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Polish District Heating Systems—Development Perspectives

Krzysztof Wojdyga
Faculty of Environmental Engineering, Warsaw University of Technology, Warsaw 00-653, Poland

Abstract: The most economical and rational means of heat supply for city inhabitants are district heating systems. Heat generated in power plants and large heat sources is cheaper than heat from individual sources. The reason for that is the amount of the generated heat and the used fuel (coal for most heat sources). District heating, a very important energy sub-sector for the Polish economy, provides heat supply to centralised heating systems, which, on average, satisfy 72% of the demand for heat in Polish cities. Therefore, several million Polish citizens use heat from district heating systems that produce heat in professional, industrial and municipal power plants. In Europe, over 100 million citizens use district heating systems. The present situation of the Polish district heating sector is a result of Poland's transformation that took place at the beginning of the 1990s. The reform put the obligation of heat supply on the local authorities, on the municipality, instead of the state. Along with the transformation, district heating also made huge technological and technical progress. Increasing expectations of recipients posed new challenges for the branch, however.

Key words: District heating, energy efficiency, cogeneration, energy planning.

1. Introduction

Currently-used district heating systems were inspired by heating installations from Greek and Roman times. Similar solutions had been known earlier in China. Already then, heat in water was used for heating and bathing. Geothermal springs were also used for these purposes.

The first water-based heating systems were created in England in the 18th century. In this way, some objects, as well as factories, were heated (1790) [1]. Waste heat from technological processes was used for heating water in public baths (1830) [1] and there were also ideas of supplying heat to buildings for workers. In 1851, a district heating system was opened in London (Crystal Palace). In the USA, in 1853, two steam district heating systems were commissioned, one of which in the Marine Academy in Annapolis, used until today. Since 1870, many new steam boiler houses were created to supply industrial and residential objects with heat through district heating systems. On the outskirts of London, in 1876, a water district heating system for a group of large residential houses was commissioned. At that time, similar systems for Zurich and Warsaw were also considered. In Warsaw, a water supply and sewage network was commissioned in 1880. The first centralised systems controlled remotely that provided heat for a few buildings were built around 1900 in the buildings of Warsaw University of Technology (1899~1901) and Jesus Christ Hospital (1897~1901). More information can be found in Ref. [2]. Fig. 1 is from collection of Warsaw University of Technology Museum [3]. They provided heating steam to all buildings in these institutions.

Heat receivers, such as radiators, were supplied with steam in a direct way. Development of heating of buildings on the one hand and problems connected with maintenance of steam systems, on the other, resulted in the situation that for safety reasons steam/water exchangers were used. In them, water was the working fluid. Industrial and office buildings were heated, and later also residential buildings in factory districts.

Corresponding author: Krzysztof Wojdyga, Ph.D., professor, research fields: district heating, energy efficiency, cogeneration, renewable energy, energy planning and pollution from exhaust gas emissions.

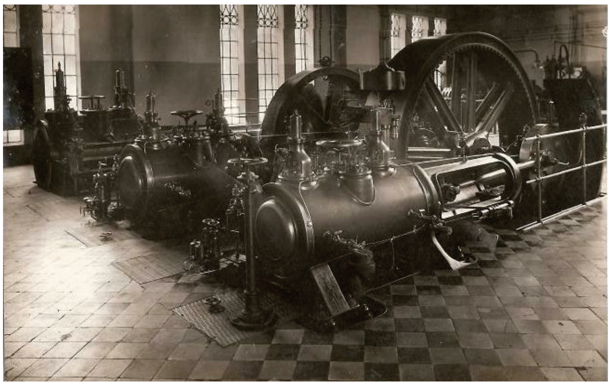

Fig. 1 Steam engine for electricity production (cogeneration) at Warsaw University of Technology [3].

In the 1930s, in the USSR (Union of Soviet Socialist Republics), huge residential districts were built for workers and they had to be heated in some way, which resulted in construction of local boiler houses and direct networks. An additional incentive for building such systems was little equipment needed, central supervision and uniform parameters.

