the best deals.

There are a number of publications about ESCOs, for instance, the report on Third Party Financing, published by the Energy Charter Secretariat.

Example 14:

In Krakow, Poland, the municipality-owned district heating enterprise, MPEC Krakow, has established a special energy service company, ESCO, which is responsible for performance contracting on energy saving with municipality owned buildings in the region such as schools, hospitals, kindergartens and offices. The rationale behind the Krakow approach is:

- focus on municipal buildings, because the transaction costs (contracts, payments, reliability) with one large partner are simple and relatively few; and,
- focus on a few standard technical solutions such as boilers, modern substations and new windows, which will alleviate the risk related to guaranteed savings in performance contracting.

For the start-up of the ESCO business in Krakow, the World Bank assisted in organizing training and consulting services as well as approved a loan to cover the operation costs of the early years of ESCO.

Municipalities are clients to energy services by being responsible for maintaining various buildings, such as nursery schools or offices. In order to save energy, the municipality may transfer planning, financing, implementation and monitoring of its heating systems to an energy partner – the so-called contractor or ESCO (Contact: www.berliner-e-agentur.de).

4.6. Leasing

In many countries, leasing of energy technology equipment is an attractive way to finance energy system modernisation. Leasing does not bind the capital of the DHE and the municipality. Leasing is feasible for equipment and system elements, which are clearly defined such as boiler units, CHP units and consumer substations.

The municipality could assist the DHE with providing partial guarantees, which would enable the DHE enter leasing contracts. The main guarantee may be bound to the installed equipment.

4.7. Guarantees for Credit Financing

The municipality could assist the DHE to obtain financing of DH rehabilitation by providing the guarantees required by the financial institutions.

Example 15:

In Klaipeda, Lithuania, the DHE used commercial financing to rehabilitate the DH system. The municipality has provided guarantees to facilitate such financing.

In case of loan from the international financing institutions a variety of guarantees are required:

- A corporate guarantee submitted by the investing company is required by IFC, the private sector arm of the World Bank Group, and NEFCO, the Nordic Environmental Finance Corporation, a member of the Nordic Investment Bank, for instance.
- Municipal guarantee may be required by the EBRD, the European Bank for Reconstruction and Development.
- Sovereign guarantee, submitted by the national government, is always required by the World Bank and often also by foreign assistance institutions.

4.8. Joint Ventures

The DHE or the municipality may establish a joint venture company with a private company to produce equipment and systems needed in district heating. It should, however, be ensured that these types of joint ventures do not distract the DHE from its core business, which is to supply heat.

To secure their share of the equity of a joint venture municipalities and the DHEs usually offer land and buildings whereas the private partners offer technology and equipment. The equity should at least be in the order of 20% of the financing needs to be eligible for external credit financing from commercial and development sources.

In a joint venture, the business risk is on all partners in proportion to their equity shares. The sharing of the risks gives an incentive to the partners to support the joint venture business.

The municipality and the DHE should have a genuine and justified interest in long term development of such business before entering a joint venture. For example, the DHE may establish a joint venture company by

- Assembling substations by using the mechanical workshop and staff outsourced from the DHE to the joint venture company, or
- Manufacturing fuel pellets from the local coal, peat or bio fuel to be used by the DHE and other energy companies in the neighbourhood.

Example 16:

In early 90's the DHE of Warsaw, owned by the municipality, and a Finnish KWH-Pipe established a joint venture company, Finpol-Rohr, to start manufacturing modern pre-insulated pipes for DH. The contribution of the municipality (via DHE) was to appoint land and building for the factory and that of the KWH-Pipe to provide the factory with manufacturing technology. Export credit financing was used from Finland to finance the equipment.

4.9. Kyoto Flexible Mechanisms

A municipality may have an opportunity to use carbon trading and JI as a source of investment financing either on national or on international level. Internationally the Netherlands and Denmark have been amongst the most active in developing carbon trading. The procedures have been now developed and information is available at the national ministry of environment.

Example 17:

A DH plant of 8 MW using biomass as fuel was constructed in Paide, Estonia. The new plant replaced an old inefficient plant using shale oil and heavy fuel oil. The owner of the plant is Pogi OÜ, a small private company that used to be the public heating utility of the Paide municipality. The new plant was provided as a turn-key delivery from Wärtsilä Biopower Oy, Finland.

The new plant substitutes biomass for shale and fuel oil in heat production thus reducing CO_2 emissions by 135,000 tonnes over the crediting period 2003-2012. The project baseline was developed by Wärtsilä Biopower Oy and independently validated by KPMG Wideri Oy.

The Finnish Government bought 100,000 tonnes of the emission reductions through the Finnish CDM/JI Pilot Programme. Necessary agreements for the transfer of the emission reductions were signed between Pogi OÜ, the Finnish Government and the Estonian Government. The price paid was € 5.34 per tonne (€ 534,000 in total), out of which 50% was paid upfront.

