

MANAGEMENT OF HEATING SYSTEMS USING MEDIUM POWER BOILERS

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ABSTRACT: Even if district heating represents currently the cheapest solution in production of thermal energy, this fact does not reflect in the preferences of Romanian consumers. In order to meet up the consumers' demands, a set of actions of resizing and management of the heating system should be performed. These actions should be taken according to the SWOT analysis of the district heating systems. The current paper will outline a SWOT analysis of the Romanian district heating systems. Further, we will compare these systems to similar district heating systems which exist around the world and to outline a set of actions to be performed in order to improve the efficiency of the corresponding management process. The case study refers to the local district heating company, Colterm SA.
KEYWORDS: district heating, medium power boilers, Colterm, management

1. INTRODUCTION

The first heating systems have appeared during the antiquity in the Roman Empire. But in the modern era, centralized heating systems were introduced in the 1880s in the US.

The first generation of modern heating systems was based on steam produced in coal-fired power stations. These systems have been dismantled or upgraded over time, so they are no longer in use at present.

The second generation of heating systems was produced between 1930 and 1970 and was based on hot water under pressure produced by coal and liquid fuel combustion. Typical for this generation are the Soviet conception systems built in Eastern Europe after the Second World War [1].

A third generation of district heating systems, developed after 1970, uses prefabricated and buried insulated pipelines for the transport of heat. These systems use water at temperatures below 100 ° C, and as fuel they use, in addition to coal, biomass and waste. In some cases, the energy used by these systems may be geothermal or solar.

Currently, the transition to the fourth generation of district heating systems is being carried out. It is desirable that these systems use water at temperatures even lower than the third generation and generally solve the problems affecting third-generation systems. [2] These systems should be able to provide heating energy, distribute heat with small losses in the grid, recycle heat from low-temperature heat sources (such as geothermal or solar sources), and be integrated into a smart management system.

Table 1. Comparison between third and fourth generation district heating systems [2]

Problem addressed	Third generation systems	Demands from the fourth generation systems
Temperature levels	Sweden 86-47 °C Denmark 78-43 °C	50-20 °C
Recirculation	Yes	No
Metering	Collective	Individual
Supervision	Many temperature errors	ICT supervision
Thermal lengths, heat exchangers	4	6-8
Thermal lengths, radiators	0.4-0.7	1.5
Hydronic balancing	Many misallocations	Perfect allocation through automated hydronic balancing
Risk of Legionella bacteria	Yes, because of hot water circulation and sometimes hot water storages	No hot water circulation and no hot water storages

Ultra-low-temperature heating systems from the fourth generation of district heating systems typically use temperatures of 35-45 ° C. For maximum efficiency, the return temperature should be as low as possible. Currently implemented and tested in Denmark, there has been an improvement in energy efficiency using fourth-generation systems. [3]

2. DISTRICT HEATING USING MEDIUM POWER BOILERS

A centralized heat supply system (in Romanian: SACET) is a convenient alternative for the urban population. Essentially, any district heating system consists of a heat generator plant, pumping stations, consumers and, of course, pipeline networks between them [4]. The heat generator plants operate with electricity, fuel liquid, biomass, natural gas, coal or unconventional energy.

District heating systems are considered to be of low power if they produce 5-10 MW of average power if they produce between 10 and 40 MW and high power if they produce more than 50MW.

