DRAFT REPORT

Austrian and European experience of district heating plants and its management

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1 Introduction

1.1 District heating

District heating is a centre piece of the energy sector in most European countries, and it is an important tool in reaching diversification of energy supplies. District heating is a very convenient heating form concentrated to satisfy the heat requirements on local heat markets.

Thus, district heating offers benefits for the individual costumer as well as for the society at large.

The district heating technology has developed continuously in Europe since the early 1960s. The basic conditions have changed several times during this period. First, it was the price difference between heavy fuel oil and kerosene used for individual heating, which made the district heating system cost effective. After the energy crisis the fuel changed to gas and residual waste and was used in large scale combined heat and power production facilities, and lately the emphasis has been on reduction of CO2 emissions favouring e.g. gas-fired combined cycle plants and biomass combustion. Thus, the technology has shown a flexibility which is not matched by other heat supply systems.

The total heat demand in the European Union and EFTA countries represent 5,425 TWh with Germany having the largest national share and representing a little bit less than one forth of the total EU and EFTA heat demand. District heating supplies 9.7 % or 530 TWh of the total heat and use. The final end use of net electricity and heat is dominated by electricity and gas supply, each accounting for 33 %. There are more than 5,000 district heating systems existing today in large, medium and small cities of Europe (Russia and Ukraine are not included), which supply heat mainly to the residential sector. In Russia and Ukraine the district heating production is four times higher than in all European countries.

This Report is intended to promote small/medium scale district heating systems. Although this is not a detailed manual for implementation of district heating, it is the intention to contribute to the understanding of the present situation in Europe and to serve as the basis for the development of a medium/long term vision for this sector in Mongolia.

1.1.1 District Heating in Austria

DH has grown in average by 5.3% annually since the early 1990s in Austria. In the Austrian energy industry, DH is one of the fastest growing sectors, and thus is responsible for a significant contribution to local and national economic growth. Especially in rural areas, where business development was stagnating. For example, the market penetration of the small biomass district heating system in Austria revitalised many of the participating communities. New means of income were created for farmers, biomass logistics, fuel supply, maintenance and operation of the plant – all contributed to local economic growth in the long run. In addition, this movement has revitalised the Austrian boiler production. Today, Austrias' biomass boiler manufacturers belong to the top in the world with a high export share (see 3).

In Austria, almost 58% of the fuel used for district heating, is gas.

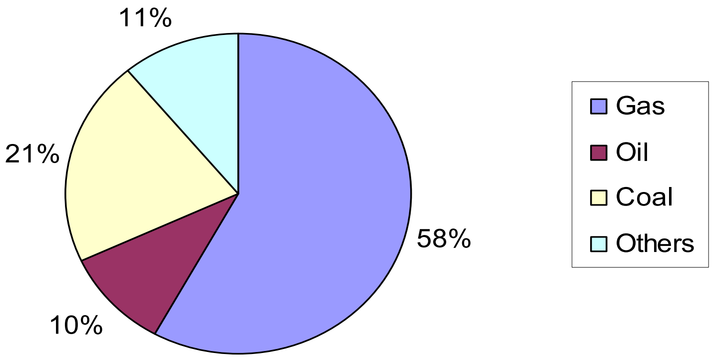


Figure 1: Fuel supply sources for DH in 2005 (Public supply only; in percent); Source: Euroheat & Power (2007).

Environmental legislation and subsidies have led to a rapidly increasing share of natural gas and fuels such as biomass and combustible household waste being used to generate district heat.

In 2002 the Austrian Parliament adopted the Austrian Green Electricity Act (Ökostromgesetz), which implements a feed-in tariff system for renewable energy and makes it mandatory to purchase 'green' electricity. The Austrian Green Electricity Act of 2002 was amended in 2006, and the CHP support system was also modified.The most important modification was that minimum efficiency standards have to be met to qualify for subsidies for existing or new CHP plants. These standards are even stricter than the requirements of the EU's CHP Directive (2004/8/EC). A new subsidy scheme with investment aids was introduced for new CHP plants where industrial, as well as utility, CHP plants are supported if they are fulfilling a set of requirements. Under the feed-in tariff system, CHP plants using biomass to produce heat and electricity qualify for 'green' electricity support payments.

Table 1: Overview of support mechanisms in Austria; Source: Euroheat & Power (2007)

Measures for CHP	Measure for RES/District Heating	Type of measures
The feed-in tariffs are linked to CHP electricity a support scheme for existing fossil CHP plants (apart from subsidies for renewables)	Subsidy for biomass DH CHP - Investments are subsidised depending on heat supplied with 15% to 30%. Subsidy on industrial buildings - 30% subsidy on investments for DH systems when heat is 100% produced out of renewables, or 15% when the heat is produced by fossil fuels	Feed in tariff for CHP Investment grand funded as a percentage of investment costs for DH and RES in DH

44 % of the DH is used in the residential sector in Austria today. Services and other sectors cover approximately 43 % of DH, followed by the industry with approximately 13 %. In Austria 5 % of the final energy consumption is supplied by DH.

1.1.2 Image of DH in Austria

According the a study (Fachverband Gas Wärme, 2007), a survey on the image and understanding of DH as heat supply option made in 2004 and 2006 had the following key results:

- District heat has a very good image in all target groups (private households, major customers, property developer, opinion leaders). Top ratings were given for convenience and reliability. Compared to other heating systems, district heating is ahead (together with biomass) particularly with regard to trendiness, security of supply, and environmental pollution control.
- The only disadvantage of district heat is its lack of individual controllability of the heating periods. It is mostly the energy suppliers who are made responsible for this drawback.
- The cost aspect polarizes: the costs of district heat are perceived both as a disadvantage and an advantage (even if less often). Compared to other heating systems, however, district heat receives rather favourable marks for its costs.
- Most of the respondents expect a further rise of district heat's market share in the near future.

For private households DH clearly represents a higher quality heating system. The positive image is also due to the many information events targeted for the DH-sector in Austria (see 2.1.1 and 5.6).

2 Summary of typical management strategies and ownership relations

2.1 Management strategies

The processes in liberalisation and privatisation in the last two decades, created new challenges for the management of district heating companies. Before the 1990s, district heating systems, especially those in Central and Eastern European Countries (CEEC), operated in a protected sphere with all advantages of a monopoly.

The majority of district heating systems have been part of state structures incorporated into municipalities or the state energy sector. Therefore many of the district heating systems have not even been independent companies.

Most of management-decisions were driven by politics. In the past, management was more or less based on the principles of an administration. Managers usually just followed the decisions of the relevant ministry or municipal council. Operational aspects have been seen as the most important issues for the management strategy; i.e. production and selling of Megawatt hours characterised the main tasks of the management. There was little experience with service aspects and consumer orientated strategies.

The internal organisation of district heating systems was hierarchic, and transparency in decision making, delegation of duties and responsibilities, clear accountability of responsibilities, coaching of staff members have been practised only to a small extent.

Through the process of privatisation a variety of different ownership forms developed, with different challenges for the management. Still a lot of officially privatised companies, especially those with a majority public share have preserved their former character and are still in a process of internal reforms, with a significant influence of public administrators.

For an internal management strategy the following table exemplifies four important responsibilities of a manager:

Table 2: Four key themes for internal management strategies

Clienting	The relationship with the consumer (customer) as an essential criterion for achieving economic targets. This principle is also applicable as internal strategy vis-à-vis the staff members. The clienting paradigm is thus systematically incorporated in the business strategy (staff member as consumer of the business).
Coaching	Coaching/Supervision of the staff members, in order to perform their duties and responsibilities
Leadership	Visions, short-, medium-, long term strategies
Operational Business	Essentially the technical aspects, it is about the control of the business, technical parameters, etc.

Especially in Central Eastern Europe, as well as one to two decades ago in the EU 15, the operational aspects (procurement, production, supply, etc.) were seen as the most important issues for a manager. Today however, the relationship to the end-user (as a real person) and the staff members has become more and more important.

2.1.1 Customer orientated business approach

One of the most important management principles is a costumer orientated business approach. Many district heating companies in Central Eastern Europe had, and still have, severe problems, because their customers change to other heat sources. These companies had and have to manage a lot of fundamental changes and reforms, but the most important challenge is a customer oriented strategy. Often customers have a wrong view on the heating sector in their country due to a none existing information/communication policy of the district heating companies. For instance, district heating is often misleadingly considered as one of the most expensive heating systems.

Therefor the ultimate principle is a customer orientated business management approach. In a nutshell, without a customer there is also no district heating. This translates into the following recommendations:

Customer's benefits come before process quality.

The business volume as benchmark for the success is not enough, and thus the following questions should not remain unanswered:

- Does the business even have a customer orientated approach?
- How high is the consumer satisfaction exactly?
- Does a organisation geared towards the consumer exist?

The same is also imperative for a growth orientated relationship within a business. As long as the consumer orientated approach is not lived in the business, it will be difficult to implement this approach. This usually results in a significant restructuring of the business philosophy.

The management level of the business must be able to adopt its view point of the business, literally to view its own business from the standpoint of the consumer. This results in the following paramount themes:

- Description of the service portfolio from the viewpoint of the consumer
- Security of supply
- Contractual matters
- Fair pricing
- Collectability, sales figures, revenues
- Accounting – composition of the bill, mode of accounting
- Confidence in the business, confidence building measueres

Instead of just producing and delivering heat and electricity, a consumer relationship is built. Once again, consumer and staff member satisfaction is more important than profit, since once this is established, the latter will follow from this. There are numerous reasons for that.

- Satisfied customers have a much higher collectability rate than unsatisfied customers.
- Satisfied customers share their content with their immediate community, which is a very powerful and convincing advertisment for the heat suppliers (snowball effect).
- Through the positive image it is easier for the suppliers to expand their business; i.e. to connect further customers.

Fair pricing and transparency of the billing system is also an important success factor. For example, the implementation of the consumption based billing in CEEC resulted in that many households got reconnected to the DH supply, some of which have been disconneted for months or even years prior to that. Consumption based billing is a consumer orientated measure, since the household can control and adapt its consumption accordingly.

The change from generation- to demand driven mode should produce not only improved heat supply efficiency and reliability, but should also ensure a better relationship with the customers. In particular, additional services may include:

- Technical personal advisory service to customers including proper operation of internal building installations;
- Better Demand Side Management resulting in smaller heat losses, rationalisation of heat use;
- Services connected with heat supply cost allocation in multi-flat buildings and individual settlements (usually this brings not only additional income for the DH Company, but also a better collection rate)
- Services connected with the operation of substations owned by customers and equipment inside buildings: availability of highly qualified technical personnel of the DH Company

2.1.2 Confidence building measures – Best Practice Example

Confindence building measures such as:

- transparency – informing customers
- canvassing for opinions
- price stability for consumers
- improving customer relations
- simplifying bills

will be discussed with an example of the successful project “Towards a modern customer – driven district heating system in Debrecen”. Debrecen with 205,000 citizens is the second largest town in Hungary after Budapest, situated 240 km east of the capital Budapest and 50 km from the Romanian border. Debrecen District Heating is an example of a very successful transformation from an inefficient centrally regulated scheme, very typical throughout

CEECs, to a modern efficient and environmentally friendly system. The district heating system has been kept in municipal ownership. The crucial element in this success story was the close cooperation between the district heating company and the municipality Debrecen.

Some basic data of the District Heating Company Debrecen

Number of residential customers: 31,000

Number of commercial and public customers: 2,300

District heated area: 4,709,355 m^2

Public customers: 2,631,330 m^2

Distribution network: 75 km

Average heat losses: 10 – 12 %

The secondary system was originally a single pipe system – in such a system thermostatic valves can hardly be installed.

Since 1997 the district heating company focused on a constant improvement of services for the customers´ needs. The public opinion of the customers was tested every two years. Between 1997 and 2002 the number of fully satisfied customers doubled. The services did not comprise only technical measures as the elimination of breakdowns, but comprised also information on possibilities for energy saving.

The information initiatives included different measures, such as meetings, leaflets, an energy advice centre, training and after sales activity like monitoring energy consumption of buildings. These analyses have been used for follow up improvements.

The leaflets are tailored to a variety of different target customers informing about improvements and future plans. The leaflets informed in detail: how every Hungarian Forint income was used by the district heating company, about easy energy saving measures like how to handle a thermostatic valve, how rooms can be ventilated efficiently and examples of successful efficiency projects in buildings of the region.

Training of volunteers as well as special trainings for the representatives of the customers communities. Volunteers have been trained to help their neighbours in realizing energy efficiency measures. The volunteers work was coordinated by the municipality.

Energy savings campaigns were held with customers.

The Energy Efficiency Advice Centre which operated between 1997 and 2002 was a very successful initiative. The office was situated in the city centre and was operated by the four biggest supply companies for water, electricity, gas and district heating. In the successor organization, the Client Service Office, clients can come and discuss any problems with heating and district heating. In 2000, 20,000 visitors received advice in the Client centre. This number tripled up to nearly 60,000 in 2002.

A Client Call Centre has been installed also, so that customers can get information over the telephone.

A very useful, important but not so widespread measure are simplified bills. It is very important that customers can understand their bills at the first glance. The bill is a crucial element in the relation to the customer and a main instrument to improve confidence between the district heating company and their client. But this is also an advantage for the district heating company as simplified bills result in fewer questions and less pressure on the Clients Service Office.

2.1.3 Heat cost allocation – a basic means for transparency in district heating

One of the most important reforms towards costumer orientation, was and is the implementation of consumption based billing or heat cost allocation. This is not only an incentive to save energy, consumption based billing is the prerequisite for transparency. Through this system the customers get real information on their costs of heating. However, the implementation of heat cost allocation alone is not sufficient. This initiative has to be combined with a well prepared information campaign for the customers. The implementation of a substantial reform without accompanying information measures could cause severe problems (see 4.2).

Heat cost allocation normally results in savings of 20 to 30 % of the former consumption. During the period of the implementation of heat cost allocation in Bulgaria, the state subsidies on heat energy have been reduced at the same time. As a consequence the reduction of subsidies compensated the savings and many people blamed the new billing system for higher costs. It was not understood that costs for heating would have been even higher without heat cost allocation. Hence, the implementation of this new billing system was accompanied by profound misunderstandings and problems.

For that reason, and at the risk of repetition; a thorough and well prepared information campaign is an important prerequisite for any reform.

Moreover, the following technical and organisational requirements are necessary for heat cost allocation:

- Every building supplied by the district heating company should be supplied with a general heat meter at the entrance. Based on the total consumption indicated by this heat meter, the consumed heat energy is allocated among the individual flats. Every radiator is equipped with a heat cost allocator and a thermostatic valve.
- The individual consumption based billing should be obligatory regulated by the law.
- All parties involved have to be informed about consequences and principles of this kind of billing.

The possibility of influence and control of the heat consumption is a main aspect of heat cost allocation. Sometimes shuting on and off of the radiators has little, or nearly no, effect on the heat consumption. If most of the heat is released by the pipes of the distribution system, a regulation of the radiators has little effect. In this special case heat cost allocation loses its meaning.

Usually the tariff is split into a fixed and a consumption based part. The respective rate between these two parts lies between 10 and 50 %. A low fixed tariff near 10 % is more stimulating for energy saving.

A central heating system has heat losses, even if no one is heating. These stand by losses are caused by circulation through pipes and heating sections or poorly isolated boilers. An apartment consumes heat through the distribution system in the house and through the walls from neighbours. This so called “heat theft” is an additional heat consumption, which causes costs. Because of insufficient laws and regulations especially in CEECs, households easily switch to another heating system, such as individual gas or electricity systems and consume additional heat through the distribution pipes, which are passing through their flats actually supplying their neighbours. However, this heat is paid by those flats still connected to district heating. There are quite a lot of cases, where households which switched to using gas or electricity, pay much less than their neighbours still supplied by district heating. It is only a question of time until the situation gets unstable and large numbers of households switch to gas and electricity. By introducing a fixed tariff, it is possible to compensate for part of this disproportion. For that reason only part of the heating costs are billed based on the consumption. These fixed costs have to be paid, even when an apartment is not heated.

With respect to the character of heat cost allocation, the method for the calculation of the heating costs should be easy and comprehensible. A scientifically correct formula is not necessary since heat cost allocation stimulates the energy saving behaviour of the consumer – transparency and easy understanding is a major principle.

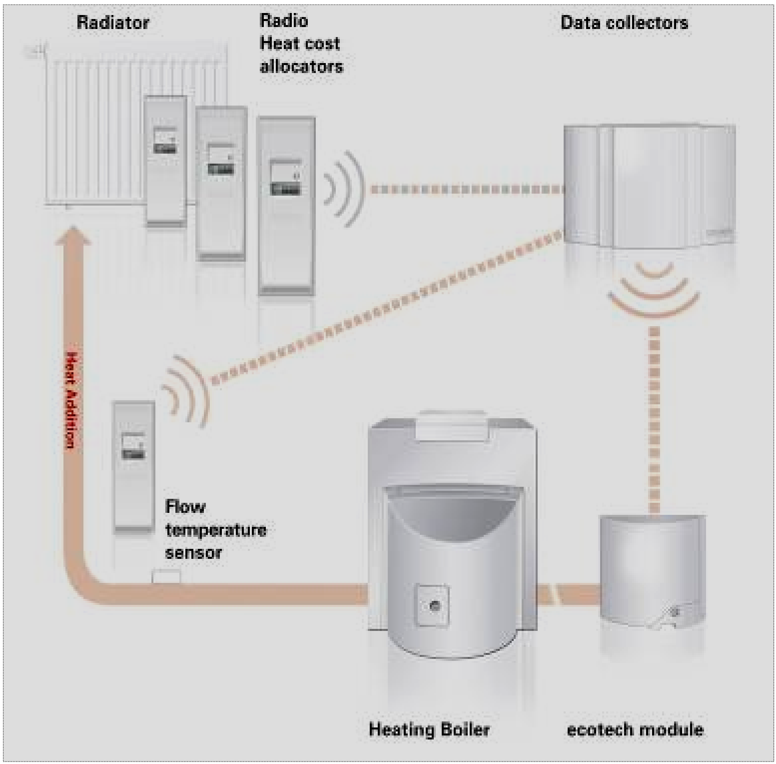
A modern district heating company has to offer the following advantages:

- Additional energy service to the customer
- Contribution to saving energy
- Contribution to reducing CO2 emissions
- Trust of clients
- Satisfied clients are more eager to pay

Advantages for households:

- Accurate cost allocation with, or without reduction factors
- Reduction of heating costs
- No entering of apartments due to Radio Frequency Technology
- Explaining of bills in the customer centers of heat cost allocation companies

The following scheme gives an impression of the most modern technology for heat cost allocation. It is not any more necessary to enter a flat for metering. By means of a radio receiver all necessary data are collected within seconds. The old evaporators are not used any more.



- Heat Cost Allocation with active Energy saving functionality
- Self-learning system with artificial intelligence adjusts the heat supply to the exact need of the building
- Additional energy savings between 6 to 10 %
- Smooth system installation
- The consequent alternative to expensive redevelopment

Figure 2: Scheme of distance data collection; Source: Angerer, TECHEM (2007)

The following figure demonstrates the comparatively good economic effect of heat cost allocation.