The total investment cost of the project was approximately € 1.9 million. The upfront payment of € 267,000 provided by the Finnish Government was fundamental for securing a loan through a commercial leasing agreement. The IRR of the project increased from 11.6% to 15.1% as a result of the carbon finance (Contact: www.greenstream.net)

5. Energy Demand from the Municipal Perspective

5.1. Energy Demand

While a potential for energy efficiency improvements exists in all countries, in economies in transition, there are many reasons for downsizing the energy systems in municipalities:

- Residential energy use in existing buildings is typically 2-3 times higher than in modern buildings in market economies. Therefore, there is a huge potential for energy conservation, which however, will materialise slowly;
- Energy consumption of industry has dropped due to economic recession. With economic growth re-emerging it is unlikely that the energy consumption will reach the initial level, because new industry is more efficient than the old and less energy intensive; and,
- The energy systems should benefit from the integration of DH with CHP in order to meet the requirements of environmental sustainability and energy efficiency. Integration will reduce energy consumption.

Therefore, a systematic downsizing of DH equipment in course of energy system rehabilitation is often needed.

Steam distribution networks used to be typical in economies in transition. Steam networks have been phased out in many cities in Poland and Germany, for instance, wherever technically possible. The reason for phasing-out steam is the poor overall economics of steam supply. The customers have mainly converted to DH.

5.2. Availability of Fuels

Availability of fuels determines the type of the heat sources and has a substantial impact on the economic, financial and environmental performance of the DH and CHP.

Renewable energy sources still struggle with barriers against becoming generally used. The municipality have the possibility to support the use of renewable sources by offering incentives and by organising the stakeholders to develop them.

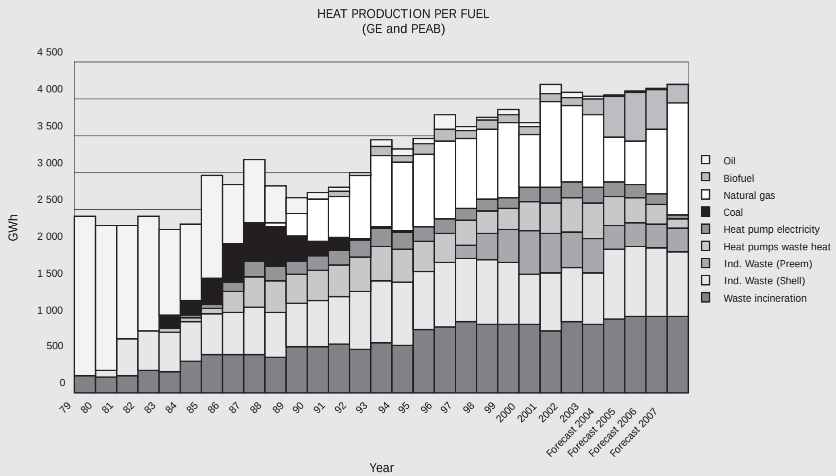
Before starting using a new fuel such as bio fuel for DH a binding contract with the fuel supplier(s) has to be agreed. Without such contract, the availability, quality and price of the new fuel may not be up to expectations, thus jeopardizing the financial viability of using the new fuel.

The municipality may have a role as supervisor of contracting between the fuel supplier and the DHE. The contract should fairly and clearly stipulate the rights and responsibilities of both parties and be consistent with the strategic plans of the municipality. The most important issues that need to be explicitly stipulated in the contract are:

- Specification of fuel quality by setting the minimum heating value and the maximum moisture, ash and sulphur content;
- Defining the price formula depending on labour costs, alternative fuel costs of DHE and taxes;
- Setting the minimum yearly volume and possible volume variations over the year; and;
- Setting financial sanctions if the performance deviates from the one agreed upon in the contract.

Example 18:

Gothenburg, Sweden, with population of 474 000 has decisively worked for replacing fossil fuel consumption with a variety of waste heat sources in the city in order to supply sustainable DH to the customers.



In 1979 oil accounted for about 90% of the fuel mix, but oil use has practically vanished (about 1% in year 2003). Simultaneously, the share of heat received from heat pumps and four industrial plants has increased to cover 69%, bio fuels 5% and natural gas 25% of the fuel mix of DH production in year 2003. This has had a substantial impact on air quality and energy efficiency in the region (Contact: www.goteborgenergi.se).

5.3. DEMAND SIDE MANAGEMENT (DSM) IN BUILDINGS

The municipality often owns a stock of various buildings, public and residential ones. Therefore, the municipality has a strong interest in managing the energy costs of the buildings. The municipality has such an interest for other buildings as well, because of the impact of heating comfort and low costs of heating on voter/ citizen satisfaction.

Information campaigns and financial incentives are useful tools for fostering DSM in buildings. Such measures can be organised together with the apartment owners, private sector companies (manufacturers of thermostatic valves and cost allocators) and international financing institutions (World Bank/GEF, EBRD, EU).

Example 19:

In late 90's the DH apartment owners were allowed to disconnect from the DH systems in Bulgaria. In this way, the heated customers had to pay for the heating costs of the non-heated customers, the free riders, as well. The Government of Bulgaria introduced a two-tier tariff structure. The government also received a loan from the World Bank to finance heat meters and controlling substations. Inhabitants of housing blocks became obliged to pay for the fixed charge regardless of them being connected to the DH system or not. Such a fixed charge was considered justified, because the DH system is available for them anytime they possibly wanted to reconnect. The municipalities organized a competitive bidding for the installations of thermostatic valves and cost allocators on the room radiators in the apartments. The joint approach of the government and the municipalities succeeded in reducing the DH disconnections and moreover, gave incentives and tools for the households to save heat. Because of these measures, the energy savings in buildings have been about 25% on average countrywide.