After the Second World War, district heating systems were developed further. One of the first cities in Poland with a district heating system was Warsaw. Realisation of the investment started with transforming a condensation power plant in Powiśle into a cogeneration plant of the power of 200 Gcal/h. The first main pipeline connecting the Powiśle Power Plant with the Palace of Culture and Science was opened in December 1953. The erection of the Palace of Culture and Science was one of the main reasons for construction of the Warsaw District Heating System. A few years later, in 1956, the right bank of Warsaw was supplied with heat by the Żerań Cogeneration Plant. It was the first power plant in Poland, the function of which was supplying a city with heat. Then, in 1962, the Power Plant Siekierki was commissioned. At that time, all installations in heated objects were supplied directly from the district heating network.

Due to the size of the systems, higher parameters in the network and mixing DH (district heating) substations were used. In view of the inefficiency of the system of industrial production, hydroelevators (ejectors) were used instead of rotodynamic pumps. Further development of the systems made such technology ineffective in maintenance. Then, hydraulic control, through orifices, was employed. At the same time, there was a shift from direct systems to indirect networks (with exchangers). This was because indoor installations influenced the functioning of the systems too much and district heating systems also influenced the functioning of the installation. In the 1950s/1960s in Warsaw, over one thousand local coal boiler houses were in use. As a result of development of the district heating systems, since 1964, the number of boiler houses was systematically falling and they were replaced with group DH substations. The Warsaw District Heating System started to develop dynamically and new recipients were connected to the network. Both heat production and power installed in heat sources were rising. In the 1960s, in all large Polish cities, district heating systems were commissioned, based on newly erected cogeneration plants.

According to current statistical data, in Poland in 2012, 431 PJ [4] of heat was produced, and 62% of that in cogeneration with electricity (270 PJ). Comparing heat returned to the system (283 PJ) and heat bought by recipients (248 PJ), it can be stated that heat losses stand at 12%. This is quite a good result, though in some European countries average losses are 9%~10%. According to a report of the president of the Energy Regulatory Office [4], the length of district heating networks in Poland is 19,790 km and the heat power—57.3 GW, which is much less than power installed in Polish power plants. The largest recipient of network heat is the municipal sector, which consumes over 60% of heat generated, followed by the industry (30%) and services (10%).

2. Development Trends of Polish District Heating Systems

With accession to the EU (European Union), Poland has accepted a number of obligations arising from EU directives. A directive is binding in member countries it aims at, though it leaves the choice of forms and methods of its implementation to national governments. Especially important for the Polish energy sector are directives connected with pollution emissions to the atmosphere. The European Council decided in March 2007 that, by 2020, the European Community should lower the emissions of CO_2 by 20% in relation to 1990, by 20%—the consumption of energy and, by 20%, it should increase the share of renewable energy. At present, even more stringent limitations of emissions are planned (in 2030—30% and in 2050—50%).

A schedule (3 times 20) was adopted:

- CO_2 emission reduction by 20%;
- increase in use of renewable energy sources to the level of 20% of total energy demand (Poland is at the level of 15%);
- increase of power efficiency by 20%.

The Directive 2009/29/EC [5] changes the directive on greenhouse gas emission allowance trading (2003/87/EC). The aim of this directive is a shift from the present system of free emissions allowances to the total abolishment of free allowances until 2027. The process should take place gradually. Starting in 2013, parallel to the existing systems, an auction system should be functioning and the number of allocated allowances should go down by 80%—in a linear way by 5.71% annually to get to 0 in 2027. Since 2013, member countries should sell on auctions all allowances which are not allocated for free and 50% of the income obtained from the sales of allowances on auctions should be spent on ecological investments or increasing the energy efficiency of a country. Electrical energy producers, starting in 2013, have the only chance of purchasing the needed emission allowances on auctions. Free allowances are allocated to district heating networks supplying so-called municipal recipients, but also high-efficiency cogeneration, specified in the 2004/8/EC [6] directive in order to satisfy economically-justified demand of heat or cool. Each year after 2013, total allowances allocation for such installations of heat generation is corrected with a linear coefficient. The number of allocated free allowances for the district heating system in 2013 stood at 80% but if the so-called fuel benchmark in relation to high-efficiency heat generation is considered, the real amount of free allocation satisfied 48% of the needs.