Multi-storey house, Neighbourhood Jidenice Brno				
	Total costs in EUR	**Savings %**	**Energy consumption in GJ**	**Savings as per GJ in EUR**
Energy cosumtion previous			1.986	
Heat energy previous			1.436	
Hot water previous			550	
Heat shield at building	92,500	52%	689	**124**
Hydraulik balancing Allocators TRVs individual billing	4,500	20%	552	**33**
Joint sealing	1,900	10%	496	**35**
			550	
Billing hot water	1,300	58%	231	**4**

Figure 3: Experience in Central Eastern Europe - economic effects of energy saving measures in apartment houses

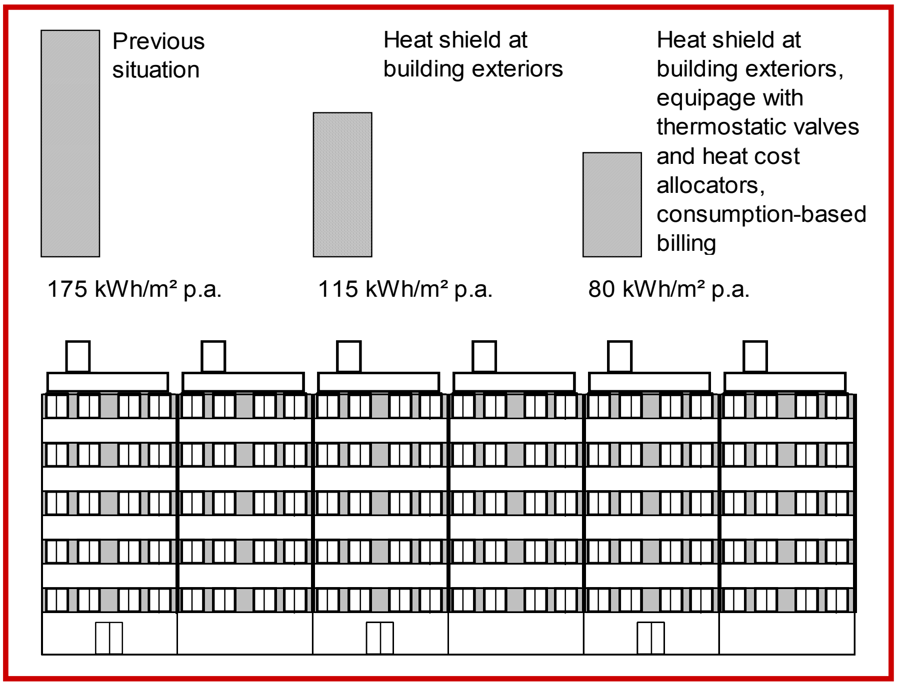


Figure 4: Experience in Central Eastern Europe, multi-storey house in the neighbourhood Jidenice in Brno Czech Republic – economic effects of energy efficiency measures in appartment houses

2.1.4 Tariffs and Prices for Heat Energy

The most important orientation for energy prices and tariffs is the market. In the case of heat energy an analyses of the costs for one MWh of all available and common heating systems is the most esstential and most important information.

Additionally, other aspects also have to be taking into acccount:

- Technical availability: a simple iron stove for solid fuels does not produce easily available heat throughout the heating season, since its operation is rather exhausting.
- Comfort: individual stoves for solid fuels are much more time consuming and need extra space for the storage of fhe fuel.
- Ecological aspects: under the circumstances that only coal is easily available in a geographical area, individual stoves will cause a lot of dirty emissions, whereas a centralized solution such as a district heating system works much more ecologically.
- Efficiency: district heating systems have the possibility to use waste heat, which otherwise has to be cooled by water or air.
- Political reasons: a municipality promotes gasification or district heating because of economical, ecological and other reasons.

This short composition underlines the fact that tariff and price aspects are not one-dimensional.

Therefore, there are a number of strategies for the access and methods for the price formation. Certainly an analyses of heat prices of existing heating systems is the most important basis. In Europe, district heating has its biggest rival in gasification. Thus, if the costs for district heating are considerably higher than heating costs with gas boilers, an investment in a district heating system will be rather problematic.

District heating tariffs are usually controlled by the national regulation authority or by a municipality running a district heating plant. Politics can act rather restrictive, as it was practiced in Central Eastern Europe until some years ago. At that time the tariff for heat was fixed to a certain level – limited by the responsible state authority. Without much consideration of the specific situation of a district heating company, the prices for the customers have been the same everywhere and usually did not cover the real costs. The difference between the real price and the fixed tariff was covered by public subsidies.

In Vienna for example, the tariff is determined to a certain extent by the municipal council. Therefore, the tariff is influenced by political decision making. If a municipality like Vienna for instance, operates a network for gas supply to households and at the same time runs a district heating system, an adjustment and coordination regarding the costs for heating between these two possibilities is necessary. Otherwise, this could potentially cause problems - if for instance, households using gas for heating would have to pay much more compared to those households supplied by district heating. Thus, the municipal policies can potentially be an important factor, if an official strategy to promote district heating exists.

A private investor, a contracting company is usually entirely orientated by economical criteria. The tariff simply has to cover all costs and a certain margin of profit is desired. The heat supply with all its aspects has to satisfy the costumers needs, in order to guarantee a satisfactory development of the business in the long run.

In regard to biomass district heating systems or other smaller district heating systems, a price margin (calculated on full costs) before tax of between 15 and 20 % is commonly practized.

2.2 Analyses of Ownership Models

The main ownership options are:

- Public
  - State owned
  - Municipally/regionally owned
  - Other public structures
- Public Private Partnership
  - Public ownership, private operation
  - Mixed public-private ownership and operation
- Public majority
- Private majority
- Private (consumer, biomass fuel co-operatives,…)
  - generation
  - generation and distribution

Until the last decade of the 20th century the district heating sector was typically in public ownership – either state owned as in the case of CEECs, or owned by municipalities or regional governments as in the case of Western European countries. Therefor even in countries with market economies public ownership prevailed. Often district heating was incorporated into universal municipal service provisions or municipal multi utility services. Thus district heating was mostly not a legal person but part of the municipality.

In Central and Eastern Europe district heating was integrated into state owned national electricity utilities.

Therefor district heating structures were not clearly defined from a financial point of view. A separate accountancy or balance usually did not exist. Cross subsidies, transferred from one municipal sector to another one, was normal practice. Hence, in general transparency in costs could hardly be found in the energy sector.

Since the 1990s important changes in DH ownership happened both in the EU and in CEEC. These changes have been driven by a general tendency towards privatisation, the energy liberalisation and competition in trading with power and natural gas (EU directives 96/92, 98/30, 2003/54, 2003/55) and the transformation from centrally planned to market economies in CEEC.

Large electricity and gas consumers like district heating companies in most European countries have access to the competitive market. Since July 2007, all costumers in the EU 15 member states including households, have free choice of their gas and electricity suppliers. The introduction of competition in the gas and electricity markets leads to economic pressure on district heating companies, especially as these companies are also often producers of electricity. Liberalisation decreased prices significantly, therefor district heating had to react to this development especially in the field of prices and marketing. Again, the position of the consumer has to be appreciated and district heating policy has to become more orientated towards their consumers and services.

These changes in the spectrum of ownership structures resulted in a more flexible and less political driven decision making process in district heating, a enhanced entry of private investors, higher pressure on return on investment, potential for economy of scale – mergers and a concentration also in the energy sector through international and multi-utility integration.

One new trend is prevailing: Public to private or public/private ownerships. Furthermore, in the future a mix of all different ownership schemes and not only one single model will exist. Public control in district heating is not dominant anymore. Still, district heating networks are mainly owned by municipalities or by the state, and occasionally by housing cooperatives and private companies.

Large DH networks supplied from large heat sources are usually operated as separate enterprises, whereas smaller DH networks are mainly operated together with the heat source. Very small DH entities are often subordinated to communal authorities as budgetary units. There are more and more privatised DH companies (mainly limited companies, sometimes joint stock companies) fully or partly owned by foreign or domestic owners. The buildings internal heating equipments and usually also the substations are owned by the building owners.

Usually large combined heat and power (CHP) plants and sometimes large heat only boiler plants are operated as separate enterprises, owned by the State or privatised as joint stock companies fully or partly owned by foreign or domestic owners or co-owners. There are also industrial heat sources which are owned and operated partly as the factory's property. These separate heat producers sell heat to district heating networks operated by DH companies. Sometimes these DH companies also operate their own heat sources (usually local heat only plants and boilers in individual buildings).

The following figure presents a national trend in DH ownership. The diagram reflects ownership shares of sold heat, as many systems are co-owned by a municipality and a private company.

This development demonstrates the European experience since the early 1990s.

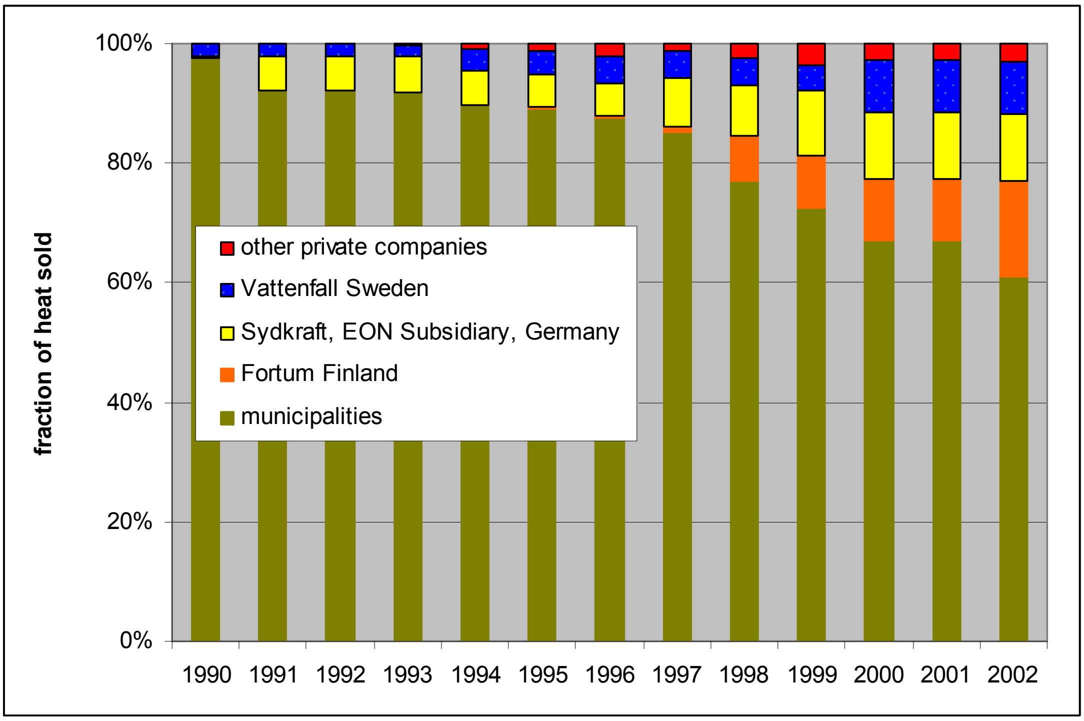


Figure 5: Ownership of Swedish district heating systems, 1990 – 2002 Source: Sven Werner, FVB

There are a number of different forms of private participation in this former public sector. Private participation means ownership through privatisation and participation in procuring public services on a contractual basis. Because of the lack of financial capital in CEEC, many district heating systems have been sold partly or completely to private (foreign or national) investors, mainly Western European public owned utilities, which is a very common variant of public ownership in this region of Europe.

Facing a variety of different ownership structures, there are a few aspects, which have to be considered:

What are the main aims of a district heating company?

- To produce and deliver heat energy as efficiently as possible.
- Clients, who are satisfied with the services.
- Ecological and clean operation of the district heating company.

Ownership structures should facilitate and aim to reach these goals. The structures have to be as flexible as possible, should allow to adopt business driven decisions quickly, and quick reactions to new challenges should be easy to handle.

Existing ownership structures are often the result of historical developments, conflicts of different interests and political ambitions.

Four major models for district heating ownership can be identified:

- public ownership by the state or municipality,
- private ownership,
- mixed private and public ownership,
- community owned cooperatives.

In the following section various ownership models will be described.

2.2.1 Privatisation

There are various forms of privatisation possible. Sometimes only parts of the heat generation or the heat network are privatised, and at other times a whole district heating system is sold to a foreign company. It is very common in Europe that district heating systems are divided into two separate entities. The municipality is operating the distribution grid and supplies the customers and a utility - an operator of power plants produces and sells heat to the district heating company. This split of activities results from the nature of district heating and its possibility and advantage to utilise waste heat from power plants.

A full 100 % privatisation generally means, that the public administration loses its control on the utility – apart from the impact of laws and regulations, regulating different issues like formation of prices and tariffs through the state energy regulating body, by determination of preferential regions for gas or district heat suppliers; e.g. environmental issues.

Sometimes only the operation and management of a district heating company is outsourced to a private company. The public partner stays owner of the assets. This form can have a certain disadvantage, if the main decision maker, the private company has no financial means to investment in order to improve efficiency. One can expect that DH plant operators manage their boiler station as efficient as possible in order to optimise their profits, which in turn should also ensure a fair price for costumers. Basically, an efficient operation is an incentive in order to optimise the profit. If the external management gets a fixed remuneration for the operation of the plant, and thus does not profit from efficiency measures, than this business construction may face difficulties. Contracting could serve as a possible solution; the contractor is owner of its own investements and profits directly from an efficient operation (see also

Private participation has a variety of different aspects. From the consumers point of view a public private partnership or privatisation should result in a more reliable, efficient and ecological operation and decision making processes should not be stalled by complicated structures.

The following advantages could be expected from a private partner:

- supply of risk capital,
- possibility for capital intensive projects,
- know how transfer,
- efficient administration and management,
- facilitation of necessary structural reforms,
- more efficient and economic operation.

In many countries and municipalities, both in Western and Central European countries, aspects of privatisation are discussed very actively. The decision to keep a district heating company in public – mostly municipal ownership, could strengthen the relation between the municipality and the district heating company and activate necessary reforms in the public administration.

It is very important to have a well developed and effective tuning between the cogeneration plants and the district heating system regarding the balance of heat and electricity production. CHP can provide a secure and highly efficient method of generating electricity and heat at the point of use. Due to the utilisation of heat from electricity generation and the avoidance of transmission losses, since electricity is generated on site, CHP can achieve a 35 per cent reduction in primary energy usage compared to conventional power stations and heat only boilers. This can allow the CHP operator to make economic savings, in case there is a suitable balance between the heat and power loads on his site.

Regarding the ownership's of heat production and distribution there are various forms practised in Europe. The heat production could be mainly state owned and the distribution under municipal control such as in Romania. In Copenhagen the heat distribution is partly owned by the municipality and by 24 other companies. Thus, even mixed structures are feasible.

It is difficult to make one sweeping statement of which situation is more efficient, private or public owned and operated district heating systems, there is just no general answer. A vast variety of operation and ownership models are conceivable – the quality of heat supply service, efficiency and other important aspects like ecology, all depend on a large number of factors. Standard solutions are not existing. Practical experience with private district heating has been in existance for a too limited time period in order to make general recommendations. The individual situation has to be thoroughly analysed in order to identify possibilities for improvements by rational, feasible and practical solutions.

The following forms of private participation are usually practised:

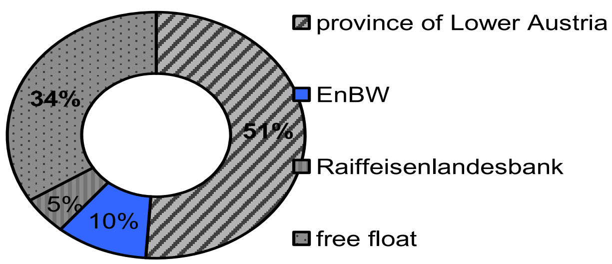
Private minority equity partnership

In this ownership model, a minority share is sold to a private company. The investor is actively identified and invited to buy shares. The owner of the district heating system keeps the majority and control. The private investor is selected by the owner normally to get more financial capital and know how.

Private equity through the stock market

Shares of the company are sold through the stock market. Shares of the company are offered on the stock market to investors. Also mixed forms of the above mentioned model and private equity through the stock market are practised; i.e. the Austrian multi utility EVN. A majority of 51 % of the EVN shares is owned by the Austrian province Lower Austria, the rest is owned by private investors and free float.

Figure 6: Ownership structure of the Austrian utility EVN, Nov. 2003, Source: EVN



Private majority (and full) equity partnership

With this model the former owner looses control and management responsibility. Most district heating companies in Bulgaria have been sold this way. The private investors bought 100 % of the assets of the Bulgarian district heating companies. The private investor has 100 % ownership and control, which could be an advantage. But there are also more critical aspects in this model. As the former public owner, a municipality or the state has no ownership any more, this could result in a harmful, disadvantageous and uninvolved attitude to district heating. The state or municipalities energy strategy could have damaging effects for district heating – as for instance if a gasification project is not adjusted with the existing district heating networks. This has happened in some Bulgarian municipalities, where former state owned district heating companies have been sold 100 % to a private investor. Because of short term politics the municipality decided to disconnect public buildings from district heating supply and to invest in individual gas boilers. Despite a thorough analyses of future options and possibilities to lower heating costs by a mutual agreement with the private investor and the consideration of efficiency measures – no common ground could be found. The aggressive business strategies of gas supplying companies endangers the future existence of the district heating system.

It is possible to maintain public control with a majority private equity ownership. The ownership structures with heat, gas and power utilities in Prague (CZ) are an interesting example.

Originally the municipality of Prague owned shares in all three utilities together with the state as a shareholder. This structure has been restructured in such a way that three holding companies have been founded as a joint venture partnership with private investors.

As a result Prague does not own direct shares in the utilities, but in the holdings that own these utilities. This holding structure allows Prague to intensify its control through acquisition of former state shares and to attract private investors with a majority share at the same time. Regarding the Prague heat distribution company, which now has also a majority private share holder, the stakeholders Prague and the private investor decided, that for key decisions an agreement of a qualified majority (that means both partners) are necessary.

A variety of different mixed ownership models such as heat delivery contracting, outsourcing of management and operation, cooperative approach, leasing and concession, will be discussed in more detail in the following section.

2.2.2 Outsourcing of Managemen and Operation - Heat delivery contracting

One of the structures with comparatively little involvement of a private partner are structures where the utility management, and/or the operation are outsourced.

There is no capital involvement from the private partner and no change of ownership. The public partner keeps the ownership and is responsible for the investments. The operator gets paid for the management.

The roles and the responsibility of ownership, operation, maintenance and investments have to be very carefully elaborated in order to avoid conflicts over the ownership structures in place.

This model is very common in the business sector of facility management. Especially companies with big office buildings and hotels leave the operation of the heating and cooling installations to specialists.

In order to cut costs and improve the operating efficiency, more and more corporations and institutions outsource their heating and cooling, turning to professional energy managers whom make a living by operating high-capacity steam and chilled-water production equipment.

Heat delivery contracting - a complex service or product, covers a number of benefits and activities such as: planning, installation, commissioning, maintenance, operation of the installation and supply of heat energy. The price of heat energy is fixed and guaranteed by contract for a defined period – usually between 10 to 15 years.

This package of services has the following advantages for a client (e.g. a municipality): Instead of a number of different partner companies responsible for one or more of this services, the client has just one partner, who is responsible for the complete procedure from planning to the operation of the heating system. There is nearly no burden to the clients budget. The tariff for heat energy is fixed for a longer period of time. Therefore the operator of the plant is interested in an efficient operation and will realise all possible efficiency measures, to produce heat in a maximum efficient way.

This system is used mainly in two cases: Firstly, the client has no interest and no Know-How to operate a complex heating installation by himself. Thus the operation is outsourced to a company, which is able to accomplish all necessary steps from planning to operation of the heating system. This example is often practised with office buildings, hotels and also apartment buildings.

In the second case, the client lacks financial capacity to invest in a new heating plant or to realise necessary investments. This alternative is often used by municipalities.

During the contracted period (therefore the somehow accidental term contracting) the contractor remains owner of his investments (heating plant, boiler station, etc.).

Not all buildings and installations are practical for contracting. The service package of contracting means a certain amount of costs, which has to be earned by the production and selling of heat energy. This results, depending on the special case or situation, in a threshold size of the heating installation or a threshold sold quantity of heat energy. Another important criterion are the achieved savings. A high potential for savings results in larger effects both for the client and the operator. Transfer costs (travel costs, local partner company, organisation of procedures for cooperation) are the normal results if a company invests in a foreign country and depend from political and economical possibilities barriers between both countries.

As a minimal sold quantity of heat energy is necessary to finance all services and investments of a contracting company, a contracting company tries to fix this quantity of energy within the mutual agreement with the client. At least the costs for the investments have to be ensured. As a usual practice a minimal quantity of heat energy is fixed in the contract. The tariff for heat enery is split into a fixed part and a consumption based part. The fixed part is foreseen to ensure the cost of financing.