6. Rehabilitation and Modernisation Activities – Framework created by Municipalities

The support of the municipality is important in initiating and running the local DH reconstruction and rehabilitation process.

The DH equipment at the consumer end is often owned by the customers themselves. Sometimes a unanimous decision of the apartment owners is needed before the consumer substation can be modernised.

The municipality should encourage the apartment owners to establish housing co-operatives or housing associations, which would take care of maintaining the courtyards, staircases, building envelope and the common utilities of the particular building. Such housing associations offer an excellent interface between the DHE and the apartment owners.

Extensions of the DH system to new areas may be hampered by restrictions on accessing private property. The DH normally needs a formal permission from the landowner for the installation of underground pipelines on private property. The municipality's assistance may be needed to support such permissions in urgent cases.

For the DHE it is important to have access to the city plan, which should give reliable information about where the city is going to expand and when, and which kind of buildings to be constructed. Such information is essential for updating the heat plan of the municipality. The heat plan will give essential information to the DHE as a basis for decisions on expansion of DH services to new areas.

The DHE should take an independent decision about expanding into new areas, because at the end the DHE will be responsible for the financial viability of the heating business in the particular area. The decision of the DHE must be based on a careful analysis of the economic and environmental sustainability.

After a decision about a DH expansion, the municipality should request, if possible, the customers of the area to sign DH agreements immediately and collectively in order to secure the use of the expensive pipeline and substations when installed. Such a request may be inserted to the land leasing/selling contracts as a condition of contract validity.

The municipality could give incentives to owners of polluting small boilers to convert to DH. The incentives may include financial carrots to those who make fast decisions. Soft financing from the national environmental authorities and agencies can be sought for such measures.

When it comes to modernisation and rehabilitation of existing DH systems, the municipality should consider whether rehabilitation is an option, or whether parts of the existing system should be abandoned and replaced by gas boilers or other heating in buildings. In general, district heating has shown to be the least cost option on the urban areas with dense heat load. For an illustration of the options at hand, a clarification is provided below of the difference between old and modern DH systems and of the optimal rehabilitation approach.

6.1. Comparison of CHP/DH Systems

The three main reasons for CHP/DH system rehabilitation in the economies in transition are the needs to improve the energy efficiency, to reduce heating costs and to reduce emissions to the environment. The differences between the DH systems in the transition and market economies are reflected in the performance indicators given in Table 2 (Benchmarking). The differences are mainly rooted in different operation philosophies:

1. In transition economies, the DH systems were typically designed to be production driven. The heat production plant regulates the heat delivered to the customers. This results in an unbalance of the production and the real need of heating, because no or little customer metering information is available. In addition, the customer has no technical means to compensate the imbalance other than by ventilating excess heat through the windows or by adding personal clothing in periods of heat deficits.
2. In the market economies, the DH systems are demand driven. The consumer substation located in the basement of each building is equipped with a weather controller. The controller automatically adjusts the supply temperature of the space heating circuit according to the outdoor temperature taking into account the building's specific heating needs. Therefore, the substation takes only needed heat from the network. The heat production therefore has to follow the actual needs.

The above differences in the operation philosophy have implications in four areas:

1. Load dispatch
   (a) In the economies in transition the heat transmission networks are operated in a radial mode. In the radial system only one heat source is allowed to supply at the time. There is no load dispatch except at the heat source. The physical loops in the network are closed with valves and the customer obtains heat from one direction only: from the single heat source.
   (b) In the looped system typical for market economies, there can be a number of different heat sources operating in a united network in parallel, thus allowing the load dispatch to minimise costs. The customer may get heat from various directions, which improves the reliability and the economics.
2. Reserve capacity
   (a) In the radial system, typical for the economies in transition, the reserve capacity has to be located at the same site as the main (single) heat source and be sized at 50-100% of the real heat load. In case of network damages, the reserve capacity has in itself no value. In a city there are typically a number of separate radial systems, each requiring their own reserve capacity. Therefore, the construction and maintenance costs for the reserve capacity are relatively high.

(b) In the looped system the heat sources can be located all over the city being connected to the integrated network, thus supporting each other. Therefore, little excess reserve capacity, only about 10% of the real heat load, is needed and the locations are much less important for being able to cope with network damages. Therefore, the cost of reserve capacity is moderate in modern and looped networks.

3. Sizing of the heat network

   (a) Water flows in radial systems are relatively big, because cooling (difference between supply and return water temperatures) is low. The constant flow, the radial type network and the tube heat exchangers with poor cooling properties cause big water flows, requiring large pipelines, which significantly add to costs.

   (b) Water flows in modern systems are relatively small, because cooling is high and networks are looped. Therefore, pipelines have relatively small diameters, thus contributing to relatively low investments and operation costs.

4. Regulation of room temperature

   (a) In most of the buildings in the economies in transition, the space heating (SH) circuit is usually regulated by means of hydro-elevators (injectors), which mix the water received from the primary network with the water returning from the SH circuit in a constant ratio. The only way to adjust the temperature of the SH circuit is to change the set value of the supply temperature collectively at the heat source.