The necessity of even partial purchase of carbon dioxide emissions allowances will significantly increase the costs of generation in power plants and CHP (combine heat and power) plants. Especially important here is the rise in costs of heat generation. Too high heat price increase which would balance the rise in generation costs in areas where a gas network is available may result in mass disconnection of recipients from the district heating system and a shift to gas heating. A possible ceiling for price increase is then the cost of gas heating.

Another directive that will greatly influence the Polish district heating system is the IED (Industrial Emission Directive) [7]. Its project was published in Brussels on December 21, 2007, and on July 7, 2010, it was adopted by the European Parliament. The directive changes the currently binding directives concerning combustion installations. It lays down permissible emission standards of sulphur dioxide, nitrogen oxides and particulate matter and introduces universal rules of aggregation of combustion installations (e.g., boilers) from which exhaust fumes are let out through one chimney and even of those located in close vicinity. The directive enters into force on January 1, 2016 but the sources supplying district heating systems will have to meet the directive requirements only in 2023. It is important that the directive covers sources of power greater than 50 MW and single installations of power no less than 15 MW. In accordance with the directive, single installations (boilers or gas turbines) of fuel power less than 15 MW do not undergo aggregation and are exempt from the directive. After 2022, and actually by 2020, there will be a necessity to incur additional costs for modernization of combustion installations in order to adjust the installations to the demands of the IED directive connected with gas pollution emissions (SO_2, NO_x, CO, particulate matter) to the atmosphere. This will result in an increase of heat generation costs, and consequently a great increase of prices for the recipients.

This may be most visible in small and medium district heating systems. Another result may be resignation of some recipients from district heat, which will further contribute to limitation of heat production and worse financial results of district heating companies. Although the IED will cover installations over 50 MW and single units of power greater than 15 MW, in order to keep good competition between these sources, national regulations will probably be passed concerning pollution emissions which will be similar or the same as for sources covered in the directive. Presently functioning power plants will be obliged to implement the directive. Construction of new pollution dedusting installations of particulate matter emissions less than 100 mg/Nm^3 in relation to 6% of oxygen content in the exhaust gas will have to be implemented by the end of 2016. And then, by 2023, particulate matter emissions can not be greater than 30 mg/Nm^3. Until 2023, it will be necessary to build high-efficiency desulphurization and denitrification installations. In Table 1, limits for pollutant emission are presented.

Other directives that will significantly influence district heating systems are Refs. [7, 8], which will be amended in order to further limit heat consumption for heating purposes. Existing buildings which have not been thermomodernised yet will be insulated with time, which will result in a decrease of heat demand.

A basic fuel in district heating sources is and for many years will be coal. The structure of fuel use in the energy balance of Poland is quite different from the structure in other EU countries. The main differences are:

- over 4 times greater coal use (Poland—62%, EU—15%);
- over 2 times smaller consumption of natural gas and liquid fuels (Poland—35%, EU—63%);
- lack of nuclear energy in Poland (EU—16%) in the structure of energy consumption.

The structure is basically the result of fuel availability in Poland. Significant resources of hard coal and lignite and lack of oil deposits result in the situation that almost 90% of the obtained primary energy is coal. A consequence of such structure of primary energy is relations between prices of fuels used in district heating. The price of coal is at present 2.5 times lower than the price of natural gas. Biomass as a fuel in district heating is also more expensive than coal.

The relations cause that natural gas (especially suitable for district heating sources of small and medium power) is not competitive in terms of price in comparison with coal. Last years' experiences show that gas prices grow much more quickly than European forecasts show, especially due to concentration of the biggest sources in a few countries and monopolist practices.

The issue of wide introduction of natural gas to the Polish district heating system is thus not only an economic problem, but also a political one and greatly influences energy security. It needs to be accepted that

Table 1 Permissible emissions of pollution from typical district heating sources.