The main items of a heat delivery contracting agreement are:

- tariff and its structure for heat energy
- period of the contract and a
- clear definition of property.

Usually the client, municipality or building owner, provides necessary real estates and the rights to use them in a defined manner. The contractor stays owner of all his investments.

This form of public private partnership is quite popular in Central Eastern European countries and a practical method to attract capital and additional know-how. Also a number of smaller district heating plants are financed by this construction in Austria and other countries. This model is successfully practiced in smaller district heating systems.

This structure has some very interesting possibilities. Under certain circumstances this structure gives a possibility to realize energy efficiency potentials. Given a fixed heat tariff, the operator has interest to produce the heat as efficiently as possible. Therefor he will realize all efficiency measures so that the economized MWh is cheaper than the produced MWh.

Outsourcing as a tool is used by governments not only to promote efficiency in service delivery but it is also used in government downsizing, which in turn stimulates activities in the private sector.

One of the most dynamic markets for outsourcing are the Countries of Central Eastern Europe. More and more public administrations discover outsourcing as a possibility to make the administration more efficient and to attract capital for investments. Many public services are partly or totally outsourced in Central Eastern Europe, such as the public supply of energy, water, garbage collection and waste management, maintenance and repairs and finally the management of public utilities such as district heating.

One of the largest global players, the French company DALKIA is very active in Central Eastern European Countries. Dalkia has 49,000 employees in more than 38 countries worldwide. It currently manages 650 district and local heating and cooling systems, including 329 in France. A subsidiary of Veolia Environnement and Electricité de France (EDF), Dalkia is the leading European provider of energy services to local authorities and businesses. Since its creation, it has focused on energy and environmental optimisation.

Romania can serve as an example, since it supported many outsourcing activities. The government has outsourced the following activities:

- Garbage collection and disposal, landfill usage;
- solid waste management;
- billings and collections including water, electricity, gas and district heating[1];
- maintenance and repairs of municipal utilities;
- management of utilities.

In the capital Bucharest, these outsourcing initiatives saved a lot of costs for paying of state employees, many of which where ghost workers. This restructering created new jobs in the private sector and additional tax income for the above mentioned concessions. Moreover, the additonal income is already exceeding what it was costing the state to provide these services in the first place.

Even though, outsourcing is a celebrated method to downsize the public sector, it is not a magic bullet and an allround solution.

[1] Techem, ista and Brunata are the largest European companies in heat cost allocation. Metering and billing of heat consumption is usually outsourced allover Europe. Perhaps Russia and the Ukraine are one of the few countries where heat cost allocation is not practiced yet. A reason for that is the remaining low and subsidized tariffs for heat.

2.2.3 Cooperatives

Cooperatives are a common and successful model in financing small biomass heating plants in Austria. As described in Chapter 3, major actors in initiating biomass heating plants are local farmers. There are two main reasons for a cooperative approach:

- more partners means more capital and distributed responsibilities and
- more fuel – wood chips for the heating plants.

The most important players and usually the initiators of heating cooperatives are farmers, who are owners of forests. The main motivation for farmers to become heat producers, is the possibility of additional revenues and the financial support as subsidies from the public budget. Farmers have a strong lobby in Europe as well as in Austria. These subsidies are part of the national support for the agricultural sector.

Subsidies are not necessary for every biomass heating project – these grants are part of the Austrian (partly European) policy to support the agricultural sector and a result of the strong farmers lobby e.g. in Austria.

The Austrian Energy Agency conducted some feasibility studies for energy and cost efficient heating systems in Bulgaria. Bulgaria has no public subsidies for such investments, but a lot of sites appear to be very attractive for biomass as a fuel. In short, one MWh heat energy produced with oil boilers costs at least € 100. One MWh heat energy from wood chips costs between € 50 and 70 (all costs for a new plant as financing, operation, etc. are included!). If the low efficiency of the old and mostly oversized oil boilers are considered, a fuel switch to biomass associated with the necessary substitution of old and inefficient boilers with new efficient biomass heating systems, this could result in savings of more than 50 %.

In Austria these subsidies are justified with the practice of gas suppliers to finance the access to gas until the supplied buildings, which is financed by big companies. The costs for a gas connection are transferred to ten thousends of clients. In contrast, regional biomass initiatives have to operate with much more cost transparency. Subsidies from other sectors are not possible, due to the small size of these initiatives. As a result, the complete costs for biomass district heating plants, including the boiler station, the network and the individual substations in the respective buildings etc., have to be financed completely by the customers through financial shares in the cooperative and their payments for heat energy.

This usually results in more complex ownership and organisational structures of rural biomass cooperatives. Besides the farmers, the households and the municipality – owner of supplied public buildings participate in a local biomass heating cooperative usually through taxes for connection to the distribution network. Providing sufficient wood chips and often also the operation of the central heating plant is the main role of the farmers.

Besides public subsidies, there are state and NGO structures and associations supporting such local initiatives with their know-how.

The ownership structure of small biomass intiatives (up to 5 MW) is usually the result of the individual situation of the project. Smaller boiler plants with less than one MW usually are integrated into existing mostly public buildings. Thus an active participation of the municipality is sometimes a necessary precondition.

After definition of the approximate project dimensions a working group is formed, which consists mainly of the future share holders of the cooperative. A prefeasibility analyses, acquistion of clients, and communication and contact point are the main tasks of the working group. After presentation of the rough project and it´s consequences for future supplied customers, preliminary agreements are arranged.

Based on a detailed analyses final heat delivery contacts are defined and signed with future clients and or shareholders.

By means of a public tender an engineering company is identified to realise the project. Sometimes specialized engineering companies participate in the project by contracting, financing a part or the complete heating installation. This model is successfully practiced in smaller district heating systems.

2.2.4 Leasing

Leasing contracts are very similar to renting contracts. The main difference is the responsibility of the lessee for maintenance and repair. In a usual renting contract maintenance and repair is the responsibility of the landlord or hirer.

Leasing is an agreement whereby the lessor conveys to the lessee in return for a series of lease payments the right to use an asset for an agreed period of time and provides automatic transfer of ownership by the end of the lease term.

The operator rents the district heating assets for a defined, usually long term, period. Operation, maintenance, investments and the cash flow of the company are in the hands of the private operator, who pays a specified amount to the public owner or invests a specified amount of capital in the district heating system. Besides, a combination of both alternatives are practised.

Leasing has some advantages as liquidity is preserved. Intermediate inputs are not necessary – the leased object is financing itself continuously. Leasing companies are more flexible than banks regarding the required collaterals. It makes the leasing more preferred than a bank loan. However, the lessee is not owner of the object and the costs over the period of utilization usually are higher because of the risks and profits of the lessor.

Leasing bears similar risks regarding maintenance such as a operation and management contract. Therefore these assets should be exactly defined in order to avoid conflicts.

The above mentioned large contracting and operating company Dalkia, practises also leasing of district heating companies. In the district heating sector leasing is quite common in financing cogeneration. Several producers of cogeneration plants offer leasing. One of the leading and oldest pioneers of gas engines, the former Austrian company Jenbacher - now General Electric – Jenbacher from Tirol, cooperates with the bank consortium HVB Leasing offering leasing packages for their cogeneration engines. After a public tender, HVB Leasing closed a deal with District Heating Company – Varna Bulgaria for the cogeneration of the company for the investment amount of EUR 1 826 030.00. This was only the first step. Currently HVB Leasing is negotiating investments for more than EUR 50 000 000 for cogeneration and renewable energy source projects.

2.2.5 Concession

Usually a municipality gives the concession to a private investor for a certain period of time. Different to leasing the concessionaire owns the district heating assets. All municipal needs and demands have to be included in the contract with the concessionaire.

Concession as a form of ownership should not be mixed with licences. Licences are sometimes required by law; i.e. usually larger heating boilers with more than 5 or 10 MW need a licence for production and supply.

2.2.6 Case Study – mixed ownership structure

At present, the largest biomass heating installation of three towns in eastern Austria (50 km south of Vienna) is under commission since autumn 2007 until autumn 2008. All these towns have an overall population of 29,000 citizens.

This biomass district heating initiative is an example of a mixed ownership structure. Main investor is one of the largest multi supply utilities in Austria – EVN. The system is operated jointly with local farmers, who are responsible to produce and supply the biomass fuel – about 60,000 m^3 wood chips per year, which is an excellent work done from the logistic point of view.

The installed thermal power consists of 10 MW biomass boilers and 18 MW gas boilers as reserve and peak boilers. 4,000 households are supplied with heat energy. The district heating network has a length of 16 km. The overall investment costs are approximately € 13 million.

The project is built on a joint cooperation of three municipalities, local farmers and the regional multi utility EVN, which has a rich experience in operating 48 biomass district heating plants in Lower Austria (Niederösterreich).

This initiative is to a significant extent driven by local politics. The regional government of Lower Austria has 51 % shares of EVN and thus is the major owner of the regional utility EVN. Cooperation with local farmers as fuel suppliers is necessary from the logistic and political point of view.

In addition, the Republic of Austria has important shares on the countries forests.

With respect to theoretical or legal principles, this situation is a classical example of Public Private Partnership. There is a private partner, the farmers – responsible to produce and to deliver quality wood chips. There is a private investor – the shareholders company EVN and we have the public involved – three municipalities with several public buildings.

In theory we have a variety of different ownership structures to optimize a given situation, but one should not forget that decision making is often influenced by politics.

Figure 7: Biomass CHP Ternitz

3 Small rural biomass district heating systems in Austria

Austria has one of the strongest market for biomass heating systems around Europe. The market covers all range of power. Austria, a country rich in forestland (47% of the land area, 3.96 million hectares), has a share of biomass use for energy among the highest in Europe (around 11%, after Finland with 17% and Sweden with 14%). By 2007 more than 1.100 biomass district heating (BDH) plants were in operation. Typically, such systems supply renewable heat for the centres of rural towns and villages, where publicly owned buildings (schools, town halls, hospitals, nursing homes etc.) are the main objects connected, followed by private homes and commercial buildings. While both biomass boilers for the combustion of wood residues, and district heating systems in urban areas, were common in Austria, the implementation of BDH systems in rural areas meant a real innovation.

The development and installation of BDH systems in rural areas of Austria started in the mid-1980s. At that time the federal provinces (and federal agencies concerned) did not explicitly formulate quantitative targets (e.g. in terms of a certain number of plants to be established, or capacity installed), but nonetheless tried to maintain support for such projects. Diffusion patterns among the nine Austrian provinces were very heterogeneous with Lower Austria, Upper Austria, Salzburg and Styria being somewhat earlier in the innovation process, followed by Burgenland, Carinthia, Tyrol and Vorarlberg. The deployment of BDH plants in Austria is generally seen as the outcome of both local initiatives and public policy. At the public policy level the main goal was initially to support agriculture and forestry.

Most farmers in Austria own forest as well as farmland. BDH plants were seen as an opportunity to offer disadvantaged farmers, and especially those in rural and/or mountainous areas, a chance to create a new source of income. Hence much of the (early) funding granted for BDH development stems from agricultural funding sources. Later, environmental funding sources were added.

BDH deployment programs have typically been managed at the level of the federal provinces. Apart from granting stand-alone funds, the federal provinces also provided co-funding to substantial funding by the Federal Ministries of Agriculture and the Environment and the European Commission. In fact, the accession of Austria to the European Union in 1995 enabled access to resources from EU regional development programs, greatly increasing the funds available for BDH plants. During the 1980s and 1990s, agricultural cooperatives received capital grants (up to 50% of the total investment cost) and soft loans from the Ministry of Agriculture. In contrast, commercial operators of BDH plants, such as owners of sawmills, could only receive grants up to 30%. In 1997, eligibility, application procedures, and payment modes for capital grants were largely harmonised, and a joint Environmental Promotion Fund (Umweltförderungsfonds), managed by a special purpose bank, was established. This has greatly reduced the complexity and overlap of the promotional schemes, and in turn increased the efficiency of funding and administration. Furthermore, technical performance guidelines introduced in 2000 as a de facto standard, together with seminars on how to achieve the performance levels indicated in the guidelines, have significantly improved the technical efficiency and economic viability of plants.

Apart from capital grants and soft loans, the reduced value added tax rate on wood products of 10% (compared to the standard VAT rate of 20%) constitutes a further, indirect subsidy. In addition, R&D funds have played an important role in the swift diffusion of BDH systems in Austria. While most of these R&D funds have been provided for project-type technical research undertaken by small and medium-sized enterprises (50% co-funding), they have also been available for long-term R&D programs, mainly aimed at enhancing combustion technology.

22 % of the Austrian residences (600,000 on 2,700,000) are heated with wood. 68.5 % of the people concerned use stove(s) for heating rooms and 31,5 % use central systems. The domestic heating is the largest market (about 60 PJ per year) for Biomass. In fact, on 1,000,000 of single stoves more than 570,000 use wood as fuel (see Table 3).

Table 3: Heating systems in Austria (2005), main domiciles by heating system and used fuel

type	N	%
single stoves	996 000	32
- natural gas (convection)	181 100	6
- electric heating	211 600	7
- other fuels	603 400	19
single storey heating	451 200	14
house -central heating	1 329 300	43
district heating	346 500	11
wood	570 600	18
coal, coke, briquette	215 500	7
fuel, oil, LPG	842 800	27
electricity	313 700	10
natural gas	777 300	25
district heat	346 500	11
others, not known	56 600	2
total	3 123 000	100

The actual most popular domestic heating systems are tile stoves. Austria has about 450,000 tile stoves : 100,000 are used as main heating system and the rest as support for the central heating system.

The main factors for the strong development of biomass technology in Austria are the high proportion of wood in the total land area and a very good developed wood processing and paper industry. These mills have installed the first large scale wood or wood waste firing installations for their own use and started to experiment with wood waste, such as saw dust, to develop practical fuels.

Another initiative for the development of biomass district heating are the farmers. They are a key factor in understanding this development. Their difficult economic situation, particularly in areas with low tourism and a declining industrial base. Due to the lack of alternatives, farmers in these areas are eagerly seeking any possibility to make money with agriculture and forestry. The majority of farmers are forest owners. In the 1980s and 1990s the wood prices decreased considerably for a number of reasons. Cheap wood imports, periodic crises in the pulp and paper industry, the increased use of recycling paper and other factors have led to an oversupply of wood. The substantial decline in wood prices is a driving force behind BDH development. Farmers are desperately looking for possibilities to market their wood at sensible prices.

If the possibilities to earn a living in other economic sectors - as tourism or industry - are good, interest in establishing BDH is usually low. The latter is true for most of the western states of Austria. Nevertheless there are some cases of prosperous tourist villages, where BDH plants were established for other reasons: comfort, local air pollution and prestige. Thus an entirely different socioeconomic context also supports the technology - but requires particularly advanced technologies as flue gas condensation to prevent any visible emissions that could bother tourists.

3.1 Main actors

Probably the three most important actors in the local / regional innovation system were: the local promoters of a BDH project; the agent/s acting in each province as a focal point; and the planners and installers.

Successful local promoters have been identified as typically well respected residents of the village that are personally highly motivated and that manage to create a consensus in the whole village to realise the project. The agent/s at the focal points (typically 1–2 persons in each federal province) acted as counsellors, taking responsibility for a number of important tasks (e.g. commissioning of feasibility studies, providing administrative support to apply for subsidies, advising on how to found a cooperative, drawing up of contracts with heat customers).The agents also maintained contact with boiler manufacturers, administrative bodies granting the subsidies, and mayors, and hence had a very important networking function with this second set of key actors. Project planners and installers were often small enterprises with fairly broad portfolios of project types, and at least initially were lacking experience with (biomass) district heating systems. As a consequence, in the early years many planning and installation mistakes were made, the most common probably being over-dimensioning of the systems, sometimes leading to excessive project costs and poor economic performance.

Two further important groups of actors not yet mentioned were the local and regional politicians authorising the grants and defending the biomass energy policy in the political arena, and the scientific community. While the former often expected rewards for their supportive actions, for example in terms of plant opening ceremonies with media attention and public involvement, the latter group played an important role in pushing the state-of-the-art of biomass combustion technology.

Finally, partly as a result of the liberalisation of the electricity market, and as part of a strategy to establish new business areas, some utilities also entered the BDH market (others followed the opposite strategy of specialisation). Since a significant proportion of the grants were only accessible to farmers, these utilities created new forms of cooperation with farmer cooperatives, in order to jointly own, build and operate BDH plants.

3.2 Diffusion dynamics and structure

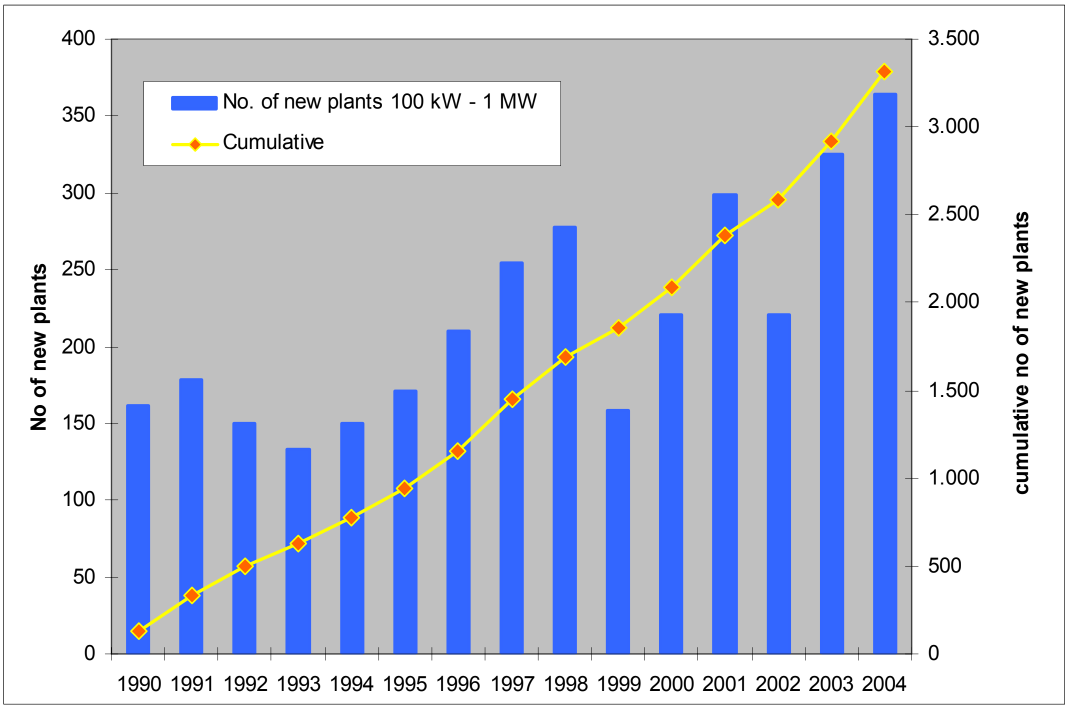


Figure 8: Depicts the diffusion of various kinds of biomass heating systems in Austria for two different size classes, Source: Madlener (2007)

In particular, from 1990 to 2004 between 150 and 350 smaller plants (100 kW–1MW) (left plot) and between 15 and 55 larger plants (41MW) (right plot) were put into operation each year, leading to a total market penetration of 3.300 small- and medium-sized plants and 460 larger-scale plants. As can be seen, the cumulative diffusion process has been relatively smooth for both size categories, and so far seems not to show any saturation trends. Source: Madlener (2007)