   (b) In modern DH systems, the weather controller connected to the DH substation makes a building level adjustment of the actual heat input.

Therefore, in order to change the operation design from a production to a demand driven type, substation rehabilitation is obviously the key element. Even then, the substation investments should be well co-ordinated with the possible investments in remote control systems, in order to obtain the expected benefits. Another issue is related to the choice of having large group substations versus small building level substations. In general, the building level substations have appeared to be more economic than the group substations.

Example 20:

In many DH rehabilitation cases the DHE has been eager to install a remote control system. The remote control system has been used to pass-by the control systems of the consumer substations, thus returning to the old production driven mode. In such a case, the remote control system was misused to destroy the new demand driven mode and the related benefits.

Differences in institutional, economic and technological conditions between the transition and market economies have lead to substantial difference in the DH systems as described below.

6.2. Benchmarking of CHP and DH

The indicative benchmarking in Table 2 below, which is based on various databases, gives an idea about the basic differences between small and large CHP/DH companies in transition and market economies.

Table 2. Indicative Benchmarking of CHP and DH.

Indicator	Small Population up to 100 000			Large Population more than 100 000			
	Transition Economy		Market Economy	Transition Economy		Market Economy	
	Before	After	Now	Before	After	Now	
DH with CHP							
Energy efficiency in total	47%	70%	80%	56%	69%	87%	%
CHP heat/Total heat production				71%	76%	>80%	
Heat production efficiency	89%	91%	85-92%	75-85%	80-88%	92-94%	%
Heat transmission efficiency	78%	85%	92%	82%	90%	95%	%
Heat distribution efficiency	68%	91%	99%	85%	91%	99%	%
Water economy	59	7	2	23	8	1	Times/year
Electricity to DH pumps/produced heat	2.0	1.0		4.4	4.1		kWh/MWh
Total heat produced/Number of staff	0.9	1.0		3.4	4.2	>10	Gwh/person
Wages out of total costs				7%	10%	10%	%
Ordered heat load density/network length	1.9	1.2		3.9	3.2		kW/m
Heat demand density per network length	3.4	2.4		7.1	6.4		MWh/m

Table 2 is based on selected DH cases in Poland and Latvia, representing the transition economies, and the countrywide DH statistics of Finland, representing the market economies. The Table indicates the potential for various types of savings to be obtained in the process of rehabilitation. Rehabilitation of a DH system in an economy in transition will change the system economics from the values "before" to values "after". The economic rate of return of completed rehabilitation projects with World Bank financing has been well above 25%, which is considered highly satisfactory.

6.3. Why Rehabilitate?

One may consider that rehabilitation of the existing DH system is not necessary and the system can be operated for long by repairing damages and keeping the system philosophy as it was when designed. This may well be the case if the customers do not have any choice but are obliged to stay with the old DH system.

In case alternative heating options are available, customers could be better off by converting to other options, such as gas heating, if this is allowed.

Table 3. Comparison of energy efficiency of DH in transition economies before (Old) and after (Modern) rehabilitation.

Energy Economy of DH	Old		Modern		Unit
Fuel energy		175		117	MWh
- combustion losses	15%	26	8%	9	MWh
- to network		149		108	MWh
- transmission losses	20%	30	7%	8	MWh
- to customers		119		100	MWh
- loss of poor regulation	16%	19	0%	0	MWh
A. Heat energy to customer		100		100	MWh
Costs					
- fuel price	20		20		euro/MWh
- fuel cost for heating		3,500		2,340	euro
- sales margin	10%	350	10%	234	euro
B. Customer's energy cost		3,850		2,574	euro
Unit cost for customer	B/A	38.5	B/A	25.7	euro/MWh

Table 3 demonstrates the difference between old and modern DH systems - before and after DH system rehabilitation. The efficiencies are indicative but rather typical. In both cases the task of the DH system is to deliver 100 units (MWh) of heat to the customers. The old system must use 50% more fuel (175 above) than the modern one (117) to meet the task. Therefore, the customer should pay almost 50% more for the heat than the customer in the modern system, provided that the fuel prices are the same.

In most transition economies the DH customers have become aware of alternative heating methods, and the heat market is often driven by the gas sector, which has attracted customers to disconnect and install individual gas heaters. Customers are also switching to electric heating.

The DHE has two options:

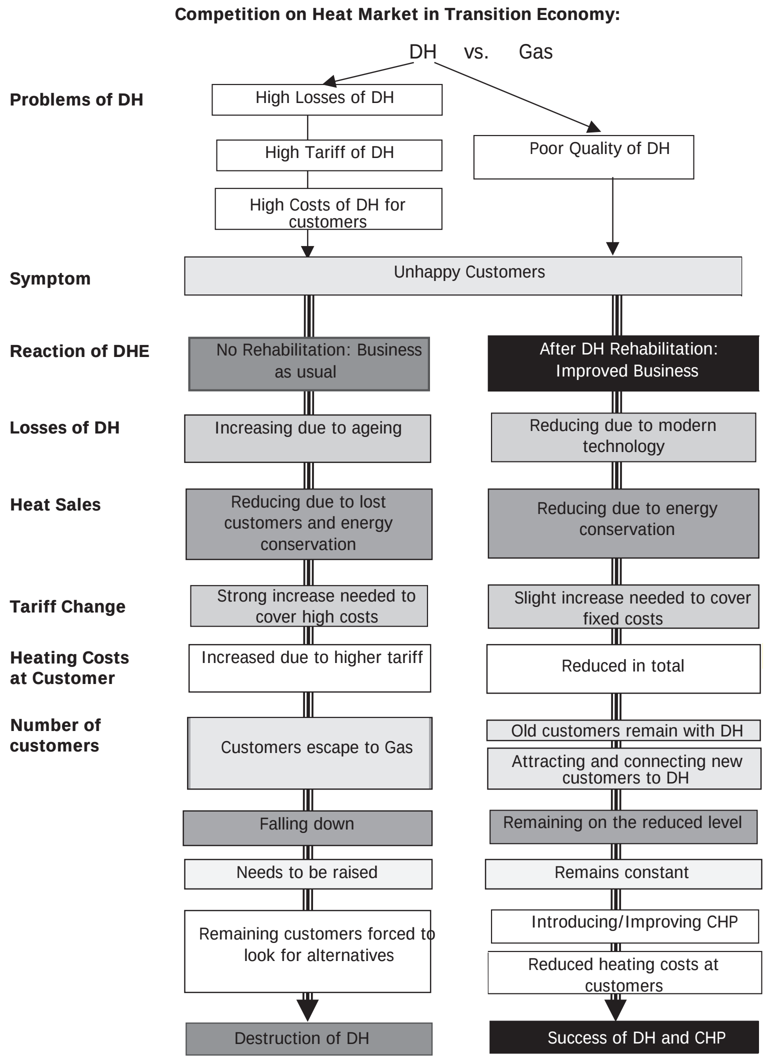
1) Business as usual, which will lead to reducing heat sales for two reasons: by losing customers to alternative heating systems and by facing energy conservation measures of the remaining customers. Ultimately business as usual may lead to destruction of the DH system, as illustrated in Figure 6, and therefore losing the possibilities for efficient CHP production forever; or,
2) To rehabilitate the DH system by modernising most of the consumer substations, a share of the network and adjusting the heat sources to variable water flow. This will also result in reducing the heat load and will contribute to keeping the customers in the DH system, because total costs are lower, the heating quality is higher, and customers will be invoiced according to meter readings. A modernised system could even attract new customers to join at incremental cost but at a high profit. In the modernised DH system, the customer has full control over the heat consumption. This has the benefit of improving the payment discipline. Additional benefits will be gained either by introducing new CHP capacity or by improving the existing. By combining an economic DH system with efficient CHP production, the DHE may end up as a nicely profitable and sound business, which is satisfactory to the customers and the owner, as illustrated in Example 23.

The municipality shall support the DHE in organising the rehabilitation program by providing strategic goals of DH development, organising information campaigns with DHE in local mass media, providing guarantees for financing, providing a city plan supporting sustainable development of heating in the region, and giving the right incentives to the DHE management.

Example 21:

Helsinki Energy, the profitable CHP/DH enterprise solely owned by Helsinki municipality with population of 500 000 and operating on open electricity and heat market, has been requested and been able to pay more than € 80 million, about 20% of the turnover, to the municipality budget every year in terms of various fees. This has been possible, because the highly integrated CHP/DH system operates efficiently at low costs.

Figure 6. Outline of the alternatives to rehabilitation of old DH systems.

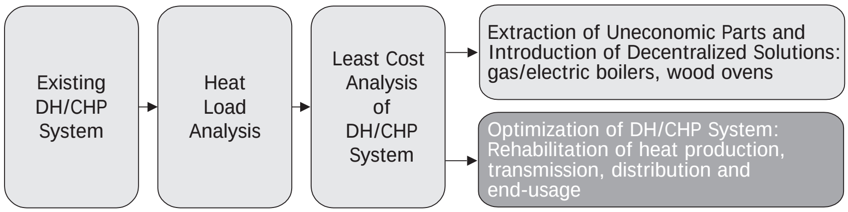


6.4. Rehabilitation Process

The process to rehabilitate the existing heating system can be divided into three phases as illustrated in Figure 7.

The heat load analysis is to review the current and the predicted heat load in order to accommodate the likely impact of the rehabilitation measures on the heat needs. A social study is usually needed to review the affordability and willingness to pay for the heating services, which may well have impact on designing, prioritising and quantifying the rehabilitation measures.

Figure 7. Process of heating system rehabilitation.



The purpose of the least cost analysis is to define the most competitive solutions for heating for the various parts of the town and various types of customers. Areas or customers that seem to be uneconomic for DH, compared to other sources of heat, shall be excluded from the DH system optimisation and planned for disconnection at a later stage.

The CHP/DH system optimisation will focus on the densely populated and industrialised core areas, where CHP/DH is the obvious least cost solution in the long run. The analyses and the optimisation are briefly discussed in the following chapters (Section 6.8.).