Heat power of the source (MWth)	Emissions of SO_2 (mg/Nm^3)			
	2001/80/EC Directive	Poland	IED	BAT (best available technics)
50~100	2,000	1,500	400	150~400
Heat power of the source (MWth)	Emissions of NO_x (mg/Nm^3)			
	2001/80/EC Directive	Poland	IED	BAT
50~100	600	600	300	90~300
Heat power of the source (MWth)	Emissions of particulate matter (mg/Nm^3)			
	2001/80/EC Directive	Poland	IED	BAT
5~50	400 (100)	400 (100)	30 (25)	5-30

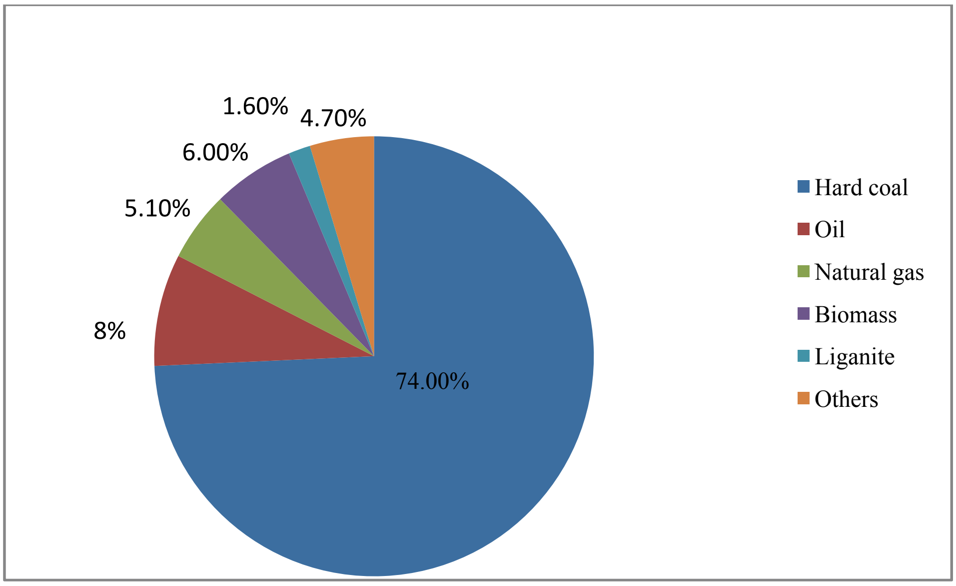

Fig. 2 Structure of fuel consumption in district heating sources (2012).

coal is a basic fuel in district heating sources of great and medium power and natural gas in small sources. Biomass and biogas, due to the local character of deposits and high transport costs, should be mainly used in power plants and CHP plants of small and medium power. Fig. 2 presents the current (2012) [4] structure of fuel consumption in district heating sources.

The change of fuel proportions in the energy sector is inevitable. Already today, due to the climate and energy package, Poland is obliged to have a 15% share of renewable energy sources by 2020. Each change of the energy mix must be balanced, however, free from any unnecessary speeding up and based on an analysis of the raw materials potential of the country. Until the mid-1800s, biofuels were the main energy source. Then, since 1900, coal was used, as well as oil and oil-products. Now it is estimated that solid biomass provides circa 11% of total energy consumed by mankind. Like each fuel, it has its advantages and disadvantages. The most important advantage is the fact that it is a renewable fuel, causes CO_2 decrease and increases energy security of the region. Disadvantages include more expensive transport, and profitability of transport only from small distances. Large humidity causes lower calorific value of the fuel; Alkali metal content decreases the temperature of slag and ash softening, the possibility of formation of dioxins and furans with inappropriate combustion. An important disadvantage is the fall in the efficiency of the combustion process resulting from the increase of chimney loss.

The act Energy Law [9] imposes an obligation to purchase heat manufactured in renewable sources and heat producers may be given additional financial means if they prove that biomass comes from farming. At present, there are few biomass producers, though. This interpretation of the regulations has made co-combustion of wood and its waste products unprofitable for professional power industry. A possible, important and quite cheap source of biomass for district heating may be municipal waste.

At present, over 80% of waste is deposited on municipal landfills. ten large incineration plants of municipal waste are planned to be built in Poland until 2019. Located in the vicinity of large cities, they should incinerate circa 1.5 million Mg of municipal waste. Far from them, however, the problem remains unsolved. Due to regulations on prohibition of landfilling waste with energy elements, there will be a huge market for the presented solution. The conducted analyses foresee that, in 2020, circa 50% of municipal waste will be recycled, 25% processed mechanically and biologically, and 25%—processed thermally. The foreseen amount of waste for 2020 is circa 15 million Mg, of which over 3.5 million Mg will be thermally processed. The constructed incineration plants will use circa 1.5 million Mg of waste.