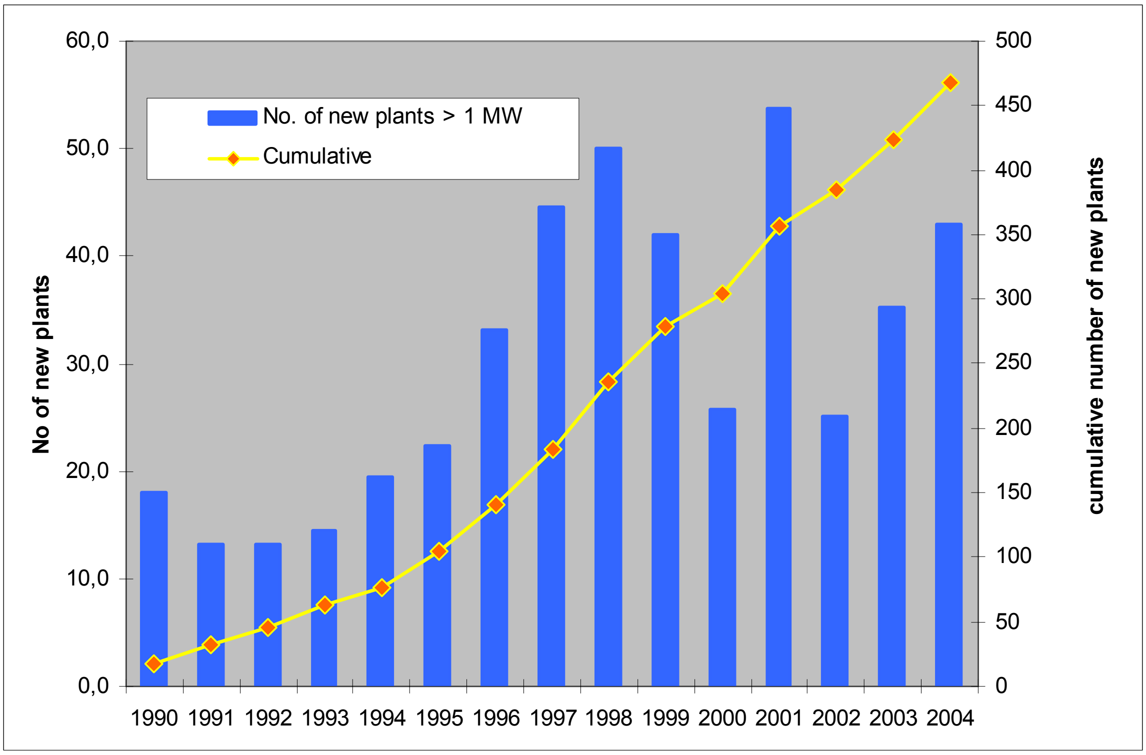


Figure 9: Number of installed biomass heating systems in Austria, by size class, 1990–2004 (upper plot: 100 kW – 1 MW; lower plot > 1 MW) Source: Madlener (2007)

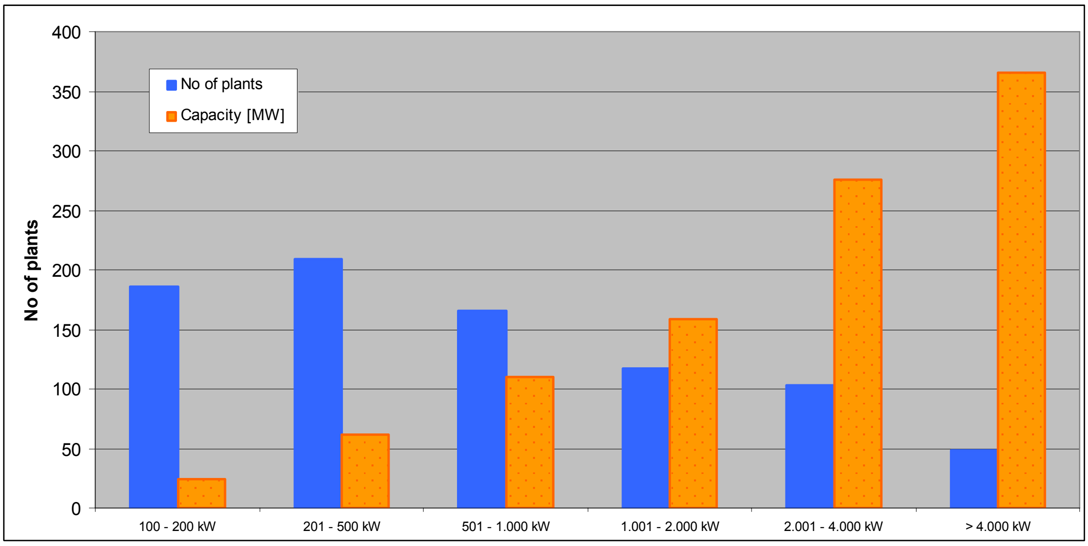


Figure 10: Biomass district heating plants in Austria, by size class, as of December 2003 (total 843 plants, 1005 MW). Source: Madlener (2007)

Figure 10 shows the distribution of Austrian BDH plants by size class (size being measured as installed capacity), in terms both of the number of plants installed (left/blue bars) and of installed capacity (right/orange bars). It can be seen that while small- and medium-scale plants up to 1MW of installed capacity clearly dominate the picture in terms of the number of plants installed, large-scale systems dominate in terms of cumulative-installed capacity. In recent years, a certain trend could be observed towards smaller systems. This trend is likely due to the growing popularity of plants, which only supply a limited number of nearby objects, aimed at reducing both specific investment costs and heat losses in the distribution grid, but it remains to be seen whether this trend will be sustained.

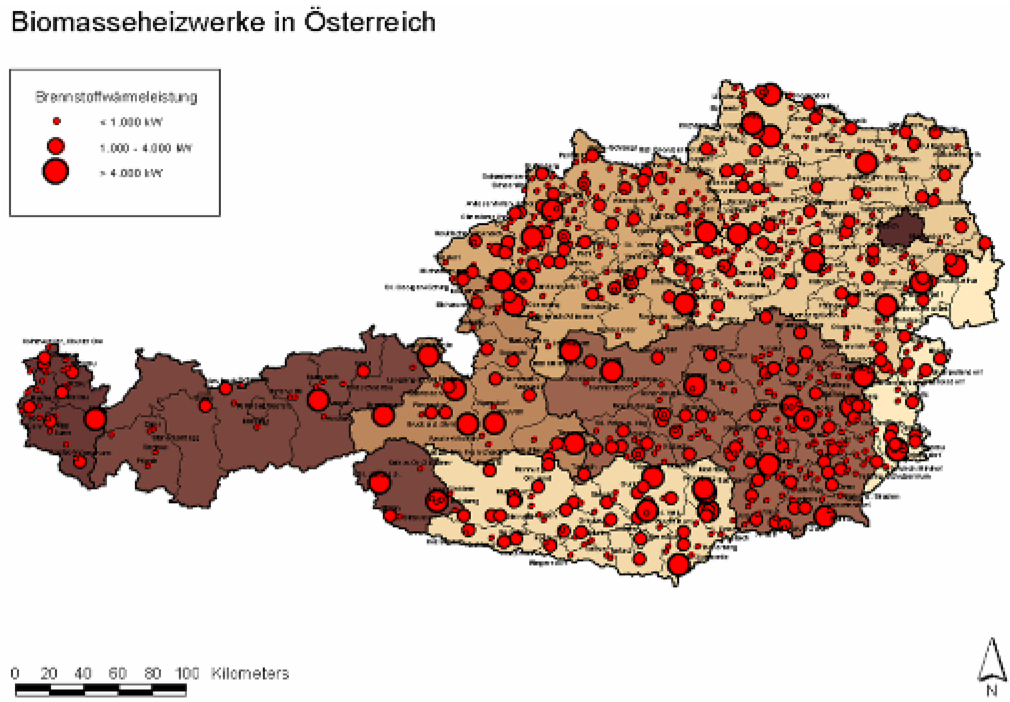


Figure 11: Biomass district heating plants in Austria 2007, by size class, as of December 2007 (total over 1100 plants, over 1100 MW).

The two most concerned part of Austria with Biomass are the Styria and the Upper Austria. Biomass is especially well developed in rural areas where firewood is the main source of energy for the one or two family houses since a long time yet. Nevertheless there are a lot of biomass systems in bigger municipalities and even in district which do not have a lot of forest because the Austrian consider that transport of wood is economically and environmentally acceptable until a distance of 70 km.

The expectations in marketing wood by establishing district heating plants have not materialised in many plants. On an average 80% of the fuels used are sawmill wastes. What might seem peculiar is, that regardless to this fact, farmers still carry on establishing plants. Obviously other expectations than short term profit play an important role in their motivation. These expectations include a long term perspective for economic success ("oil will get more expensive sometime") and the local social prestige of realising environmentally sound "sustainable" innovation.

3.3 Socioeconomic conditions

A central economic precondition is the readiness of consumers to connect to the district heating grid, even though it is clearly more expensive than individual heating. This readiness is driven by a number of motivations ranging from environmental protection and local self sufficiency to significant comfort gains. Economic considerations play neither a central role nor are they consistent. This conclusion is emphasised by a survey on the opinions and experiences of customers that yielded no consistent relationship between the economic evaluation of BDH by consumers and the actual heat prices paid (which showed a variation of more than 20%).

On the other hand sociocultural factors play a more important role than might be expected.

A major barrier present particularly in early innovating villages was distrust in the new technology. Will it work? What will be its impact on village life? Who is going to profit from the project? These are some of the questions usually discussed for months at the village inns. There seems to be no way out of confronting this distrust in new technology. It is an anthropological constant, present regardless of the type of innovation and the specific cultural context. Distrust in innovations from the outside plays a central role for the cultural integrity of a society. This form of distrust is not only an individual phenomenon; it is also a social one. Rational economic and technical considerations will only serve to create trust if they both symbolically and factually converge with the social meaning accepted by the majority of the society affected.

Essentially since the 1950s rural communities in Austria have experienced the profound impacts of technical innovations in agriculture, that did not only change the way agriculture was conducted completely but also changed rural culture. New forms of life and increasing economic pressures on farmers have left social disintegration and a feeling of meaninglessness in many places. The result is suspicion regarding any form of innovation further changing and possibly destroying local cultural habits, simultaneously combined with a strong desire for any meaningful initiative that will give new hope for rural development. The tension between these two dispositions explains the great spectrum of responses to the suggestion to establish a BMDH. Both full collective support and vivid conflicts may be associated with a project.

In most cases studied, these conflicts have been settled somehow. However BDH consultants told us that in many villages that originally had considered a BDH plant, such conflicts actually stopped the development of the project.

We distinguished two basic categories of conflicts. The first one is related with the so called "syndrome of acquired depression" that seems related to the general cultural and social disintegration in such rural areas as mentioned above. These developments, in many places combined with a long-lasting autocratic local political elite, may lead to total apathy within the population. People have lost all hope for a better future. An innovative project not only challenges this depressed attitude but probably also the ruling elite. The principal attitude in such a village is distrust and rivalry. Under these conditions, according to our survey, the main arguments against a BDH project are irrational or pseudo-economic.

The second type of conflict is related to the "NIMBY Syndrome"(i.e., Not-in-my-backyard Syndrome)- BDH is nice for everybody except those who live close to the chimney and fear to be bothered by smoke or noise. This type of conflict appears quite often in places with many new settlers, usually upper-class residents from urban areas seeking unspoiled nature in the countryside. These settlers are usually well organised and try to use rational or even scientific arguments to stop the project.

It is of central importance for a BDH project that conflicts are properly addressed on time and managed in the best possible way. Even if a project succeeds despite severe conflicts economic disadvantages are often considerable. We found that the average investment costs for plants meeting strong or very strong resistance were 30% higher than for plants with no resistance. Cost increases are caused e.g. by extra requirements for licensing. Lower heat sales due to the unwillingness of opponents to connect to the grid may also have a serious economic impact.

3.4 The role of policies for supporting technology introduction

The Austrian political system allows to study the effects of different policies on BDH deployment individually. Austria is a federal republic with 9 different states. The energy policy of these states is quite different and had a profound impact on the rate of diffusion of BDH technology. The vast majority of BDH plants is situated in only 3 states.

The comparison of state policies and their impact shows the differing role of economic incentives during diffusion. During the early development phase of BDH implementation management was of central importance. Successful introduction happened only in provinces, that established a dedicated institution or focal point that managed the day to day problems of early introduction. These institutions facilitated co-operation among all relevant actors, conducted public information activities and provided advice to local developers. When, after 5-10 years of dedicated introduction management the establishment of a plant became more of a routine process, economic incentives established in neighbouring provinces were able to set off diffusion immediately. Nevertheless management efforts to keep the development on track are still necessary, almost 20 years after the first plant was established. Actual tasks that need to be addressed are e.g. the establishment of a program to upgrade old plants, the development of more efficient subsidy regimes, educational activities for operators etc.

Besides the mentioned management structures, of course, the availability of subsidies is of critical importance. Typically, plants receive subsidies of 30-50% of investment costs. What can be learned from the Austrian subsidy policies? Certainly subsidies have been very effective in enabling a dynamic technology introduction process. However, regardless to the substantial growth of the market and significant technology advances prices for BDH establishment could not be reduced. At the contrary: the deflated specific investment costs have been rising considerably, as shown by Figure 5. This price increase is to some extent due to the fact that plants could be built under less favourable local conditions. To some extent the availability of subsidies could have also undermined the incentive to build as economical as possible. Investigations, whether subsidies have also had an effect on the price level of equipment are under way. The standard deviation of specific investment costs is very high and decreases only slowly by the end of the period. Given this high variation of costs it seems feasible, to introduce a more competitive subsidy scheme, that selects projects for support according to economic and technical performance criteria. Such a scheme is presently under consideration.

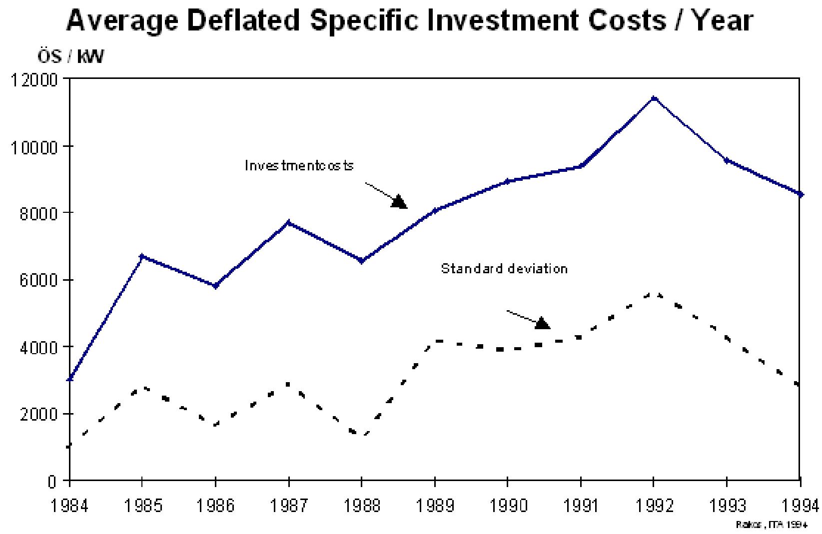


Figure 12: Average Deflated Specific Investment Costs/Year; Source: Rakos (AEA).

Given the complex approach necessary to set of technology deployment, two common myths regarding renewable energy can be discarded: myth one says renewable energy is primarily a question of research. Myth two says it is nothing but a question of economic incentives. Neither myth is true. Both research and economic incentives are important ingredients - however they must be integrated in a systemic approach that takes into account the complexity of setting up a new energy system.

3.5 The economical and technical background

Wood as a fuel has been used, since men started to make fire. The new aspects of modern biomass boilers, is their easy to handle operation, by automatic transport systems for the fuel and the ash, and a controlled supply of primary and secondary air, which results in a high annual use efficiency of about 90 %.

The fuel partly standardized, are either pellets – small cylinders pressed from wood dust, or chips a more crude fuel made from logwood by chippers. This standardization makes the handling of wood fuel nearly as easy as gas or oil.

Biomass boilers are about 30 % more expensive as gas or oil boilers. The main reason for their higher costs is the much more massive construction and more complicated transport systems for the fuel.

Figure 13: Wood chipper with mechanized feeding

Figure 14: Wood chip delivery

Figure 15: Wood chip delivery, standardized system with air blower

The diameter of the pipes and the diameter of their connection to the storage is always 150 mm. The chips are blown through the pipes into the storage.

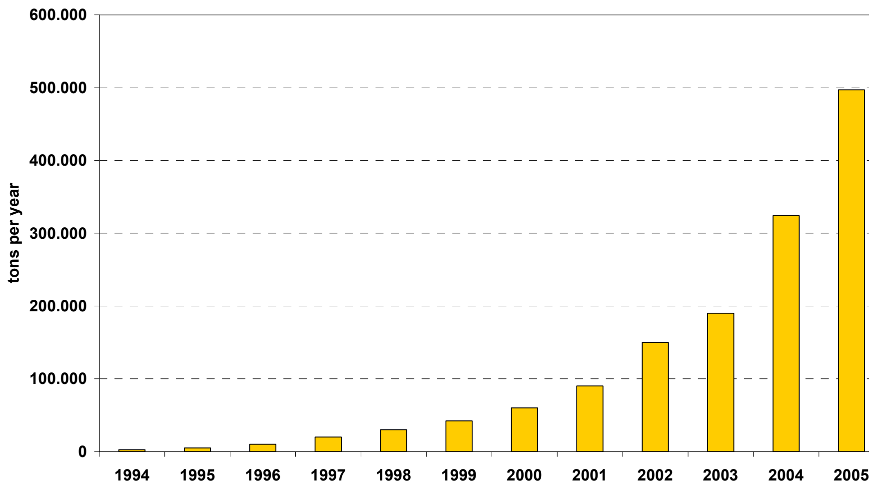


Figure 16: Annual pellets production in Austria

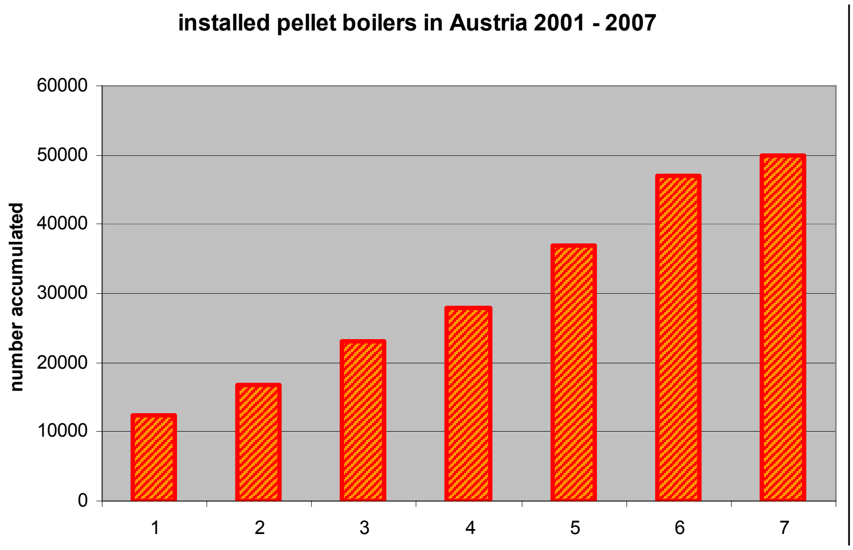


Figure 17: Accumulated numbers of pellet boiler installation, Austria, 2001–2007

In the years 2005 and 2006 the number of installed boilers reached 10.000 boilers per year. Theses sales fell strongly in 2007, because of a sharp rise of pellet prices of about 50 %. This strong increase was result of a lack of capacities in pellet production and speculation of the producers. During 2007 the price level normalized.

The advantage of pellets compared with wood chips is their relatively small volume, their well defined geometry and size. So automatic transport systems for pellets in modern boilers work without any problems. The calorific value of pellets is 4,9 kWh / kg. Still they need more space in a storage as oil for instance. 1 m^3 pellets equals 320 litre oil. 2 kg of pellets equal 1 litre oil. The price per kWh is significant lower than oil and gas – at the moment the price for 1 MWh pellets is 30 to 34 Euro. Pellet boilers and log wood are mainly used for one family houses or an installed power up to 50 kW.

Larger installations especially district heating systems are working mainly with wood chips, as chips are two times cheaper than pellets. The calorific value of pellets is 3,14 kWh / kg (with a humidity of 35 %). 1 m^3 wood chips equals 73 litre oil. 3,2 kg chips equal 1 litre oil.