6.5. Heat Load Analysis

The local industry shall be reviewed and the following questions shall be addressed:

- The importance of the local industry for local employment?
- The likelihood of the industry to stay in business for example based on the experience with the structure of the similar industry in EU countries?
- What kind of new industry can be attracted to the site, based on the natural resources or the skills of the local labour force?

The demographic situation shall be reviewed:

- Birth rate of the latest five years and possible trends?
- Factors for attracting people into the town (clean air and water, urban entertainment offers,...) and reasons for inhabitants to move out of town over the next 10-20 years? How likely is it?

6.6. Least Cost Analysis

An analysis of the town heating parameters should identify the least cost solution for various types of customers and different areas of the town based on:

- Heat load density;
- Availability and costs of various fuels;
- Availability and price of (industrial) waste heat;

- Affordability for the inhabitants;
- Existence of DH networks and gas distribution networks;
- Environmental priorities; and,
- Feasibility of new CHP or extending the existing one.

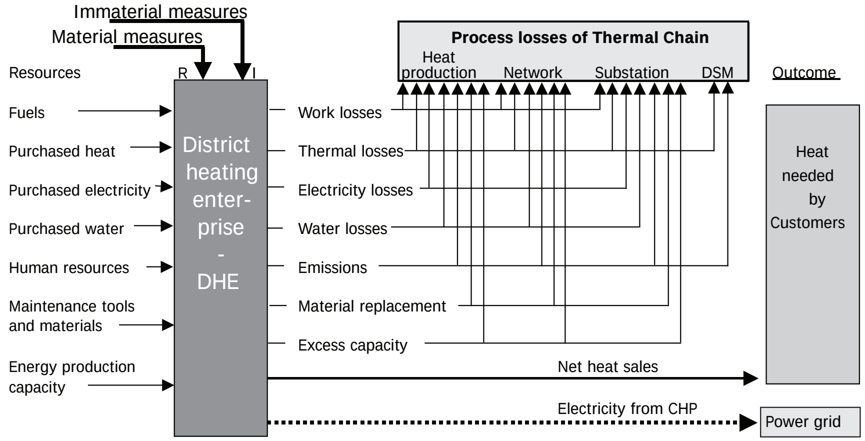
6.7. Economic and Financial Analyses

The differences between the economic and financial analyses of the rehabilitation project are:

The Economic Analysis of the project considers the results of the project for the community level: how much the particular community has invested in and how much was benefited from the DH rehabilitation project. Therefore, the prices and costs are expressed without taxes. The emission charges may be considerably high because the inclusion of the impacts on society (human health, material corrosion).

The Financial Analysis considers the project on the company level: how much the particular DHE has invested and how much it has benefited from the rehabilitation project. Therefore, the prices include taxes and the actual emission charges paid by the DHE.

Figure 8. Resource flows of a DH system.



In both the financial and the economic analyses, Figure 8 can be applied. A cash flow analysis is made for 10 to 20 years ahead for two cases: first the business "without" and second "with" the project. The difference in cash flows between the two will be composed of differences in resource components such as the costs of staff, in heat transmission and distribution losses, in electricity and water consumption, in combustion efficiency, and in emissions.

One may assume that the heat used by the customers remains constant during the years, because the DHE normally have no direct impact on the building envelope and the internal installations, except the consumer substation, which may be considered as part of the heat distribution system of the DHE.

The consumer substation is a little problematic from the economic and financial point of view. It is located in the customer's premises and often is owned by the customer. The heat meter is located between the substation and the heat transmission network. Therefore, energy savings caused by the substation modernisation will reduce the heat sales of the DHE and it is possibly not in the interest of the DHE to invest in substation modernisation and simultaneously to reduce heat sales. On the other hand, it is very difficult to get the customers to invest in substation modernisation due to their financial restrictions and the complicated decision making processes. The economic justification usually easily exists but for the financial profitability, there must be either a substation leasing arrangement or an operation & maintenance fee paid by the customer to the DHE.

The international financing institutions (IFIs) always require an additional financial analysis of the entire DHE and usually including the owner (municipality) in case the municipality and the DHE are strongly linked. Such a financial analysis of the company and its owner is needed to assess the borrower's creditworthiness.

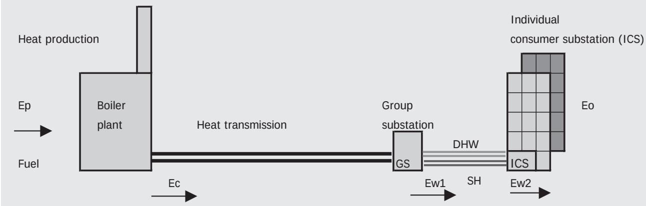
6.8. CHP/DH System Optimisation in a Rehabilitation Process

Rehabilitation of a production driven DH system offers a considerable potential of energy savings. In Figure 10 the energy balance of an imaginary DH system is presented before and after being completely rehabilitated.

Fortunately, a lot of good experience about the order and size of DH system rehabilitation measures is available. The experience shows that the optimal starting point is to divide the city into heating type specific areas. Those areas roughly having a heat load density higher than 0.5 MWh/km are potential for DH, the others for local heat sources. Construction of a DH system, if not existing yet, shall be started in areas with the highest density and located near the central heat source.