In Poland, a significant share (over 50%) of heat production lies with district heating systems. In large Polish district heating systems, almost 90% of heat is cogenerated. Smaller systems do not use cogeneration installations. New CHP sources should be built in small and medium district heating systems, where there is a large cogeneration potential (Table 2). In order to make use of it, active state policy is necessary to support such solutions.

In October 2012, the Directive 2012/27/EC on energy efficiency was passed [10]. The directive changed the Directives 2009/125/EC and 2010/30/EC and repealed the Directives 2004/8/EC and 2006/32/EC. The new directive mainly pertains to widely understood energy efficiency and its main goal is a 20% decrease of primary energy consumption in the EU, which is an important factor influencing the success of the EU energy strategy for 2020. The document points to means that allow to create good conditions for improving energy efficiency. Member countries should encourage implementation of means and procedures supporting cogeneration installations of total nominal heat power less than 20 MW to encourage dispersed energy generation. There is a question, however, whether the role of cogeneration is sufficiently stressed in the directive. It seems that in the full content of the directive, the issue is marginalised. Definitions of cogeneration and high-efficiency cogeneration used in EU legislation should not exclude other definitions in state legislation for purposes other than those specified in EU legislation.

The presented huge economic potential of cogeneration is insufficiently used in Poland. In 2009, in Poland, circa 250 PJ of heat was cogenerated, which means that only 64% of the potential seen as economic is used. For a few years, these proportions have not changed. This shows that the mechanisms of cogeneration support presently used in Poland have been inadequate. In 2009, only 25 TWh of electrical energy was cogenerated, which accounts for only circa 35% of energy that could potentially be cogenerated if the whole economic potential was used (Fig. 3). The reasons for inadequate development of cogeneration are economic (financial), legal, administrative and social barriers. Other barriers include those hindering the development of district heating systems. At the present state of power technology development, there are no technical barriers.

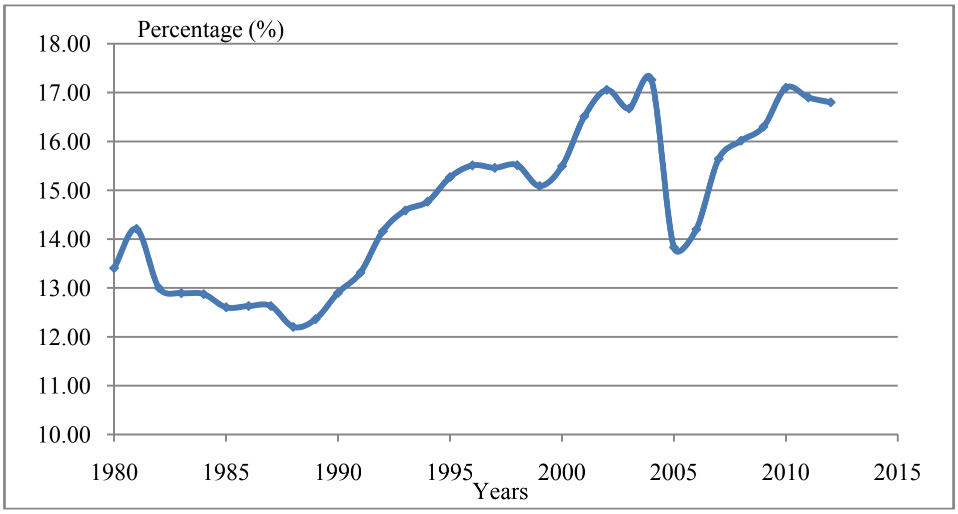

Fig. 3 Electricity production in cogeneration in relation to total electricity production [4].

Table 2 Economic potential of cogeneration [11].