The price is lower than the price for pellets. The price for one MWh is 16,5 Euro. A disadvantage is the significant need for the storage room, which is 15 times larger as for oil.

Pellets

Wood Chips

Figure 18: pellets & wood chips – fuels for automatic biomass installations; Source: NÖ Landwirtschaftskammer

Following figures should give an impression on the price stability of biomass fuels:

- black: oil
- yellow: gas
- pink: DH
- brown: pellets
- green: log wood
- dark green: wood chips
- orange: electricity

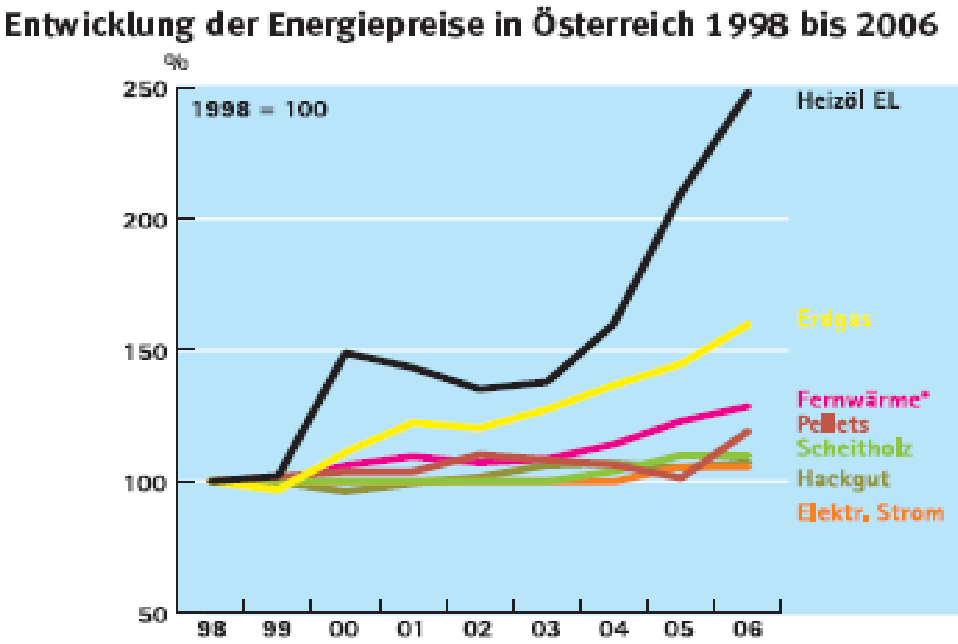


Figure 19: Development of energy prices in Austria, 1998 – 2006

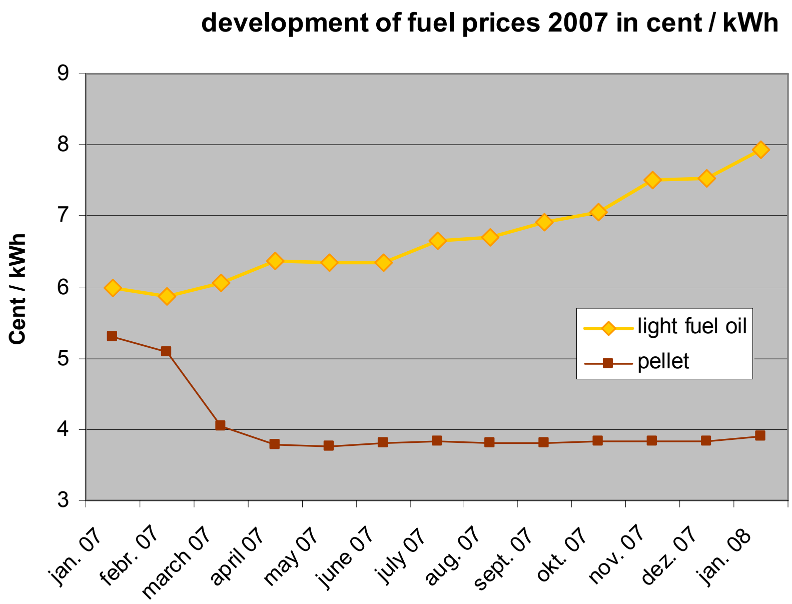


Figure 20: Development of light fuel oil & pellets in Cent / kWh, 2007

Figure 21: Boiler with different burning systems,„throw in“ burning system, “rotating grade system”

More than 60 enterprises are working in Austria in the production and the installation of biomass systems. A lot of research programmes have been undertaken in order to improve biomass systems especially in the field of the environment. The research concerned all range of power.

A big study has been led by O.O. Energiesparverband (Upper Austrian Energy Efficiency Association) which shows that biomass use will double in the next 20 years. It is probably a little too optimistic but it shows how the use of biomass is yet growing in Austria. Thus, in the future, the market for small scale systems will yet increase but the authorities are trying to develop small scale boilers for central heating or biomass district heating rather than stoves because they are seen as most environmental respectful.

3.6 Case study: the steps to a biomass district heating project

This case study supports the arguments from above, and examplifies the most important steps to a successful biomass district heating project in a more practical way.

Small and medium scale district heating in Austria means in most cases biomass district heating. There are about 1,100 biomass district heating plants in operation in Austria with an installed power of about 1,300 MW in 2007. They convert about 10 PJ of biomass (mostly forest based) to heat for heating and providing hot water.

Their power ranges from very small plants (50 kW to 200 kW) for the supply of a group of houses or single big buildings to medium scale plants (200 kW to 2 MW) for the supply of villages, parts of small towns, industrial- and big buildings to big plants in the range of 2 to 20 MW for the supply of towns and cities, or for providing process heat for the wood processing industry.

Some of the big plants are additionally equipped with a CHP (combined heat and power supply system) which produces electricity. Technically, the ORC process is applied for mediums scale plants, big plants usually have a steam process (turbine or engine). Financially, CHP is feasible when the electricity is used in industrial processes to substitute for purchased electricity, or when it is supported by special feed-in-tariffs or other incentives, as is the case in Austria and Germany, for example.

In the following, the typical steps to a biomass district heating project are summarised.

3.6.1 Development of a project

3.6.1.1 From the first idea to the principal decision

In most cases, the idea to build a district heating plant originates in a small group of people, or even is the idea of a single person, at the occasion when a new building in a community or village is being planned (school, a new settlement, …) or when the existing heating systems of buildings are outdated and need refurbishment or replacement. Other groups who are motivated to build a district heating plant can be farmers who want to sell biomass fuel like woodchips from their forests.

Such groups of plant owners to-be would receive support in the form of first advice. This advice is provided by agricultural associations and chambers, by the energy offices of the federated states of Austria, by utilities, or by freely available electronic tools like www.bioheat.info. The result of this advice is a rough assessment of the project feasibility. If a project appears to be feasible (technically, financially, organisational), and if there are people willing to develop and carry out the project, the decision for the realisation of the project will be positive.

3.6.1.2 Formation of the project team, social embedding

A necessary pre-condition for the successful realisation of a district heating project is a team of proponents who are responsible for project management and realisation. The team should be composed in a way to comprise both, technical, economic, legal and managerial competence, and broad acceptance by the local population.

For a district heating project with many private houses to be connected to a pipe system, social embedding of the project is crucial, because it is a free decision for the would-be-customers to connect or not to the grid. This means practically, that the people of the village which would have to connect their houses to the district heating system, which means, besides others, costs for them, would have to trust in the project team. Trust can be reinforced with a positive communication strategy.

3.6.1.3 Planning of the plant

Four aspects appear to be necessary prerequisites for a successful project:

- Technical aspects of the planning process. This means aspects like size and accessibility of fuel storage, dimensioning of the boiler, length of the pipe system etc.
- Organisational and legal aspects
- Financial aspects
- Planning for the successful operation of a plant

Technical aspects

Two principal figures allow to roughly asses the feasibility of a project:

At least 1,200 kWh/m sold heat per m of pipe

At least 4,000 hours per year of full time operation of boiler

Further technical aspects can be shortly summarised:

- Boundary of the area to be supplied;
- Heating load connected;
- Pipe system: optimising dimensioning (diameter) and route of pipeline;
- Power of the boiler(s);
  - One or two boilers,
  - Fossil fuels boiler for peak demand and as an energy reserve,
- Fuel supply: contracts with fuel (=biomass-, woodchip-)suppliers;
- Storage and feeding system for the fuel;
- Dimensioning and optimisation of the pumps;
- Building where boiler and fuel will be situated;
- Heat transfer system in the buildings connected to the grid;

Organisational and legal aspects, ownership

In Austria, different forms of corporate organisations – or forms of enterprise – for the supply of district heat are applied. Principally, there are

- Private companies (non incorporated firms)
- Capital companies (limited liability company)
- (agricultural) cooperative societies
- Utilities

In most cases, agricultural cooperatives and limited companies operate plants.

Practically, also mergers of the above organisational and legal structures apply. For example, an agricultural cooperative owns the boiler and the related equipment and supplies the biomass fuel. This cooperative sells the heat it produces in the boiler to an utility. The utility owns and operates the pipe system and sells the heat to the customers. If this construction is applied, the exact definition of the interface is very important.

Investment- and Running Costs

The usual costs for a district heating plant appear as follows:

Investment costs of the biomass boiler

Power of Biomass boiler	investment in 1,000 €
100 kW	25
150 kW	30 to 40
200 kW	45 to 55
350 kW	55 to 70
500 kW	70 to 110
750 kW	120 to 150
1 MW	140 to 180

Boiler house

Building, boiler house:	750.- per m^2
Fuel storage:	75.- per m^3
Pipes, pumps, electric equipment in boiler house:	125.- per kW

District heating grid

These costs depend heavily on costs for excavation, which are lower on grassland and higher at the road in a town, for example:

Main pipe system:	180.- to 255.- per running meter
Connection system to house:	150.- to 190.- per running meter

Heat transfer station at the site of the customer:

kW of heat transfer	costs in 1,000 €
up to 20	3.5
40	3.75
60	4.25
100	6.25
200	8.5
500	15
700	19.5

Other costs

Planning, advice: ca. 10% of total investment costs

Running costs

Running costs appear during the operation of a plant. Empirical values are added if available.

- Costs for the fuel (biomass) (see below)
- Costs for electricity of pumps, equipment: 1.5 € per MWh sold
- Reserve for repairing, service and maintenance costs: 0.5 to 2.5% of total investment costs
- Chimney cleaner
- Personnel costs, administration: 2.2 € per MWh sold
- Insurance: 1.5 to 2.5 per mill
- Taxes, interests

Fuel costs

Fuel costs, especially for biomass based fuels, depend on time, amount, water content, place of delivery and on other circumstances. In the following, prices, which are being paid by a district heating supplier for woodchips, supplied to the site of the plant, are presented.

They apply for delivery between July 1st 2008 and June 30th, 2009. Prices include 12% of VAT:

Water content (%)	Price per ton of woodchips in € incl. 12% VAT
10	69.30
20	61.38
30	53.46
40	45.54
50	37.62

Financing

Ideally, a district heating plant should be financed by the income from the heat it sells to its customers. Practically, the operators-to-be of a district heating plant will finance the plant jointly by

- Equity,
- Subsidies and
- Loans

Equity should amount to at least 15% of total investment. Equity will partly be raised from the customers, who pay for the connection to the district heating system. Connection costs would, for example, typically amount to 140.- € per kW. Customers would also pay for the heat transfer station.

In Austria, biomass based district heating systems can be subsidised with investment subsidies up to 30% of relevant investment costs.

Bank loans would finance the rest of the project. Interest rates would amount to 5 to 6% per year.

3.6.2 Running a plant

Costs for the customers

Customers of a district heating plant pay a tariff which is typically comprised of three parts (the figures in the following appear for a biomass district heating plant in Lower Austria):

Price for power (€/kW connected):	25.- (alternatively, € per m^2 can be applied)
Price for the heat (€/MWh supplied):	60.-
Price for measuring service (€/year):	50.-

3.6.3 Recommendations

Most important for the successful operation of a district heating plant is the trust of the customers in the operators of a plant. To obtain and keep this trust, some measures can be applied:

- The operators and owners are familiar to the customers, they are from the same village and well known as reliable persons.
- Local craftsmen are being employed at the construction and operation of the plant. If possible, local farmers supply the fuel
- The customers understand that the district heating project is not only a vehicle for (local) tycoons to enrich themselves.
- The idea of building a district heating plant is well communicated to the villagers and customers from the very beginning. For that purpose, also traditional communication channels are applied like local pubs, local festivals, newspapers, open discussions, or information activities and –events. After completition of the planning, an open presentation to the public is carried out.
- Potential fears and resistance against the plant are well addressed from the beginning on.
- People who are not convinced by the project are not treated as fools, their mistrust of the project is taken serious.
- The real costs of the project, especially the future costs for the customers, are openly discussed and presented.
- The site for the plant is defined cordially with the customers, NIMBY (not in my backyard-) reactions are addressed.
- The advantages of the district heating plant, as compared to the status quo, are addressed. These advantages range from local reduction of hazardous emissions, reduced working load for the customers due to switch off of the individual heating systems to the CO_2-neutrality of the new heating system.
- Buildings which are potentially used by the whole population, like schools, the church, shops, kindergartens etc. are supplied by heat, so everybody experiences the advantages.
- The perception of ownership of the plant by the customers can be established and be further extended by special measures like a joint opening ceremony, an open house in the district heating plant once a year, the establishment of a playground for children next to the boiler house, excursions for schools etc.
- A brochure which presents the completed project is being produced and distributed.

This whole chapter and the described recommendations should serve as a best practice example, and at least certain parts should be used as a roadmap for the short/medium strategy in regard to promoting district heating in Mongolia.

3.6.4 Case Study: The biomass plant in Steinakirchen, Lower Austria

Starting point of the project was that the heating systems in the schools, the city hall, the kindergarten and the church in the village needed refurbishment. Additionally, farmers and forest owners complained that selling firewood had become more and more difficult because many households had switched their fuel supply to natural gas and heating oil.

In March 2000, a cooperative of potential biomass-suppliers formed who wanted to build a district heating plant and supply it with woodchips. Members of the cooperative own altogether about 500 hectars of forests, the cooperative is able to supply 1,400 m^3 of woodchips per year, which amounts to roughly 80% or more of the annual fuel demand of the plant.

Support and first advice was provided by Agrar Plus, which is an agency owned by the Federal State of Lower Austria. Agrar Plus supports different types of projects in rural areas by advice.

Problems for the project were the identification of the site for the heating plant – too close to existing buildings meant resistance by the neighbours, too far from the buildings would mean too high costs for pipe system and pumping power – and the persuasion of a sufficient amount of customers to make the project financially feasible. These problems were tackled and solved during a pre-planning and planning process which took two years.

Detailled planning started in late 2001. On Oct. 5th, 2001 the project was presented to the public. Construction at the site, which means building of the boiler-house, purchasing and installing the boilers, digging the ditch for, and laying of, the pipe-system, connecting the houses and completing the plant ready to run, was implemented between June and September 2002. Such short periods of installationafter a relatively long periode for project preparation are common for biomass district heating plants. Altogether 12 companies, planners, suppliers and local craftsmen were involved in the construction and completition of the plant.

The plant is dimensioned for the buildings in the center of Steinakirchen. If needed, it could be extended to furtner buildings.

Technical and financial parameters for this plant

Connected heat load	789 kW (589 kW public buildings, 200 kW private homes and reserve)
Power of the boiler	500 kW, Peak demand supplied by a heat storage puffer with 15 m^3
Reserve system	heating oil
Length pipe system	340 m
Annual fuel demand	1,400 m^3 woodchips

The fuel supply by the cooperative generates an income of roughly 20,000.- € per year for the members of the cooperative

Total investment	550,000.- €

Reduction of emissions by the project

CO_2	-352 tons per year
SO_2	-90%
NO_x	-31%
C_xH_y	-87%
CO	-71%
Dust	-31%

Costs for the customers

Connection of the building:	1,090.- € + 145.- per kW (one time charge)
Heat transfer station:	3,270.- (one time charge)

Heat tariff: € 20.35 per kW + € 53.05 per MWh + € 58.14 per year

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4 District Heating in Central and Eastern Europe

4.1 Introduction

DH and CHP play a vital role in the energy supply of Central- and Eastern European Countries (CEEC).

The supply rate averages more than 40 % on the total room heat market in those countries. Large cities have an even higher share and it can average more than 60 %. For example, the DH supply of Moscau, which has approx. 12 Mio. Inhabitants has a connection value of approx. 12.000 MW and a share of 82 % on the total room heat market. However, the rehabilitation demand in the heating and DH sector is rather large. Heat losses of 20 to 30 % are not seldom.

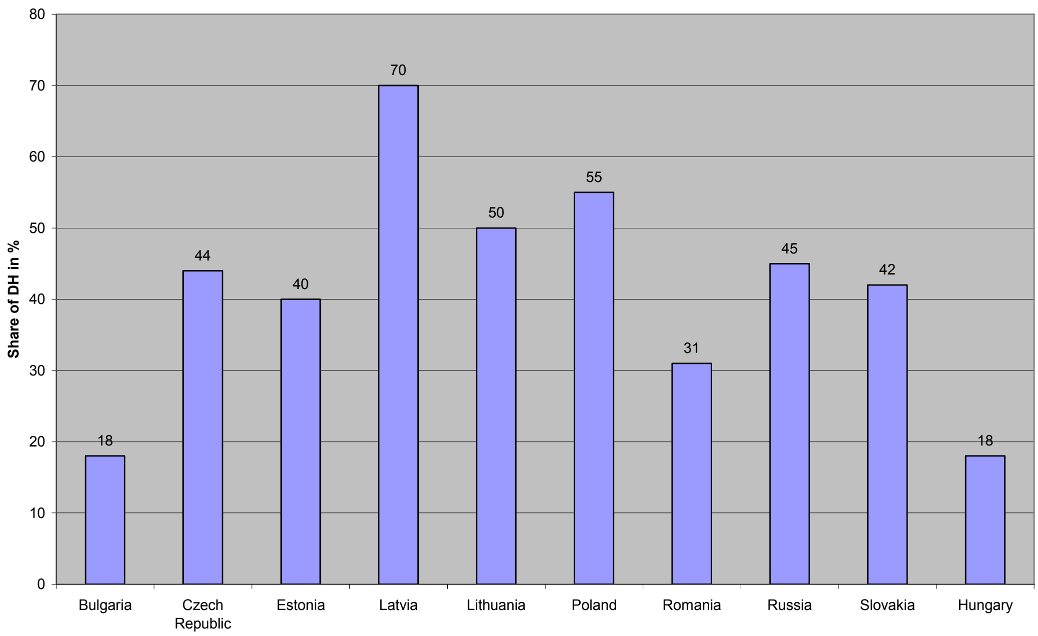

Figure 22: Share of DH supply on the room heat supply in Eastern Europe, 2005; Source: AGFW

In the past heat prices were extremely low and consumers covered only a small percentage of the real cost. The substantial percentage of heat generation and transmission costs was covered by subsidies from central and municipal budgets.

Reduced subsidies as a consequence of the economic transformation and consequent rapid increase of heat prices have been an economic shock to heat consumers, especially households.

4.1.1 Private sector involvement

Prior to the privatisation, district heating companies were not legal entities and independent economic entities but a part of a large governmental energy complex. This meant that costs for, and income of, these DH plants, the debts, and basically all business management parameters of the plants, were unknown and thus it was difficult to put a realistic price on the sold heat. The most important step ahead of the privatisation was the legal and economic outsourcing of those companies. A pressing issue is the business accounting seperation, which is necessary in order to estimate the value through the balance sheets.

A big obstacle for private investors can be subsidised DH tariffs (since they are not cost-covering and thus are not cost transparent). Legal uncertainty is another potential obstacle for private investors.