The rehabilitation case presented in Figure 9, demonstrates the energy efficiency improvement of a DH system located in a city with population ranging of 20,000 to 30,000. In such a case the potential savings in coal equivalent are about 22 tons a year.

Figure 9. Energy efficiency of a typical DH system in an economy in transition before and after comprehensive rehabilitation.



				Energy Efficiency of DH System Before	After	
0	Real heat demand	Eo	Real heat sales (based on meter readings if available)	1000	1000	TJ
1	Building control efficiency	Eo/Ew2	Modern substation reducing open window losses	83%	100%	
2	GS Efficiency	Ew2/Ew1	Elimination of GS and DHW Piping	96%	99%	
3	Network efficiency	Ew1/Ec	Preinsulated pipelines reducing transmission losses	85%	93%	
4	Production efficiency	Ec/Ep	Elimination of low-efficiency HOB's and adding control	85%	90%	
5	Total system efficiency	Eo/Ep		58%	83%	
6	Fuel consumption			1737	1207	TJ
7	Fuel Energy Savings				530	TJ
	In percentage				31%	
	Conversion to coal equivalent				24.0	GJ/ton
8	Fuel savings in natural gas equivalent				22.1	th. tons

Substantial water losses of a DH system indicate that something is badly wrong in the system. In the DH systems in the economies in transition there is often lack of metered data. Only the consumed make-up water and the produced heat energy are measured at the heat source. Little or nothing is measured in the network and at the customers. Therefore, there is no quantitative information about where the water vanishes in the system. Important water losses, however, result in poor quality of the network water. The water treatment capacity is not capable of treating the needed water volumes. Poor water quality is the main reason for internal corrosion of pipelines and heat exchangers in the DH system and blocking of tubes and control devices in buildings.

In general, rehabilitation of the existing DH system should proceed in the order as follows, even though the order should be checked with the case specific economic analysis:

1) Modernisation of all consumer substations by means of
   - A water temperature controller in the space heating circuit to adjust the supply water temperature according to the prevailing outdoor air temperature and the building specific properties;
   - A heat meter to record the heat consumption on building level for billing and collecting purposes; and,
   - A heat exchanger to separate the DH network hydraulically from the space heating circuit. The heat exchanger is an efficient way to eliminate the huge water losses, which is a problem for many reasons.
2) Installation of thermostatic valves and cost allocators to the radiators in apartments as a demand side measure - DSM. The DSM may be given to the private sector, since the apartments should be not taken care by the DHEs. Often apartments are owned by inhabitants. Therefore, the DHE may not have access to the apartments neither can be responsible for the radiator equipment that they do not control. The customer may feel that the DHE has a conflict

of interest in promoting DSM, and consequently losing heat sales. The DSM offers the customers both means and incentives for energy conservation and they should finance the DSM investments. A loan for as couple of years at low interest rate should be available for the customers to facilitate the financing. The municipality organise information dissemination campaigns about the DSM in local mass media, provide financial incentives to customers to adopt such measures.

3) Rehabilitation of the water treatment system will improve the quality of the reduced need of make-up water, thanks to heat exchangers installed to the substations. The improved water quality will extend the lifetime of the pipelines and the armatures, thus substantially reducing the need of repair and replacement of equipment in the future.

4) Frequency controlled pumps at the heat source may save up to 70% of the electricity consumption due to the joint effect of the pump controller and the temperature controllers at the consumer substations.

5) Installation of network sectioning valves, some of them remotely operated from the central control room. The sectioning valves are needed to isolate parts of the network for immediate repair in case of acute damages.

6) Elimination of coal fired small boilers. The customers of the eliminated boilers should be connected to the DH system, if located near the customers, or new gas boilers should be installed. The municipality should provide the boiler owners with incentives to small coal boiler elimination.

7) Installation of a flue gas temperature control system on some of the newest boilers. This increases the combustion efficiency and reduces emissions. The rehabilitated boilers will be used as base load units and the others as peak load units.

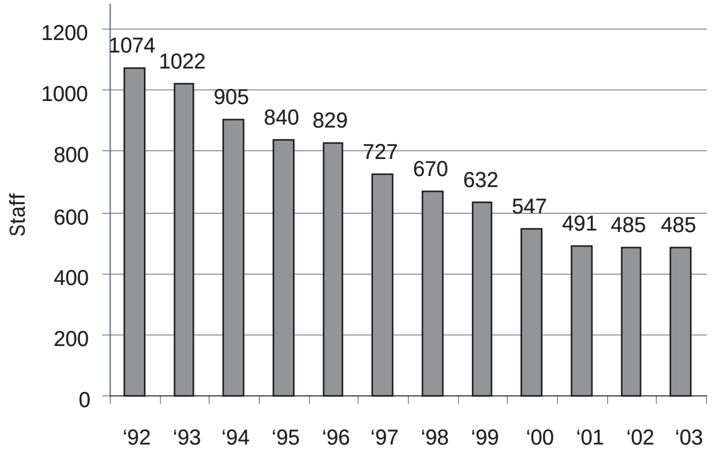
8) Re-insulation of aboveground pipelines with polyurethane foam elements and steel plates. They shall be installed in a way which prevents stealing the insulation and plates. The municipality should require that the new pipeline cover has a decent look.