Year	2010	2015	2020	2025	2030
Economic potential of heat (TWh)	122.6	119.5	119.0	118.0	113.9
Economic potential of electricity (coal) (TWh)	55.44	54	53.3	53.3	50.7
Economic potential of electricity (gas) (TWh)	86	82.3	80.9	79.8	74.6

The total effect (decrease in fuel consumption and result of changing the fuel from coal to gas) is circa 67 mln Mg CO_2 or 44 mln Mg CO_2 for the assumed emission indices for electrical energy cogeneration from coal, respectively.

Thanks to relatively large district heating systems, it is possible to introduce production units of quite large powers, and thus relatively smaller unit costs. At the same time, with currently low heat prices, there is no social acceptance for their increase, so cogeneration investments do not guarantee a return on investment without additional support. In many cases (e.g., for gas-powered installations) operational costs exceed income from sales of heat and electricity [10]. Thus, development of cogeneration without a support system is impossible. If we compare electrical energy cogeneration with other EU countries, then in absolute values, production is one the largest in Europe. In Fig. 4, electricity production in cogeneration in EU countries was presented.

3. District Heating Systems

Increasing the efficiency of a district heating system means increasing efficiency in the source, in the transmission network and in DH substations.

In order to increase the efficiency of district heating systems, one needs to conduct hydraulic simulations of flow to obtain proper hydraulic adjustment of the network, i.e., optimum pressures on the supply and return. Appropriate, optimum temperature on the supply of the district heating network will also allow to limit heat losses. Constant monitoring and adjustment of parameters "on-line" will also allow to detect failures earlier and limit working water losses. In DH substations, in the first place, it is necessary to adjust the substation to the heat demands of the object by installation of weather regulation systems and flow adjustment. Introduction of such improvements will allow to increase the energy efficiency of the whole DH system. High-efficiency pumps should also be used—with their characteristics adjusted to the powered circuit, along with pump control. Introduction of cool production from network water (of the temperature like for the summer season—68~75 °C) will result in greater source efficiency through its better use and decreasing relative heat losses in the summer season. Another advantage will be decreasing electrical energy consumption (and smaller burden on electrical supply lines) by compressing cool generation units and a significant increase of cool production efficiency in relation to compressing systems.

Another important reason for incorrect maintenance of pipelines are heat losses through the working fluid. Here two phenomena should be mentioned:

- heat losses due to heat transfer through the insulation of pipelines;
- heat losses connected with pipeline leakages.

A common opinion that heat losses in a district heating network are large is not always true. The total length of district heating networks in Poland is estimated to be 19,000 km. This number includes both systems with small heat losses, as well as networks with virtually no insulation and very large losses.

Available data show that real annual heat losses in Polish district heating systems (both losses through heat transfer and losses connected with network water losses in relation to production technology, technical condition and network size) may vary in the range of 10%~30% of the heat produced. In the summer season, when the DH system works only for hot water purposes, relative heat losses sometimes exceed 50%.

Calculated heat losses in district heating systems for design conditions (norm PN-85/B-02421 and earlier ones) are determined at the level of circa 8%. In case of modern solutions—pre-insulated networks—the losses may fall to 6%. Comparing these with heat losses in foreign DH systems (Fig. 5), it can be assumed that there are real possibilities to limit heat losses to a large extent. For example, in Finland (where design temperatures reach −38 °C), annual heat losses are estimated at the level of 6%~7%. Maximum values are 3% for most modern technologies of pipeline insulation and 15% for DH systems constructed in the 1960s.

It needs to be remembered, however, that there is a relation between heat losses and network load. In networks supplying dispersed systems, especially detached houses, losses of even the best constructed networks will be much greater than in systems powering large residential districts [12]. Another problem is estimation of profitability of replacement of networks with significant heat losses. The conducted analyses show that if the pipeline is in good technical condition, its replacement only because of excessive heat losses is economically unprofitable. This relation is shown in Fig. 6. On the other hand, if the pipeline is drastically underburdened but has very good insulation, it also generates excessive losses. Its replacement only because of losses is unprofitable, though. A reason for DH system replacement is ensuring energy security of network heat recipients.