The following questions have to be addressed before private investors engage:

- is the ownership ensured (right of property),
- which rights does one have in regard to the tariff structure/composition,
- has the fuel supplier the right to stopp the supply all of a sudden or to increase the price,

In a nutshell, the basic framework conditions have to be clear and transparent for all stakeholders involved. If certain framework conditions/legal documents are not in place, the risk is disproportionally high on the side of the private investor. Further obstacles can be the reputation of the country, such was the case in Bulgaria and Romania. Inflation, economic framework conditions, political connections, all these issues have to be taken into account.

4.2 District heating in Bulgaria

In Bulgaria, almost all DH systems were built between 1960 to 1980. In the densely populated urban areas of Bulgaria, DH plays a dominant role by supplying approximately 500,000 flats with heat. Gas and coal are used as fuel.

46 companies have licenses for the production of electrical and thermal energy. Most of them are industrial firms, which operate combined heat and power plants. These industrial enterprises do additionally operate some small networks for heat supply for residential buildings.

The difference between classic DH companies which were established to supply heat to various buildings, and industrial enterprises, who operate the combined heat and power plants and mostly cover their own demand, is not always that clear.

The official status of the DH sector in Bulgaria is not quite complete. For example, the municipal DH company in the town of Smolyan is not mentioned in any list. Of the 46 companies with licenses for the production of electrical and thermal energy, 25 are likely to be classic DH companies, which supply mostly external buildings and other companies.

Apart from 4 DH companies (Pernik, Shumen, Smolyan and Sofia), all companies are in private hands. The DH companies in Sofia and Smolyan are owned by the municipalities themselves, the other two in Pernik and Shumen are 100% state-owned property. Since the beginning of 2008, the procedures for the privatisation of DH systems of Pernik, Shumen and Sofia are under preparation.

The largest DH company is the one in Sofia, which alone accounts for approximately one third of the entire DH sectors concerned. 87% of Sofia’s households are supplied by them.

In the reform era after 1989, all DH systems had many technical, financial and political problems to overcome. In the 1990s, awareness slowly grew for the real costs and the poor condition and inefficient operation of the DH systems in place. The collapse of the industry, and thus the elimination of the largest customers and the reduction of subsidies for the DH prices have also aggravated the situation further.

In addition, the confidence of the customers in their heat supplier declined rapidly. The DH companies were considered part of the government, which saw its reputation with the fall of the iron curtain almost irreparably destroyed.

The subsidy cuts, which increased the heat prices more and more, irritated many customers additionally. Most recently, a few corruption cases have further damaged the confidence in the DH sector.

Public relations and customer orientation are still an alien practice for the DH companies at present. Furthmore, the quality of heat supply is often insufficient in several rooms, and sometimes it is even necessary to use individual furnaces in addition. The customers were not informed about the imminent reforms, such as subsidy cuts, the introduction of the usage-bound heat billing system and the privatisation of the sector.

Customer care is not on top of the agenda. The DH companies were at best interested in their sold MWh. As a result, the originally fairly good payment behaviour declined and more and more households deregistered from DH and switched mostly to electric heaters. This damaged the already weak financial DH companies even further.

Small suppliers often have to suspend their heat deliveries, e.g. Kazanlak DH, heating period 2005 / 06: they could not pay their gas bill; Stamboliyski DH, heating period 2005 / 06: their licence was withdrawn from the regulator.

In 2004, the privatization of DH companies started. To date, all but the 4 mentioned enterprises from above (Pernik, Shumen, Smolyan and Sofia) are privatized.

4.2.1 Installed capacity

In 1994, the heat supplied (heating load) to industrial enterprises amounted to 1.782 MW and for households and public buildings to 7.439 MW.

Table 4: Installed capacity of 22 DH systems, 1997. Source: USAID (2006)

	Installed capacity in MW	**Peak load in MW**	**Share of used load on Peak load**
Companies	**MW**	**MW**	**%**
Sofia	5.314	2.705	51%
Pernik	384	219	57%
Sliven	291	167	57%
Kazanlak	81	47	58%
Pleven	471	263	56%
Gabrovo	105	57	54%
Plovdiv - Nord	390	224	57%
Plovdiv - Süd	419	233	56%
Shumen	477	281	59%
Burgas	477	286	60%
Varna	128	77	60%
Ruse	273	148	54%
Vraza	235	140	60%
Veliko Tarnovo	138	80	58%
Razgrad	19	11	58%
Yambol	36	19	53%
Lozniza	3	2	67%
Pravets	33	20	61%
Samokov	16	10	63%
Lovech	8	5	63%
Triavna	19	10	53%
Iskrez	2	1	50%
Total	**9.319**	**5.004**	**54%**

Obviously, the entire DH sector consists of oversized plants. In actual fact, only approximately 54% of the installed capacity is used. This leads to an inefficient operation of the plants.

4.2.2 Efficiency of heat production, transmission and distribution

The average efficiency in the production of heat for all the 14 plants reviewed above is 90%. For installations with cogeneration, the rate is 82.5% and for the normal heat plants 92%.

The heat losses in the distribution systems without Cogeneration are slightly higher at 21.4%. For systems with Cogeneration, the rate is 19%. One of the reasons for this might be that Sofia DH, which also operates plants for Cogeneration, has substantially reduced its distribution losses in the most recent years. In 2004 the losses amounted to approximately 16.6%.

For the remaining 13 plants, which were analysed, the network - losses averaged 24.2%.

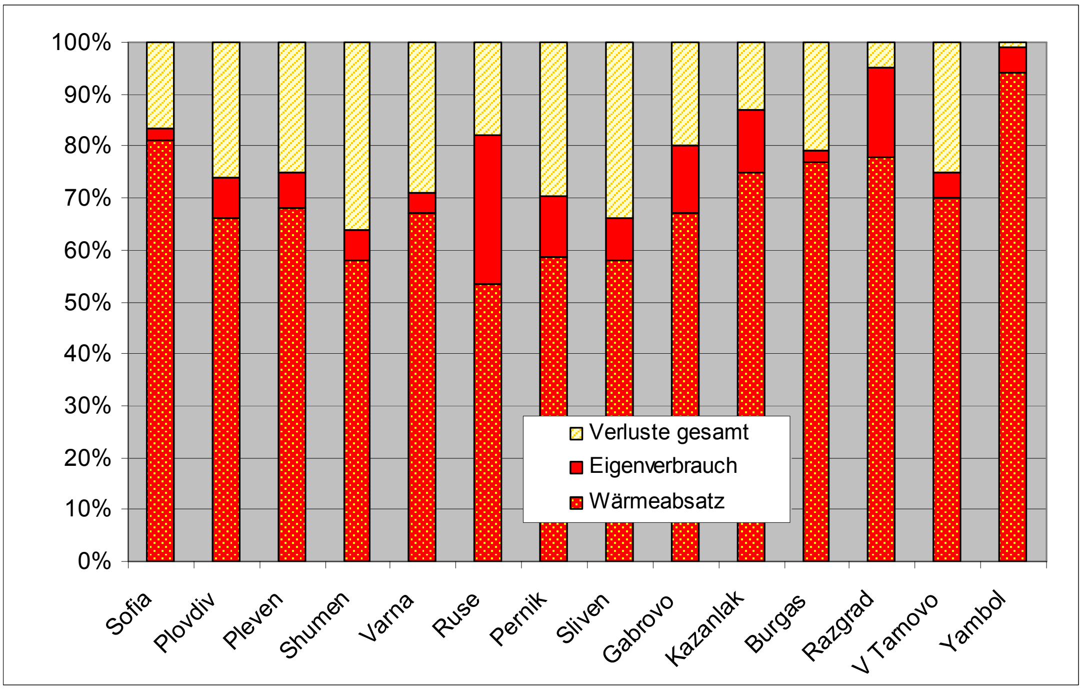

Figure 23: Shares - distribution losses, own consumption and heat sales, 2004. Source: USAID (2006)

The small distribution losses of the DH Yambol and the large domestic consumption of DH Ruse strike out. The DH Ruse also operates a thermal power plant.

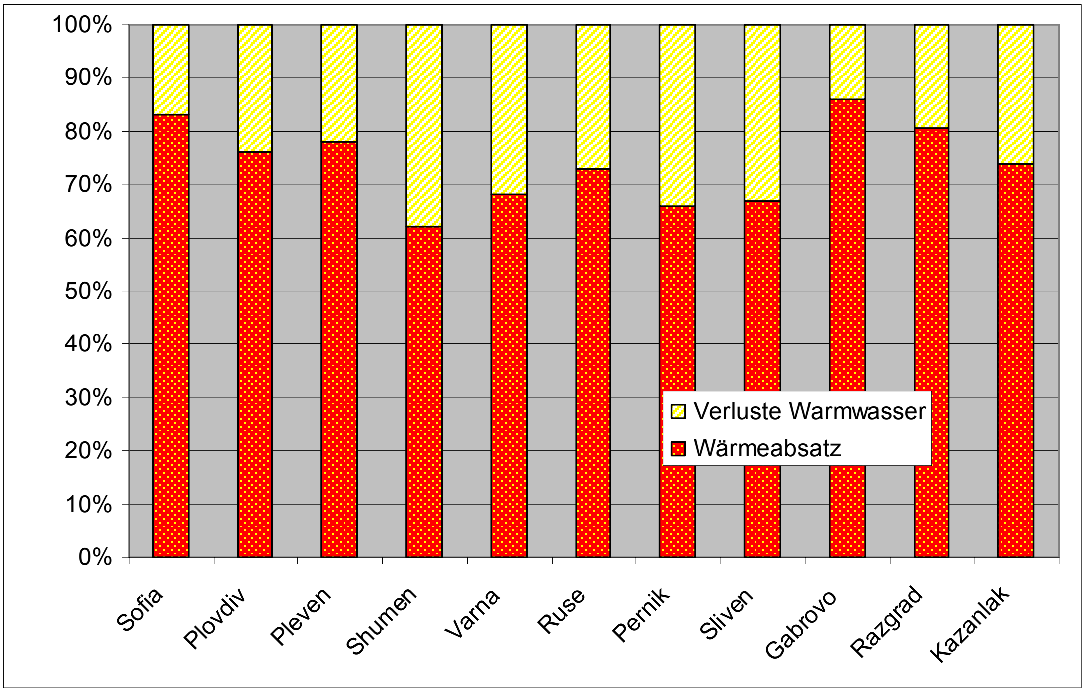

Figure 24: Shares - distribution losses and heat sales for heat, hot water, 2004. Source: USAID (2006)

The distribution losses with steam are much higher. Especially the DH Sofia and Plovdiv have very high losses of more than 60% in the steam distribution. This is explained by the sharp decline of steam demand from the industry since the 1990s, and because of the negligible investments in the steam network.

Table 5: Production and efficiency of selected district heating plants, 2004; Source: USAID (2006)

	Unit	Sofia	Plovdiv	Pleven	Shumen	Varna	Vraza	Pernik	Sliven	Gabrovo	Kazanlak	Burgas	Razgrad	V Tarnovo	Yambol
Total energy production	10^6 kWh	6.472	704	548	118	106	1.111	890	293	70,4	110	290	39,5	85,4	3,3
Input coal	10^6 kWh	7.565	850	706	140	115	2.242	2.613	792	120	144	301	41,9	107	5,1
Efficiency of production	%	85,5	82,7	77,7	84,4	91,9	49,6	34,1	37,0	58,7	76,7	96,4	94,3	79,6	65,1
Coal equvivalent of electricity production	10^6 kWh	1.595	212	149	24,0	10,5	1.453	2.117	623	21,8	6,8				
Efficiency electricity production	%	54,9	64,3	48,2	51,0	30,0	31,7	24,4	28,3	39,7	46,4				
Input coal for heat	10^6 kWh	5.970	639	557	116	105	790	496	169	98	137	301	41,9	107	5,1
Efficiency of heat production	%	93,7	88,8	85,6	91,4	98,2	82,4	75,5	68,9	62,9	78,2	96,4	94,3	79,6	65,1
Total electricity production	10^6 kWh	876,0	136	71,90	12,20	3,16	460	516	176	8,65	3,17				
Own consumption electr. power	10^6 kWh	222	17,80	15,80	4,34	0,45	71,50	127	28,50	2,90	0,74				
Own consumption electr. power	%	25,3	13,1	21,9	35,4	14,2	15,5	24,6	16,2	33,5	23,4				

Table 6: Production and efficiency of selected district heating plants, 2004; Source: USAID (2006)

	Unit	Sofia	Plovdiv	Pleven	Shumen	Varna	Vraza	Pernik	Sliven	Gabrovo	Kazanlak	Burgas	Razgrad	V Tarnovo	Yambol
Total heat production	10^6 kWh	5.596	568	476	106	103	651	374	117	61,7	107	290	39,5	85,4	3,3
Heat production steam	10^6 kWh	97,43	62,18	106,08			207,78		21,06	4,20	37,35	3,85	3,15		0,43
Heat production hot water	10^6 kWh	5.349	461	338	99	99	263	329	87	50	58	281	34	81	3
Heat production own consumption	10^6 kWh	148,79	43,94	32,57	6,63	3,81	179,87	41,87	8,62	7,45	11,96	4,67	1,89	3,94	0,029
Heat production own consumption	%	2,7	7,7	6,8	6,3	3,7	27,6	11,2	7,4	12,1	11,1	1,6	4,8	4,6	0,9
Heat sales steam	10^6 kWh	36,50	18,72	64,34			154,25		9,68	3,39	37,35	3,85	3,05		0,43
Heat sales hot water	10^6 kWh	4481,9	355,0	263,0	61,8	68,2	195,7	219,4	58,9	38,2	43,4	220,0	27,8	60,1	2,7
Total heat sales	10^6 kWh	4.518,4	373,7	327,6	61,8	68,2	350,0	219,4	68,5	41,6	80,7	223,9	30,9	60,1	3,1
Total heat sales	%	80,7	65,9	68,7	58,5	66,2	53,8	58,6	58,8	67,4	75,2	77,2	78,2	70,4	93,9
Heat losses	%	15,5	18,7	15,7	35,3	30,1	10,4	29,2	24,1	19,3	13,7		16,7	25,0	
Total heat losses, steam and hot water	%	16,6	26,4	24,4	35,3	30,1	18,6	29,2	33,9	20,6	13,7	21,2	17,0	25,0	5,2

4.2.3 Tariffs, heat billing and policy of the regulators

During the 1990s the financial result of all district heating plants was negative. The main reason for this was the low government-regulated price in place for households. The tariff was set uniformally for all district heating companies but the production and distribution costs of the heat could not be covered. Despite government subsidies of the heat price, the number of customers from the household sector constantly decreased.

Despite the ongoing subsidy reductions the district heating companies encountered further losses through the following reasons: Insufficient investments, poor billing and dunning processes, and an increasing number of customers which unsubscribed from the heat supply. The subsidies for the heat price would only have covered the costs if the customer had paid the heating costs. However, this was not always the case.

In the 1990s, the situation of the district heating sector in Bulgaria can be described as follows:

- The heat tariff did not cover the costs for production, transport and distribution of the heat
- The district heating companies were subsidized from the side of the state budget
- No equity capital for investments existed
- From a financial (accounting) point of view, DH companies could not cleary be distinguished
- There were no incentives in place for the improvement of the efficiency
- The heat billing was based on a flat-rate, the households had no possibility to regulate the heat intake – except by sealing the radiators.

In 2002 the Law on a usage-bound heat billing system was introduced and started to dismantle the subsidies. A tariff reform was launched in 2005 which completed the abolition of the subsidies altogether. The heat prices for businesses on the other hand, have not been subsidised since 1st of September 1998. At that time, two different heat tariffs existed: one for households and one for businesses. For households, there was a national wide equally high tariff in place, which was independent from the DH company. The household tariff was approved by the Council of Ministers based on a proposal of the regulator. This rate covered about 60% of the actual costs. For industrial enterprises, the tariff with the DH companies was individually defined and agreed by contract. This tariff was a collective set of all costs and a 7% surcharge.

Subject to a plan of the government, the subsidies for households should be eliminated by 2001. In actual fact however, the tariff increases did not lead to a complete subsidy reduction, but to a significant decline of customers. Depending on the district heating company, around 20 % to 50% of the clients unsubscribed from the supply.

The tariff for households was increased as follows:

1999	22 %
2000	6,8 %
2001	2,7 %

Taking inflation into account, the increase of these three years only amounted to 8 %. However almost all customers only noticed the nominal increases but not the real increases which led to a mass deregistration from the DH supply.

This situation has resulted in an additional cost of the heat supply for households, which continued to receive DH. There are several reasons for this, firstly those households heated the walls of the deregistered neighbours, and secondly, they had to cover the heat losses of the entire heat distribution of the building, which was obviously split between less and less households. This meant that the tendency of deregistering from DH even further intensified.

All concerned legal entities, including the government, the regulator and the Energy Ministry as owner of the district heating companies, did not enlighten the population about the real extent of the tariff progression. This neglect of the customer and the non-existent communication/information policy brought the state district heating companies in a serious existential crisis.

Since 2002, the State regulator DKEWR (Държавната комисия за енергийно и водно регулиране, State Energy and Water Regulatory Commission SEWRC) is responsible for the determination of heat tariff. The method of the regulator to regulate the price of the district heating sector is called ‘return on assets’. Furthermore, the regulator determines ‘preferential’ prices for electrical energy from Cogeneration.

As mentioned above, a law on usage-bound billing came into force in 2002. Technical prerequisite for this billing system is a ‘summenwärmezähler - is a sum heat meter’ provided for each building, which collects the heat data for the whole building. The heat load is then, based on the individual consumption, divided between the individual apartments. The installation of these heat meters was supported by World Bank loans.

In order to be able to account for the heat transfer of one apartment to another, or the distribution network in the building, a split tariff was introduced. This meant that part of the delivered heat, which was measured for the whole building on the heat meter in the basement, was fixed depending the respective size of the flats. In other words, this meant that flats which had their radiators switched off, still had to pay a fixed amount between 10 % - 20 % of the heat consumption of the whole building corresponding with their flat size (in the years between 2001 – 2006 this fixed amount fluctuated between 0 % - 30 %. This also means, that the regulator and the legislator experimented with this system in order to find the most appropriate model of heat billing). The remaining consumed heat was than, according to the consumption, measured and divided between the flats. In the years 2002 to 2006, it was up to the residents of the building to decide how high the fixed rate of the heating costs should be.

According to the regulation this fixed rate amounted to 10 % - 30 % and had to be paid by all the households, independent of their real consumption. A majority of 85% of the households decided to opt for a share of 15%. The result was that all radiators had to be fitted with thermostatic valves according to the new regulation. If that was not the case, the heat billing was according to a flat rate - based on the size of the flat and an additional surcharge of 10 %. These changes meant that many households opened up their radiators and put them back into operation, and thus re-connected to the DH.

In the period between 2000 and the end of 2003, almost all 500,000 DH supplied flats in Bulgaria were switched to usage-bound heat billing system. The costs for an apartment with 4 radiators amounted to BGN 200 or € 100. The installation of these facilities (thermostat valves and heat cost allocator) and the readings and billing were carried out by specialized firms, which had a special license from the state regulator. The successful companies deducted the costs for the installed facilities via payment by instalments in order to strain the budget of the households not to the maximum.

At the time of the introduction of this billing system, the monthly income of an average Bulgarian household amounted to € 150 to 250. The annual cost for heating and hot water during this period amounted to € 200 to 300.

At the time of the introduction of the statutory usage-bound billing system, the heat tariff was still regulated and amounted for the households to the following:

Fixed rate: 0.045 BGN / m3

Heat Tariff: 34.05 BGN / MWh [2]

Exchange rate: 1 € = 2 BGN

The introduction of the usage-bound split tariffs mainly brought benefits for the customers.

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[2] After the complete abolishment of the subsidies in 2005, the heat tariffs of the DH companies doubbled or even trippled.

Mainly because now the customers had the possibility to individually regulate their heat consumption via the thermostat valves and did not have to use drastic measures such as seal their radiators. The achieved savings amounted to 20 – 30 %. Nevertheless, those measures lead to long lasting irrelevant and controversial campaigns in the media, initiated through the Bulgarian Association of Consumers.