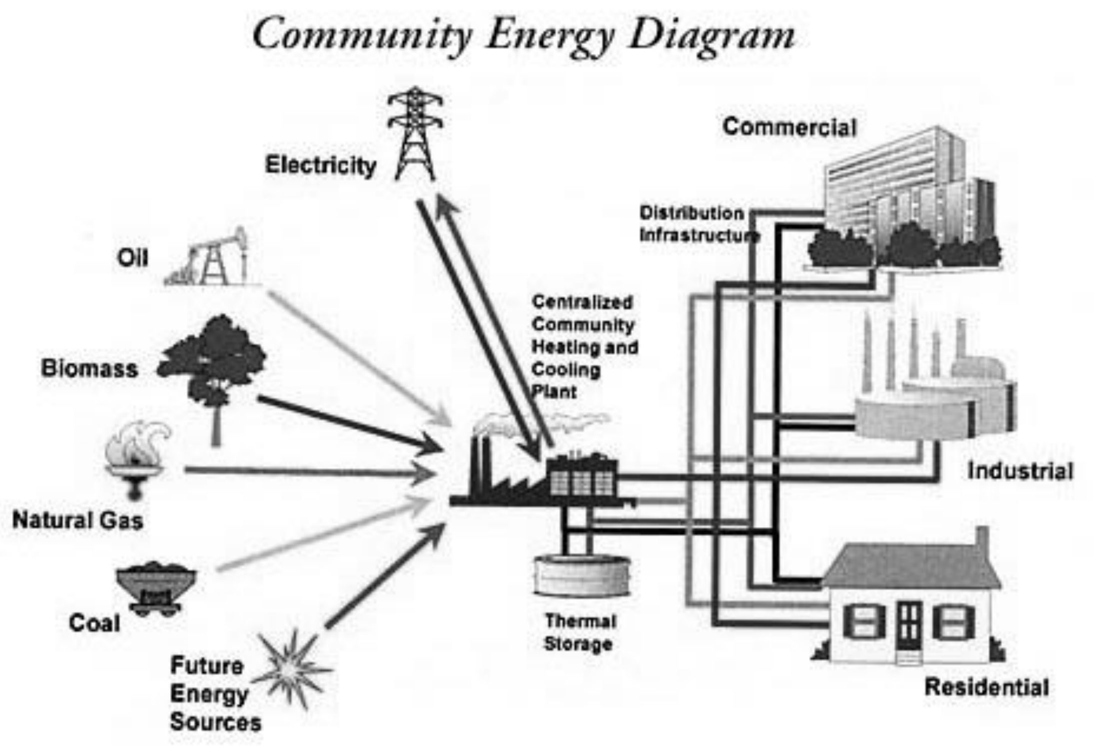

Figure 1. Structure of a district heating system [5]

In modern Romania, the National Energy System was created and developed between 1951 and 1989. The main energy resources used were natural gas, oil, coal and hydro power, and the energy producing equipment used was either imported from the USSR, Czechoslovakia, France or Germany, or produced in the country on the basis of licenses from international equipment suppliers.

After 1991, the National Energy System was reorganized, while the reducing the energy consumption and production. In addition to traditionally used resources, unconventional energy resources - renewable energy sources emerged. In order to comply with national and EU environmental standards, installation and installation of filters for greenhouse gases and noxes are required. However, the work is hampered by the lack of funds, while a current problem is the reduction of centralized heat production due to the reduction in demand in this direction.

The thermal power plants built in the 1980s in Romania are generally medium power plants.

The district heating company in Timişoara, COLTERM SA, was founded in 2004, taking over the assets of TERMOCET 2002 (which managed the central heating and primary distribution network of the thermal agent) and CALOR (which managed the secondary distribution network of the thermal agent, district heating plants). Colterm currently has two medium and large hot water boilers (58 MW and 116 MW) and three industrial steam boilers. The power supply is powered by a medium power turbine (19.7 MW) powered by industrial steam boilers. It also has a low-power cogeneration plant, put into operation in 2007.

Cogeneration is a process by which fossil fuels are used efficiently. Thus, the residual heat obtained in a thermoelectric plant will be used for the production of heating agent (steam or hot water).