9) Replacement of up to 10-15% of the underground pipelines by pre-insulated pipes in locations where external water is frequently found in network chambers.

10) Reduction of staff. Many DHEs have been successful in reducing the number of staff, taking advantage of modern equipment and systems (See Figure 10).

11) Last but not least, invest in capacity building of the CHP/DH staff in areas of marketing and public relations, environmental management, financial management, economic analysis, personnel assessment, quality assurance, preventive maintenance and modern technology. The experience of completed large DH rehabilitation projects shows that staff education in course of the project is essential for a successful project.

Figure 10: The DHE of Gdynia, Poland, reduced by 55% their staff from 1992 to 2003, while the number and capacity of heat customers increased.



Based on the rehabilitation measures listed above, substantial benefits can be obtained, as has been demonstrated by a number of comprehensive DH system rehabilitation projects in Poland and the Baltic countries.

7. Conclusions

DH and CHP offer an efficient and environmentally sustainable way of producing heat and electric power on urban areas, while integrating the energy supply and using low-grade energy sources in an environmentally acceptable manner.

There are a number of institutional barriers for sustainable development of DH and CHP in the municipalities. The local DHE has often difficulties in overcoming such barriers and private investors are still reluctant to enter DH/CHP projects. In economies in transition, the municipality shall support the DHE in organising the DH system rehabilitation program by means of providing strategic goals to the development of heating, providing a city plan supporting a sustainable development in the region, organising information campaigns with the DHE in local mass media, and providing guarantees for finance.

In order to alleviate barriers to CHP/DH, the municipality has a key role, because:

- City planning impacts on the heat load density. A high density is an important factor for the economics of DH;
- City planning may allocate some city areas with high density to DH and the others with lower density to other heating modes;
- Connecting the building stock owned by the municipality to the DH system with the obligation to pay for the heat;
- Setting strategic goals for the DHE, that they usually own, regarding the quality and the part of the costs of heating, which are controlled by the DHE;
- Guarantees for financing of DH rehabilitation and development are usually needed. The DHE may not have access to commercial credits on its own; and,
- Supporting the DHE management by giving operational independence, supervising the management performance regularly and encouraging to co-operation with other DHEs, manufacturers and other stakeholders is an effective way to improve the managerial capacity.

LITERATURE

Evans, M.: Coming in from the Cold: District Heating Policy in Transition, IEA - International Energy Agency, 2004 (Contact: www.iea.org).

DHCAN:

- The Case for District Heating: 1000 Cities Can't be Wrong
- District Heating System Institutional Guide
- District Heating Management Guide,
- District heating System Management Guide
- District Heating System Rehabilitation and Modernisation Guide

(Contact: www.euroheat.org/workgroup4/).

Gochenour, C.: District Energy Trends, Issues, and Opportunities, World Bank technical paper no 293, March 2001.

Gochenour, C.: Regulation of heat and Electricity Produced in Combined heat and Power Plants, World Bank working paper no 27201. Washington, DC; Oct. 2003.

Meyer, A.: International Experience in Heat Pricing and Billing: Issues in Design and Implementation and Lessons Learned, draft Report for ESMAP – Energy Sector Management Assistance Program of the World Bank, September 2003 (Contact: www.esmap.org).

Nuorkivi, A.: Institutional Handbook for Combined Heat and Power Production with District Heating, Baltic Sea Region Energy Co-operation – BASREC, 2002 (Contact: www.cbss.st/basrec/documents/enereff/).

Third Party Financing - Achieving its Potential, Energy Charter Treaty, Protocol On Energy Efficiency and Related Environmental Aspects – PEEREA, 2003 (Contact: www.encharter.org).

Werner S. at al: Promotion and Recognition of DHC and CHP Benefits in Greenhouse Gas Policy and Trading Programs. IEA District heating and Cooling Programme (Contact: www.iea-dhc.org).

GLOSSARY

CDM	Clean Development Mechanisms
CHP	Combined heat and power, also known as cogeneration
CO2	Carbon Dioxide
DH	District Heating
DHE	District Heating Enterprise
DSM	Demand-side management
EBRD	European Bank for Reconstruction and Development
ESMAP	Energy Sector Management Assistance Programme (established by the World Bank and the United Nations)
ESCO	Energy Service Company
EU	European Union
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GWh	Gigawatt hour
HAPs	Heat assistance payments
HOB	Heat only boiler
IEA	International Energy Agency
IFIs	International Financial Institutions
IRR	Internal Rate of Return
JI	Joint Implementation
km	Kilometre
kWh	Kilowatt hour
m2	Square meter
MW	Megawatt
MWh	Megawatt hour
PEEREA	Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects
SH	Space heating

Energy Charter Secretariat
Boulevard de la Woluwe, 56 • B-1200 Brussels • Belgium
ISBN 90-5948-038-4
Dépôt légal D/2005/7850/5
2005

ENERGY CHARTER SECRETARIAT
2005

ENERGY CHARTER SECRETARIAT
Boulevard de la Woluwe, 56
B-1200 Brussels, Belgium

Tel: +32 2 775 98 00
Fax: +32 2 775 98 01
E-mail: info@encharter.org

www.encharter.org

ISBN 90-5948-038-4
D/2005/7850/5
9 789059 480384