As mentioned above, during this period the subsidies for district heating were also dismantled, and the savings through the usage-bound billing system were not apparent nor comprehensible for the end-users. On the contrary, the heating costs increased after the abolishment of the subsidies. The usage-bound billing system even had the reputation that it was one further mean to get the better of the households.

These confusing debates were not clarified through an adequate information/communication policy of the Ministry for Economics and Energy. Thus, this legislative initiative was rather damaging for the image of DH and thus the undeniable advantages of this new billing system were not fully appreciated.

That is why it is important to stress the relevance of a well organised information campaign/policy and furthermore the involvement of the customers in such initiatives. It seems that finally in 2008, slowly some objective discussions are beginning to emerge, and some policies from certain energy suppliers are starting to think for the first time in a customer-orientated manner.

The payment behaviour of the customers was according to the involved companies satisfactory. 70 to 75% of households paid their bills regularly. Only about 1 to 2% of invoices were uncollectible. The remaining 25 to 30% paid their bills late. The cause of these late payments was mainly due to the poor dunning process of the district heating companies themselves. In some cases, billing reminders were never sent out, so that some customers did not pay for months or years and when the companies finally caught up with them, the dept was so huge that the dept could no longer be recovered.

Comparison of different heating systems and fuel

Despite the increase of the tariffs, district heating in urban areas is still one of the cheapest ways of heating. In Table 8 the prices of different heating systems are compared. Natural gas for households is only available since a few years. Previously, natural gas was exclusively used for industry, power plants and district heating plants. Many regions are still not connected to the gas network.

The gasification of the households is done in a rather slow manner. For most households, the connection costs to the gas network are too high. Precise data on the connected household numbers are not published. The number of households connected to the gas network is estimated at approximately 150,000. At the end of 2003, around 3,360 and the end of 2004 around 4,700 households were connected to the gas network. Only 2.5% of natural gas is used for the household sector. The costs for equipping a flat amounts to around € 800. The connection fee is between € 100 to 450 per household, depending on the gas companies. The price which is related to the calorific value of natural gas is comparable with that of DH. Officially, there is no regulation in place which states that the gas network cannot be extended to DH served areas.

In practice however, only areas which are not supplied by DH are issued with a licence.

Table 7: Energy sources for space heating, 1997; Source: Velody at al (2003)

	Sofia		City		Country		Total	
	1	2	1	2	1	2	1	2
	%	%	%	%	%	%	%	%
District heating	68,29	71,07	10,75	18,63	0,00	0,00	14,47	19,65
Electric power	11,59	12,30	33,02	44,96	2,61	5,23	18,57	28,73
Wood / Coal	20,12	13,74	55,03	34,91	97,39	94,00	66,38	50,10
Oil	0,00	0,72	0,68	0,99	0,00	0,08	0,33	0,68
other	0,00	2,17	0,51	0,62	0,00	0,25	0,25	0,84

1: households with below avarage income
2: households with above avarage income

Electric energy is a serious competition for DH. Many households switched from DH to electric heaters. The main reason is likely to be the easy regulation. With the introduction of the usage-bound heat billing system those flats also had the same conditions as the other flats. At present, air conditioning systems (Luft Wärmepumpen) are very popular. In the transition period, when the outside temperature is above 0 ° C, heating with those heating devices is relatively cheap.

Wood and coal is mostly available in rural areas. In smaller cities, especially cities without DH solid fuel stoves have substantially increased. Oil has no importance in the household sector. Public buildings are often heated with oil boilers, especially in those regions which are not connected to the gas network. In the areas which are connected and supplied by the existing gas network, the burner of the oil boilers are exchanged with gas burners. This is one of the most widely used measures in regard to public buildings.

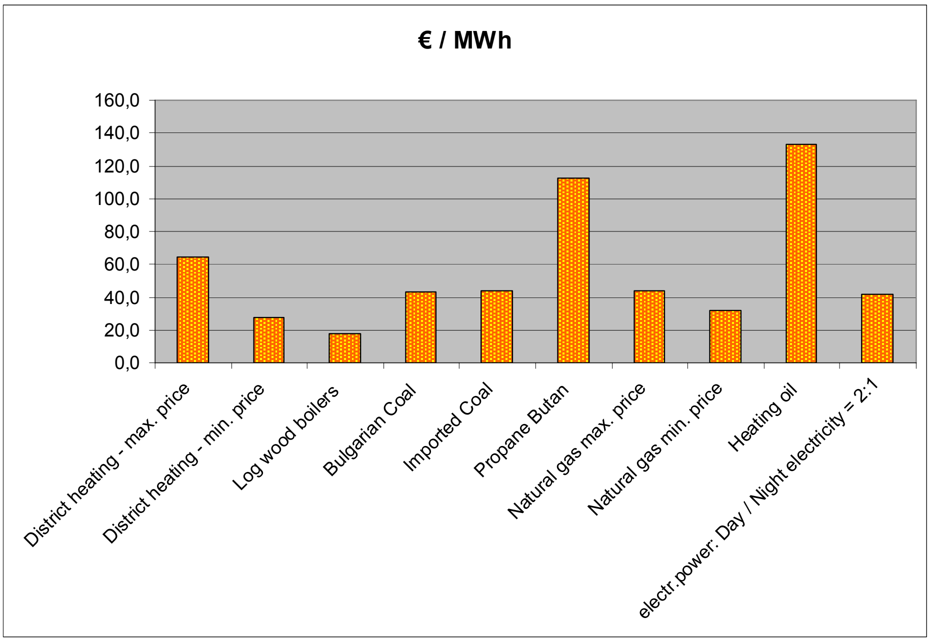

Figure 25: Comparison of specific heat cost of various energy sources, taking into account the annual use efficiency of the plant

Table 8: Comparison of the specific heat cost of various energy sources, taking into account the annual use efficiency of the plant

	Price / MWh	η
District heating - max. price	64,7	
District heating - min. price	27,4	
Log wood boilers	17,6	80%
Bulgarian Coal	43,3	80%
Imported Coal	44,1	80%
Propane Butan	112,5	85%
Natural gas max. price	44,1	90%
Natural gas min. price	31,6	90%
Heating oil	133,4	85%
electr.power: Day / Night electricity = 2:1	41,43	95%

4.3 District Heating in Romania

4.3.1 Case Study: District Heating Piatra Neamt, Romania

The DH company of Piatra Neamt is a stock corporation with five owners, whereas the municipality of Piatra Neamt owns 99,5 % of the stock shares.

The DH system is decentralised and consists of 50 individual boiler units, which supplies a total of 465 residential buildings with 13.740 flats, respectively 618.300 m2 floor space.

Most of the local boiler units have already been modernised; i.e. have been exchanged with standardised container systems.

The old boiler units use 176 m3 gas or 1,57 MWh of gas for the production of one MWh of heat. In comparison the new boiler units use 130 m3 gas or 1,16 MWh of gas for the production of one MWh of heat.

Hence, the efficiency of the new boiler units has increased by 26 %.

The flats belong 90 % to private owners. The heat is invoiced on a flat rate but are also usage-bound (according to consumption).

The heat delivery to the individual residential buildings occurs directly without a heat exchanger. The secondary system in the residential buildings is an open system, with an open expansion tank on the roof of the building, which creates corrosion through the access of air. The distribution system in the buildings is not insulated. Improvement of the heat distribution in the buildings as well as an indirect heat transfer (transmission) through the installation of automatic heat exchanger could improve the efficiency significantly.

The heat tariff amounts to 121 Lei / Gcal incl. 19 % VAT or respectively € 33,61 / MWh. The heat tariff of DH Vienna is about the same in comparison: € 31,83 / MWh incl. 20 % VAT. The DH Vienna invoices for space heating a flat- and energy rate (Grund und Arbeitspreis) –

incl. the flat rate one MWh, with a specific consumption of 100 kWh / m2 per year in a flat of 70 m2, would amount to € 34,83.

80 % of the heat tariff of the old units result from the gas costs. In comparison the heat tariff of the new units only result from 60 % of the gas costs. The heat is still subsidies (see Figure 26).

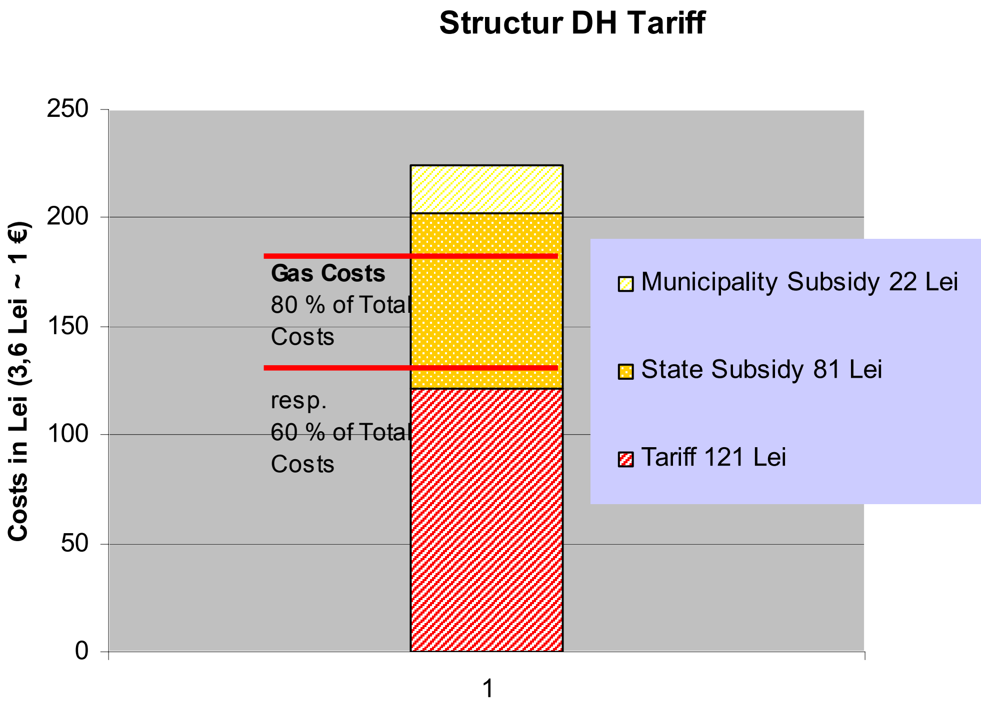

Figure 26: Structure of the heat tariff of DH „Locato" – Piatra Neamt

The tariff of 121 Lei per Gcal does not cover the production costs. The real costs for one Gcal amount to 221 Lei, or respectively € 53,3 per MWh. The municipality subsidises this price with 10 % and the state with 45 % substitution of the gas costs.

9,4 % of the total costs result from the expenditure of the modernisation and maintenance. The same amount of heat from individual gas boiler costs approximately the same amount. At a heat value of 10,4 kWh / m3 and an annual degree of utilisation (efficiency) a combined gas boiler (heat, warm water) of 90 %, one MWh heat costs € 31,4 incl. VAT at a flat heating (Gasetagenheizung) in Piatra Neamt. Thus, approximately 7 % less.

Numerous flats in the DH supplied buildings changed however to a individual gas port with self-contained central heating. In this case, the possibility of a fuel switch to biomass (wood chips) should be taken into consideration. At present, one MWh natural gas costs € 23,56, one MWh from wood chips costs € 16,5.

Plants of the DH „Locato“ - Piatra Neamt

Figure 27: Old DH station with 6 x 0,5 MW gas boilers

Figure 28: Plants of the DH „Locato“ - Piatra Neamt: Interior room of the old DH station, also a favourite place of the locals to keep their potted plants

Figure 29:Old gas boilers – 500 kW, the burner can only be regulated manually

Figure 30: Old gas boilers – 500 kW

Figure 31: Block boiler unit, the funnel is attached to the residential building

Figure 32: Modernised block boiler units in a standardised container construction

Figure 33: Modernised unit

Figure 34: Modernised unit

Figure 35: DH supplied building with numerous flats, which have switched to individual gasetagenheizungen – see the funnel next to the windows

Figure 36: Individual gas supply in flats in a DH supplied building

As soon as households can afford a switch to an individual gas supply and gas-floor heating, a lot get disconnected from the district heating. Because of these problems the DH system in Piatra Neamt has difficulties surviving. Through the individual boiler a lot of the advantages of the district heating disappear, especially such as the independence of the fuel and waste heat utilisation. Additionally, the old inefficient units burden the DH company even more.

Many DH systems in Romania face the same problem, not only from the competition of natural gas. Most of the flats supplied by DH are not yet switched to individual heat cost billing. In mid 2008, according to Techem (Heizkostendienstleister), approximately 600.000 flats, thus only one third of the 2 Million flats supplied by DH, pay according to their real consumption. With gas-floor heating, the consumption can be individually regulated and is also billed according to the consumption. This enhances the attractiveness of these systems.

In conclusion, the DH companies do not practice a consumer orientated strategy – they see themselves rather as heat producers than as a service provider.

5 District Heating of Vienna

5.1 Overview

The history of Vienna's municipal district heating company Wien Energie which was founded in 1963 is well documented. In this section, we explore the current status of the DH network of this company and the companies strategy and attitude towards its clients and what initiatives have been introduced in the last decades. Today District Heating Vienna is one of the most popular municipal services.

According to Wien Energie (Annual Report 2006/2007), they deliver electrical power and gas to a total of around 1.2 million private customers, 230,000 businesses and 4,500 farms within its supply area. Approximately 270,000 customers are also supplied with district heating.

With 5,453 employees and 194 trainees, Wien Energie is also one of the largest employers and providers of on-the-job training in the Greater Vienna metropolitan area. Wien Energie GmbH is a wholly-owned subsidiary of Wiener Stadtwerke Holding AG and, as such, is indirectly owned by the City of Vienna. Wien Energie Fernwärme (Wien Energie District Heating) is the largest player in Austria's district heating market and also operates waste incineration facilities. The corporate strategy and objectives of Wien Energie are stated clearly in their Annual Reports and range from security of supply and sustainable management to commercial success. Ensuring a reliable supply of electricity, gas and heating, as well as associated services, for around two million customers requires vision and the resources for continuous investments in infrastructure.

5.2 CHP for district heating

In addition to its sources of renewable energy (solar, photovoltaic, wind, etc.) Wien Energie also has efficient thermal power stations at Simmering, Donaustadt and Leopoldau with a total electrical capacity of around 1.500 MW and a thermal capacity of 1.050 MW. According to Wien Energie, the use of combined heat and power technology enables the waste heat from electricity production to be used as district heating, allowing efficiency ratios of up to 86 % to be reached. Around 61.5 % of the total production of district heating originates from these CHP plants; around 35 % comes from the incineration of waste. Only 4 % of district heating requirements are covered by primary energy sources used to meet demand during peak periods.

Furthermore Wien Energie states that these savings in terms of fuel allow CO2 emissions to be cut by 1.257 million tonnes per year compared to using heating oil. A comparison of the various methods of heating highlights the advantages of district heating: it creates only around a third of the emissions associated with heating oil. And, with just 132 kg of CO2 per MWh of output energy, it is also much more environmentally friendly than oil burning power stations.

In 2008, Wien Energie has accumulated almost 40 years of experience in the use of highly efficient technologies in the field of DH. Because of the co-generation technology, the waste heat generated in the thermal power stations can now be used for district heating purposes. Around 61,5% of the entire heat requirements of Viennese DH is generated this way. The remaining heat is obtained from waste incineration, the co-generation plant owned by OMV at it refinery in Schwechat and from peak load boilers and heating centres.

In total, Wien Energie states that it has the capacity to generate up to 2,871 MW of district heating which is then distributed to customers via a network of pipes extending over 1,000 km. This network consists of supply and return pipes through which the heated water reaches the customer and cooled water flows back. The actual heat exchange takes place in converter substations in the cellar of the customer's house where the district heating water heats the water in the building's own central heating and hot water systems.

5.3 DH network infrastructure

The network infrastructure of Wien Energie DH is divided into primary and secondary networks. Large quantities of heat are transported through the primary network at high pressure. This is then fed into the secondary network at so-called transfer stations. The narrower, low-pressure pipes of the secondary network transport the heat to customer's building and heating systems. According to Wien Energie in 2006/2007, the total district heating network consists of 1,079 km of pipelines.

Table 9: DH network in km; Source: Wien Energie

District heating network in km	2006/2007
Primary network	528.3
Secondary network	546.6
Total district heating network	1,079.9

5.4 Local heating

Energiecomfort, a subsidiary of Wien Energie, has specialised in this field. With a workforce of around 135 in Austria, Energiecomfort provides heating to over 600 business and more than 9,000 private customers.

Unlike district heating, which is the supply of large numbers of customers in metropolitan areas using major power plants and extensive distribution networks, local heating is on a smaller scale and relies on environmentally sensitive biomass heat generation distributed through a communal network of heating pipes.

Table 10: LH network in km; Source: Wien Energie

Local heating network in km	2006/2007
Primary network	40.2
Secondary network	19.5
Total local heating network	59.7

5.5 Case Study: Biomass power plant

In October 2006, the largest forest biomass power plant in Europe started its full operation. The plant has a total installed capacity of 66 MW. This power station supplies around 48,000 households with electricity and a further 12,000 with district heating. In comparison to a conventional thermal power station, this facility saves around 144,000 tonnes of CO2 per year according to Wien Energie. The investment volume amounted to € 52 million.

Figure 37: Biomass power plant; Source: Wien Energie

5.6 Customer Service: Operating Day and Night

For Wien Energie, satisfied customers combined with a sustainable and environmentally sensitive approach to tapping natural resources remain top priorities, as stated in their Annual Reports. The first plans for the establishment of customer advice centres were developed as early as 1983. The milestones reached since then include the opening of an energy advice section at a customer service centre in the mid 1980s, numerous trade fairs, cooperations, the so-called Wien Energie Days and the Energy Savings Voucher scheme that was in place until 2002. According to Wien Energie, the range of services offered are constantly adapted to meet changing circumstances. Wien Energie further states, that today this translates to providing numerous advisory services via their Website. However, personal contact remains the top priority for Wien Energie. Around 270 employees work in a total of twelve customer centres conveniently located throughout the Wien Energie supply area, as well as in the Group's call centre.

Table 11: Timeline of Wien Energie energy advice, Source. Wien Energie

1988	The first energy advice was offered at an information event. Many such events are now held every year as a means of informing customers
1989	The first major energy saving campaign in Vienna
1991	Organisation of the first ever Wien Energie Days event
1992	Opening of an advice and building grants centre for solar energy
1993	Development of an energy saving board game as a tool to promote awareness of the use of energy
1993	Use of a book of energy-saving vouchers as an unbureaucratic way of offering advice (discontinued in 2002)
1994	First special training of employees to become energy consultants
1997	The Energy Advice Centre (Wien Energy House) opens on Mariahilfer Strasse. Over 700,000 visitors and rising
Since 1997	Educational tours at the Energy Advice Centre for groups of all ages
1998	First involvement in the Vienna Holiday Game – a series of summer events
2001	Start of educational seminars for pensioners on the subjects of the Internet, mobile phones and digital photography
Since 2005	Training events for teachers on various energy-related topics

The Wien Energie customer advice centre celebrated its 10th anniversary in 2007, in which it has set new benchmarks in the areas of customer advice and care.