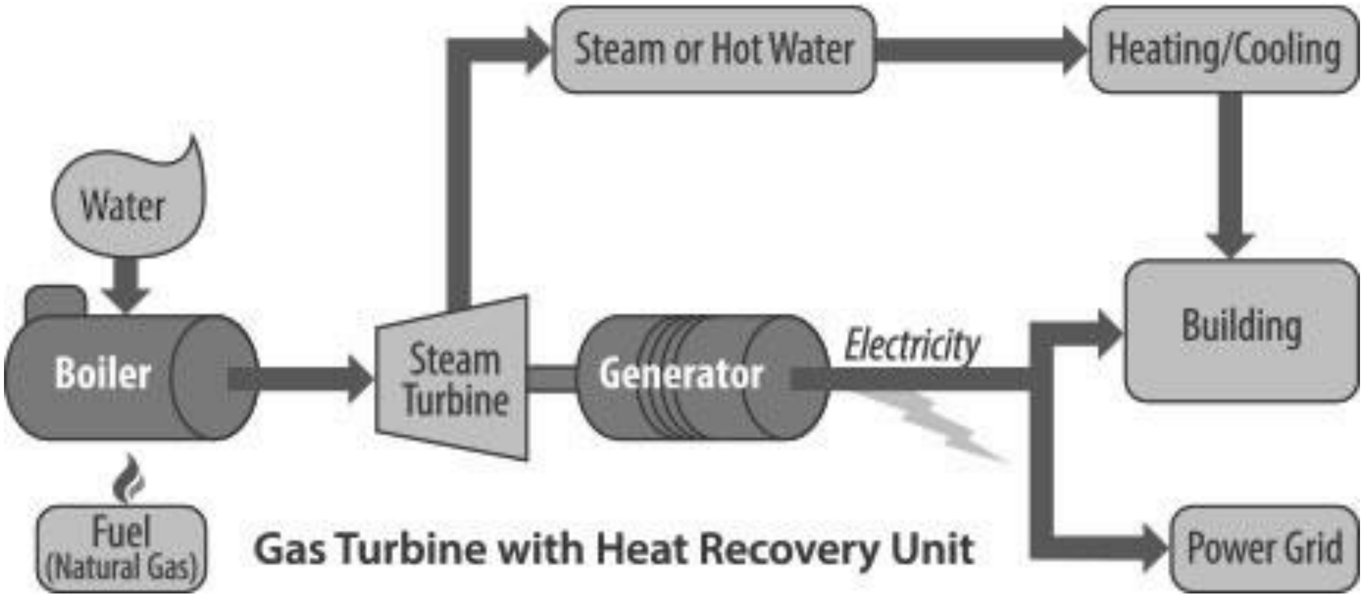

Figure 2. Efficient cogeneration [6]

3. SWOT ANALYSIS

For a medium power plant district heating system, we identified the following elements during the SWOT analysis. The issues we have identified at Colterm are similar to those identified at national district heating systems [7].

3.1 Strenghts

- Less polluting than individual alternatives.
- One of the most efficient heating solutions currently in use, especially in the context of rising energy prices.
- The cost of repairing or servicing the facilities, usually associated with individual heating solutions, is null from the point of view of consumers.
- There is no explosion hazard concerning the consumers and a casual explosion does not affect them.

3.2 Weaknesses

- Most of the equipment and technologies used are of the second generation, technically and morally obsolete.
- From the consumer point of view, the central heating energy price is high and the social protection measures are uneven.
- Energy losses in the distribution network, both in the back-flow pipelines and inside the residential buildings, which are mostly not energetically upgraded. At residential building levels, these losses may be in the order of 40-50%.
- Management often deficient and low negotiation ability of the managerial staff.
- Vertical Metering System for Thermal Energy Consumption.
- Poor sizing of the distribution network, which produces either loss or bottlenecks.

3.3 Opportunities

- Introduction of the horizontal metering system with the following advantages: elimination of thermal losses in the basements, consumers become practically independent of the neighbors, pollution is reduced.
- Using alternative, renewable resources (biofuels, solar energy).
- Use the high geothermal potential of the area to achieve energy savings.
- Domestic waste processing, in partnership with the local sanitation company, for the purpose of producing biogas.
- Upgrading and expanding distribution networks with loss-limiting effect.
- Promoting efficient cogeneration.

3.4 Threats

- Disconnection of consumers caused by prices and losses in the distribution network, which results in additional losses.
- The attractiveness of individual apartment heating sources, which leads to consumer disconnection.
- Lack of a national policy to promote high efficiency cogeneration and a lack of differentiation of fuel prices between industrial and individual consumers.
- Difficulties in repayment of internal and external credits, which leads to the impossibility of obtaining new credits for development.