6 Bibliography

Austrian Energy Agency (2008, online). www.energyagency.at

Austrian Energy Agency (1998). Lessons Learned from the introduction of Biomass District Heating in Austria. http://www.energyagency.at/projekte/biomass.htm

Austrian Energy Agency (2008, online). Austrian-Bulgarian Energy Partnership http://www.energyagency.at/projekte/bul_enpa.htm

Austria Energy Agency (2008, online). Austrian-Romanian Energy Partnership (internal Report)

Austrian Energy Agency (2006). Successful CHP-Projects in Slovak Republic

Austrian Energy Agency (2006). Successful CHP-Projects in Czech Republic

Dalkia (2008, online). http://www.dalkia.de

District Heating in Candidate Countries (DHCAN, 2007).Towards a modern customer – driven district heating system in Debrecen

District Heating in Candidate Countries (DHCAN, 2007). Management Guide

District Heating in Candidate Countries (DHCAN, 2007). Rehabilitation and Modernisation Guide

EnEffect – Centre for energy efficiency (2008, online). http://www.eneffect.bg/

Energieeffizienzverband für Wärme, Kälte und KWK – AGFW (2008, online). http://www.agfw.de/

Euroheat & Power (2007). District Heating and Cooling – Country by Country / 2007 Survey

Euroheat & Power (2001). District Heat in Europe – Country by Country / 2001 Survey

Fachverband Gas Wärme (2007). Image of District Heat in Austria

FVB District Energy (2008, online). http://www.fvb.se/FVBDE.index.html

International Energy Agency (2008). Energy Policies of IEA Countries – Austria 2007 Review

Madlener, R. (2007). Innovation diffusion, public policy, and local initiative: The case of wood-fuelled district heating systems in Austria. Energy Policy 35, 1992-2008

Madlener, R. (2007). Economic and CO2 mitigation impacts of promoting biomass heating systems: An input-output study for Voralberg, Austria. Energy Policy 35, 6021-6035

Niederösterreichische Landwirtschaftskammer (2008, online) http://www.landwirtschaftskammer.at/niederoesterreich/

Personal Communication (2008). Ing. Litschantsky (Consultant Wien Energie)

Techem Messtechnik GmbH (2008). Personal Communication (Angerer)

Velody, M., Cain, M., Philips, M. (2003). A Regional Review of Social Safety Net Approaches in Support of Energy Sector Reform

USAID (2006). Urban Heating in Bulgaria – Experience from the Transition and Future Directions

Wien Energie (2008, online). http://www.wienenergie.at/

Wien Energie (2007). Geschäftsbericht 2006/2007

World Energy Council (2002). Neptune Declaration

7 Appendix

7.1 Combined heat and power generation

The link between district heating and Combined Heat and Power (CHP) is close in the EU. DH based on CHP is an important factor for sustainable energy development. It is an efficient way to reduce greenhouse gas emissions. However, maintaining such systems is a multi-sided problem and it solution depend on the economic situation in a specific country, existing heat-generating sources, and the state of the heat supply and distribution pipelines in a particular DH system, fuel prices and many other factors.

At a WEC Workshop ‘Restructuring and privatising the district heat and CHP industries in central and eastern Europe’ guidelines for revitalizing district heating and cogeneration in Central and Eastern Europe were elaborated. The outcome is also known as the ‘Neptune Declaration’. This declaration expresses the common opinion of symposium participants on financing issues, regulator functions and the role of municipalities in maintaining DH systems.

With regard to financing, Governments (national, regional and municipal) should:

- encourage foreign investments in granting national or most-favoured nation status, without exception, and secure a predictable legislative and regulatory framework;
- encourage third-party financing of DH/CHP investments;
- eliminate old debt, thus enabling a fresh start of the DH/CHP industries;
- compensate for foregone revenues of DH/CHP companies, as a result of applying special heat tariffs for the poor.

The Neptune declaration advises that the regulation functions should be transferred to the municipal level. Municipalities should encourage liberalization of energy prices at the local level, focus on long-term plans based on community needs and abstain from operational activities, rather than entrusting the ownership or management of DH/CHP companies to the private sector. Fostering renovation and restructuring of DHS, the liberalization of energy prices and privatization is expected to open paths to the private capital market. The guidelines are urgent for DH systems that were established under planned economies, with the economic viability of DH systems in CEEC that is still being an issue of serious concern. Addressing barriers for the renovation and restructuring of DH system on the national and regional levels could be one of these processes stimulating measures, according to the Declaration.

The general idea of heat price calculation in CHP plants should be based on the avoided costs method, comparing CHP plant total costs with total costs of separate generation of heat and electricity, using the same fuel. The price of electricity generated in CHP plant should be competitive with the price of electricity available in the same locality from a power grid with the same voltage.

The following case studies are taken from two brochures published by the Austrian Energy Agency in 2006. They should serve as practical examples of how the know-how from Austria has successfully been transferred to the Czech Republic and to the Slovak Republic.

7.2 Case Study 1: Municipality Lehota pod Vtáčnikom

7.2.1 Background

The municipality of Lehota pod Vtáčnikom is located in the middle of Slovakia. It operates its own heat source for thermal energy supply for their citizens and public buildings. This central heating station supplies approximately 300 households.

Until November 2001, the heating station operated with brown coal fired boilers.

In 2001, the boiler house reconstruction was finished and the following capacity was installed:

- 3 pcs. Natural gas fired boilers with thermal output 1,100 kW
- CHP unit TEDOM T 45 – Mann 42SPE, thermal output 65 kW_{th}, thermal efficiency 50.4 %, electrical output 44 kW_{el}, electrical efficiency 34.1 %.

Figure 38: The natural gas fired boilers

The CHP unit was dimensioned for a stable operating mode according to the summer heat consumption, with power production partially for their own consumption and partially for the sale into the public grid.

This approach resulted in an annual running time of approximately 8,400 hours, and the following energy balances:

In this operating mode a substantive overflow of electricity is produced and sold to the public grid:

Total power production is 337,190 kWh p.a., of which 126,819 kWh is self-consumed and the remaining 210,371 kWh p.a. is sold.

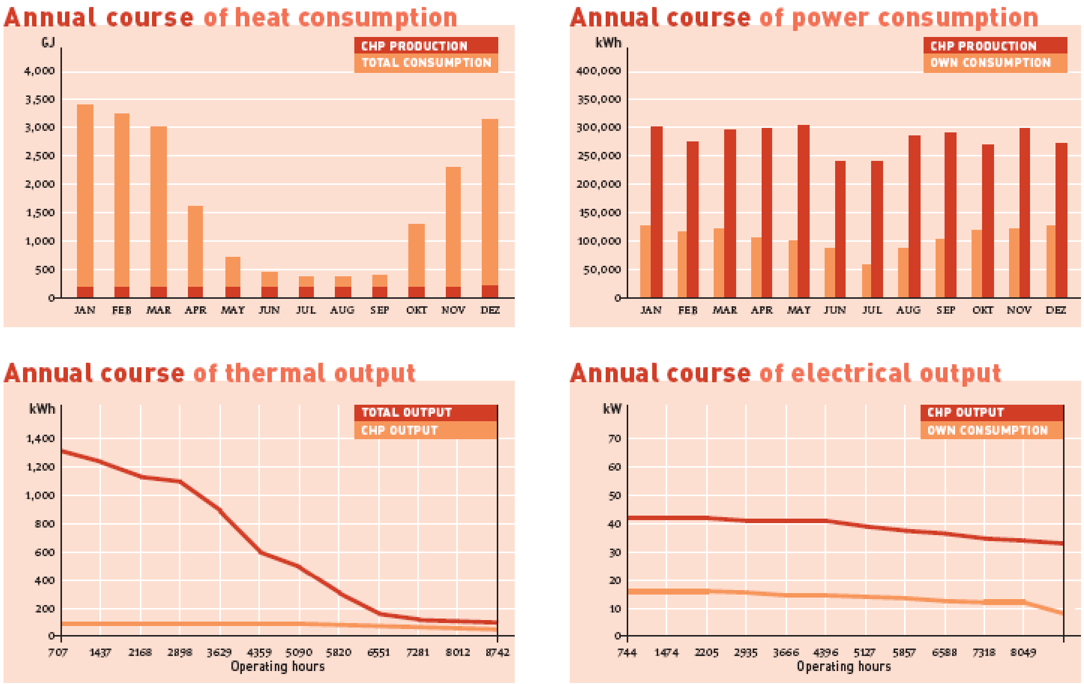

Figure 39: Various Data

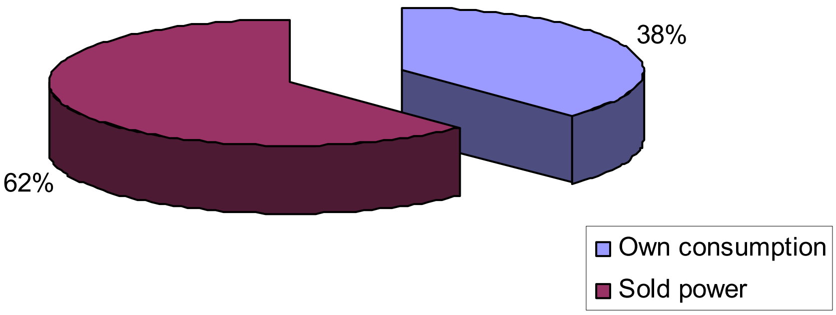

Figure 40: Almost two thirds of produced power are sold to the public grid

7.2.2 Project impact and results

Economical benefits of own combined heat and power production results from cost saving through the power purchase, and revenues from the power sale to the public grid. Environmental benefits result from the elimination of solid fossil fuel combustion in residential areas.

7.2.3 Financial issues

The described project was supported by the PHARE – 15MECU Environmental Grant Scheme which financed 40 per cent of total investment cost, and the Austrian Environmental Support Abroad scheme, which financed 15 per cent of total investment cost.

7.3 Case Study 2: Case Study CHP Banovce Nad Bebravou, Slovak Republic

7.3.1 Background

BYTTHERM is the company operating this CHP plant, which is situated in Bànovce nad Bebravou, a town in the Midwest of Slovakia.

In 2002, an energy audit was used to evaluate the possibility of decreasing the total energy cost for inhabitants of Bànovce nad Bebravou. One possibility to stop the growth in operating costs was to choose a project where the production of both, own electricity in combination with heat, could be realised.

7.3.2 Project Description

For the first phase of the project implementation the installation of CHP technology, a boiler house in the settlement of `Stred`, was selected. The annual production capacity of this boiler house amounted to 30,100 GJ of thermal energy for heat and hot water supply for approximately 1,000 households.

Figure 41: Outside-view of the boiler house

The project was developed in 2002. The machinery of the CHP plant was dimensioned for maximum running time, with the aim to self-consume most of the produced heat and power. Only the excess of electricity production is sold and fed into the public grid.

Figure 42: CHP-units in the boiler house

7.3.3 Configuration of energy source

The following thermal sources are installed in the boiler house:

- 3 x natural gas fired boiler with thermal output 2,650 kW. One boiler is equipped with exhaust economizer for water heating
- 2 x CHP Unit TEDOM PREMI S 22 AP with thermal output 45.5 kW_{th} and electrical output 22 kW_{el}

A heat water storage tank with 10,000 l volume was installed in order to absorb the discrepency between hot water consumption and production.

The discrepancy between demand and production results from a decrease in hot water consumption in the summer night hours (23.00–04.00).

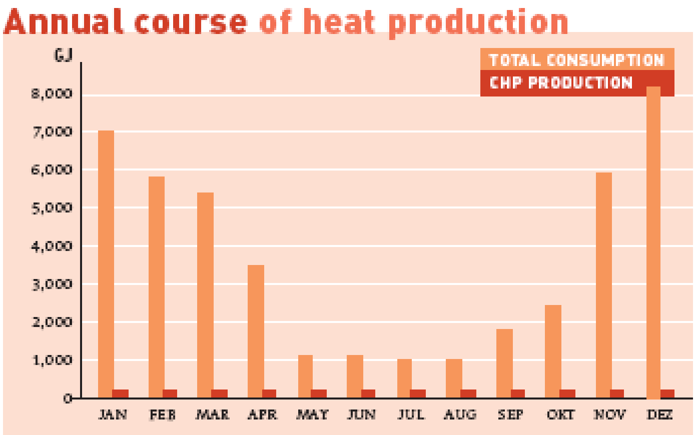

Figure 43: Annual course of heat production

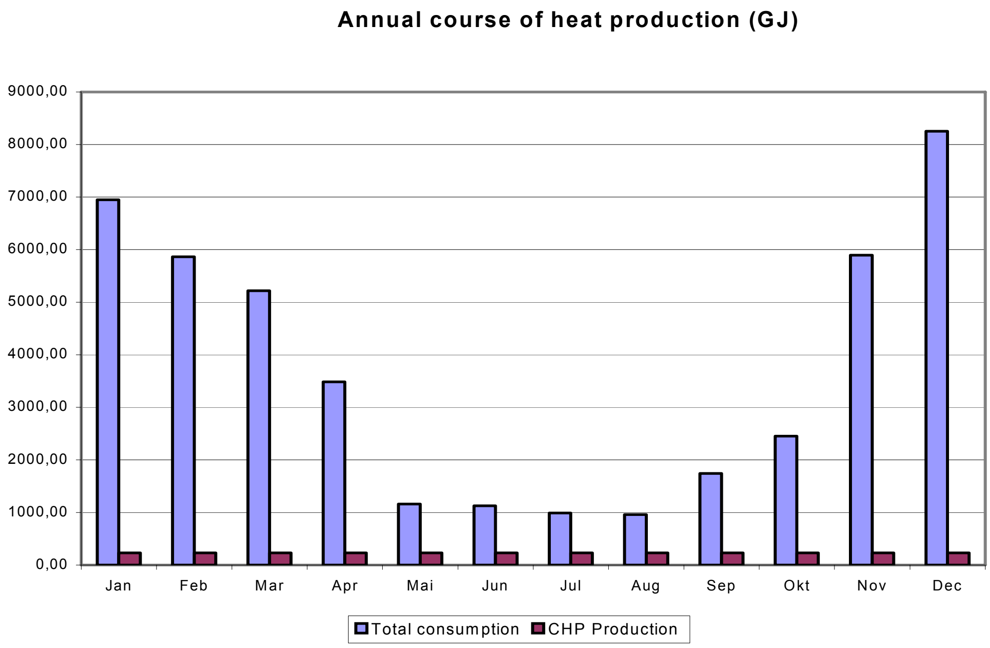

Figure 44: Annual course of heat production (GJ)

The discrepancy between own production and consumption of power is solved through the sale or purchase of power overflow.

The balance of this relationship is as follows:

Total own electricity consumption	179,812 kWh
Electricity production in CHP	313,280 kWh
Own consumption of produced power	159,961 kWh
Electricity purchase	19,851 kWh
Electricity for sale	153,319 kWh

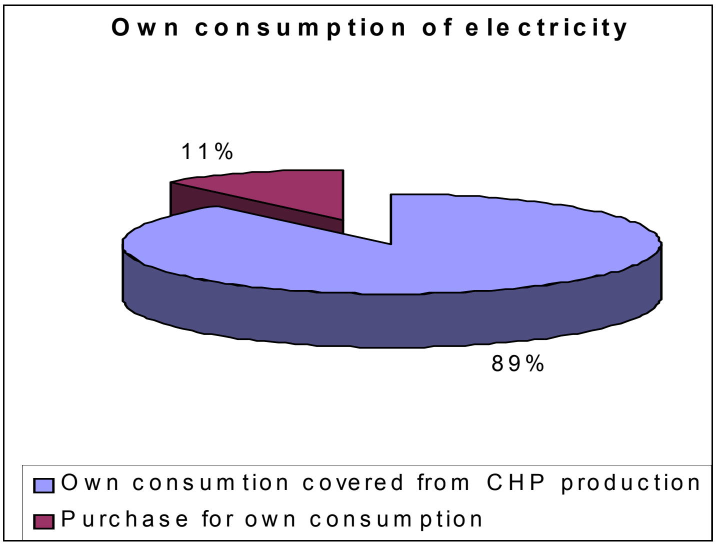

Figure 45: Own consumption of electricity

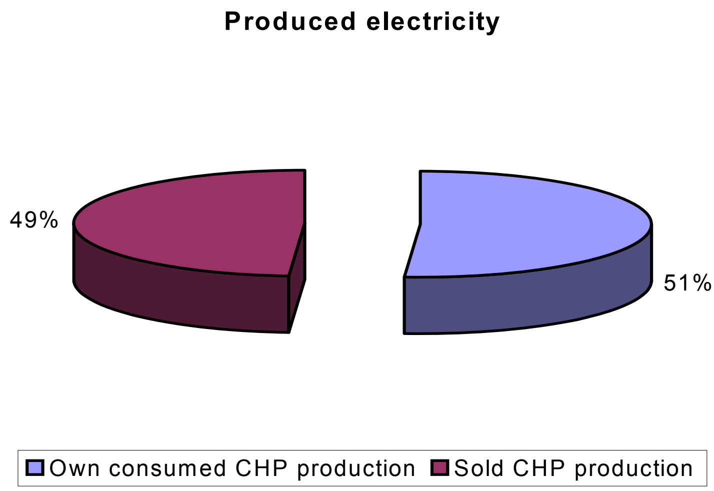

Figure 46: Produced electricity

7.3.4 Project impacts and results

The economical benefits of this project result from operational cost savings for the purchase of electricity. Additionally, this highly efficient CHP plant also guarantees an environmentally friendly energy production.

7.3.5 Financial issues

The described project was implemented with the financial support of the Slovak state fund for the support of energy efficiency projects and renewable energy sources, which covered 85 per cent of the total investment costs.

7.4 Case Study 3: CHP for Knezice, Czech Republic

7.4.1 Background

Kněžice is a village in Central Bohemia, about 70 km east of Prague. The only enterprise in the village is an agricultural farm. All energy needs in the village, including electricity for the farm, are currently provided by fossil fuels (coal and coke).

Within the framework of the Energy Self-Sustainable Village Agenda, a project with three main aims was developed:

- To transform the agricultural waste and municipal sewage into biologically stable substrate and biogas;
- To exploit biogas as waste of fermentation for replacement of fossil fuels combustion; and
- To exploit the solid residue from fermentation as valuable fertilizer.

Anaerobic fermentation is a quickly developing process, which agrees well with the modern energy and environmental requirements. The fermentation plant, combined with a CHP system, utilizes agricultural waste and produces heat, power and fertilizer. Many projects of this type in the Czech Republic follow this design. The owner of the fermentation and generation plant is the town of Kněžice, and the operator is Energetika Kněžice, Ltd.

7.4.2 Project Description

The proposed biogas production system in Kněžice is a wet fermentation system. The biomass entering the fermenter (max. volume 2,800 m^3) is composed of manure, municipal waste, slurry and silage. The generation plant should supply heat for the biogas plant requirements (fermenter heating, about 200 kW), for the production of hot service water and for the space heating of 156 private houses. Excess electricity production is to be fed into the grid.

The generation plant will consist of two boilers (0.4 and 0.8 MW), fuelled with wood chips and straw, and a CHP module with an output of 330 kWel. The two boilers are to be operated as peak boilers as well. After economic assessment and feasibility studies, this appeared to be the most favourable solution.

The biogas production system will be put into service in June 2006 and the DH system in September 2006.

7.4.3 Technical Characteristics

CHP module	1 GE Jenbacher JMS 208 GS-B.LC
Electricity output, CHP module	330 kW
Thermal output, CHP module	405 kW
Biogas input, CHP module	831 kW
Thermal output, peak boilers	1 x 400, 1 x 800 kW
Electricity efficiency, CHP modules	38.10%
Thermal efficiency, CHP modules	50.25%
Total efficiency, CHP modules	88.35%
Efficiency, boilers	89.0%
Hot water system	80/60°C

Figure 47: Biogas production system in Kněžice

Figure 48: Location for CHP unit installation.

7.4.4 Financial Issues

The investment for the whole project totaled CZK 120 million (approximately € 4,211,000). Of that, the investment for district heating was CZK 32 million, and the total for the fermentation and generation plant was about CZK 60 million, which was too much to be covered by the town alone. A low-interest loan provided under the ERDF programme (75%) and a loan from the State Environmental Fund of the Czech Republic (10%) makes the investment possible. The payback period is about 15 years. Furthermore, the project is supported by Kommunalkredit Austria with an amount equalling approximately 15% of the capital.

7.4.5 Impacts and Results

The amount of polluting emissions avoided by this plant in comparison to conventional energy consumption is about:

SO_2	45.5 t/yr
NOx	5.6 t/yr
CO	13.1 t/yr
NMVOC	2.6 t/yr
Particulates	2.9 t/yr
CO_2	3,122 t/yr

Versorgungssicherheit
Wettbewerbsfähigkeit
Nachhaltigkeit
Perspektiven

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