4. PLAN OF MANAGEMENT WITH RESPECT TO INCREASING THE COMPETITIVITY

If network losses can be addressed by an adequate re-dimensioning of the pipes, a particular situation is the one in which bottlenecks occurs on the network.

These bottlenecks occur when pipes are too thin to meet consumer demand, which results in pressure differences in the thermal agent. Traditionally, these bottlenecks have been addressed by increasing the temperature of the thermal agent or by resizing the distribution pipes. Modern bottleneck avoidance techniques refer to the installation of local heat sources on the other side of the bottleneck, to adequate demand management, or the installation of thermal energy storage systems. [8]

It is not possible to discuss a thermal energy management system without discussing a storage system. Heat sources are: solid or liquid fossil fuels, geothermal fuel, solar energy, nuclear fuel, industrial waste fuels and biomass. For each of these types of fuel there are specific storage techniques, using materials with appropriate properties (such as melting point, high latent heat, high thermal conductivity, etc.). Typically, they are water, oils, molten salts (eg "sun salt" with 60% $NaNO_3$ and 40% KNO_3), liquid metals (such as sodium), rocks and sands (marble, granite, basalt etc.).), cement blocks, etc. [9] Moreover, thermal energy storage solutions represent a solution to the problem of solid fuel dependence.

Currently in Romania, only 20% of the transport network and 31% of the distribution network have been upgraded. Net losses are around 25%, far below the target of 15%. [10]

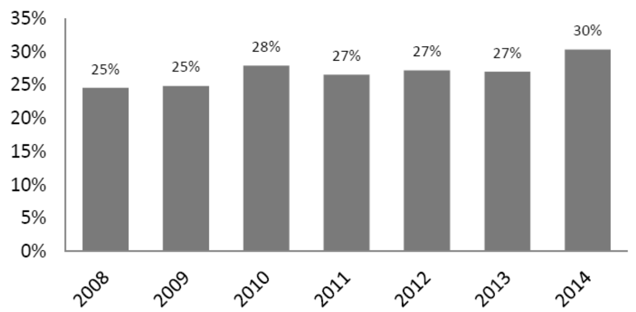

Figure 3. Medium losses in thermal energy between 2008 and 2014 [10]

The management of the district heating system in order to increase its efficiency should focus on the following directions [11]:

- Limiting heat losses along the distribution network
- Limiting heat losses associated with leakages from heating system elements
- Complete hydraulic analyses
- Use of several types of resources to produce heat at a specific thermal point
- Using short and long term thermal demand forecasting procedures
- Use of cogeneration systems based on domestic hot water demand
- Use of heat tanks to handle demand peaks

Another direction is waste and waste processing to get biofuel. Sludge from sewage treatment plants, manure, food waste, grease, oils can be successfully processed. [12]

In the framework of efficient management, it is important to attract European funds for the rehabilitation or replacement of existing equipment in order to have a positive impact on the evolution of environmental factors. Such a project has already been implemented between 2013-2016 at Colterm. [13] Also, through European projects, 5 district heating stations were transformed into new thermal points. In the period 2014-2020, Colterm is considering attracting European funds through the Operational Program for Large Infrastructure, but also funds from the state budget through the 2014-2020 Heating Program.

5. CONCLUSIONS

As most of the heating systems in Romania are second generation, technically and morally obsolete, the implementation of a management system for increasing competitiveness is even more imperative.

The current needs of the population are in line with the efficiency trends of the thermal energy production systems and the tendencies of production reduction. Therefore, at least for the next decade, district heating systems using medium power boilers are a reality to be taken into account.

Effective management to increase the competitiveness of these medium power systems should constantly take into account SWOT analysis and should be oriented towards rehabilitation and upgrading by attracting European funds, using heat storage systems, using efficient cogeneration, and also on the use of multiple fuel sources within power plants.

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