Another factor connected with the general quality of the DH system is its hydraulic tightness. System

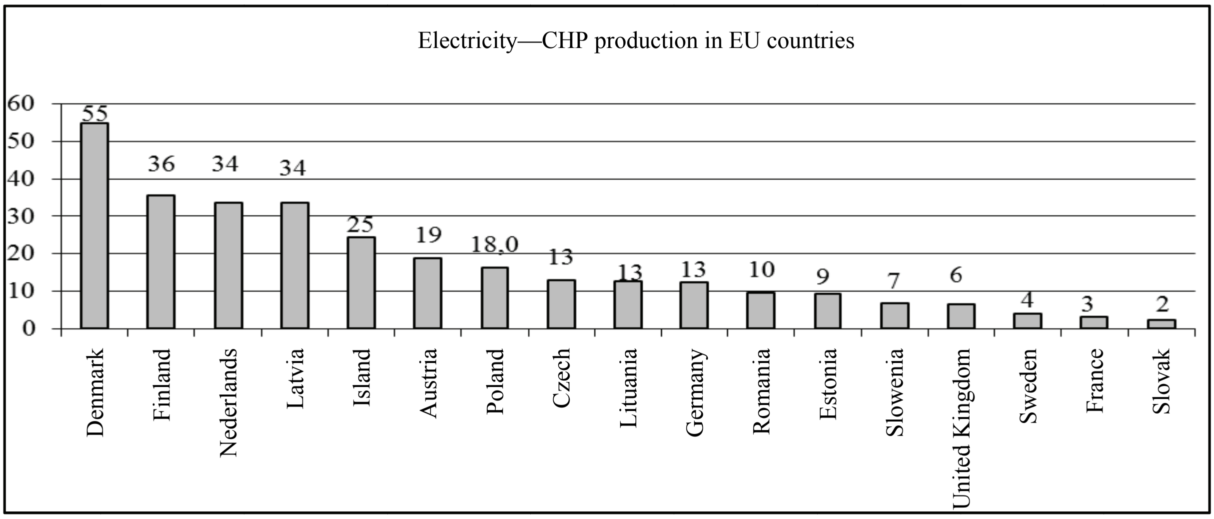

Fig. 4 Comparison of electricity production (relative) in cogeneration in EU countries [13].

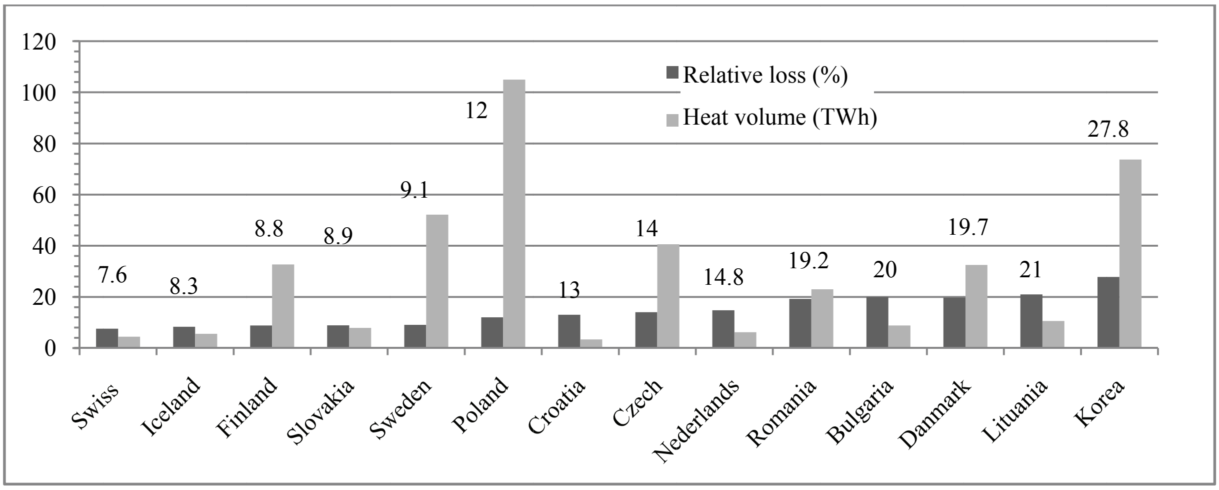

Fig. 5 Heat losses in European DH systems [13].

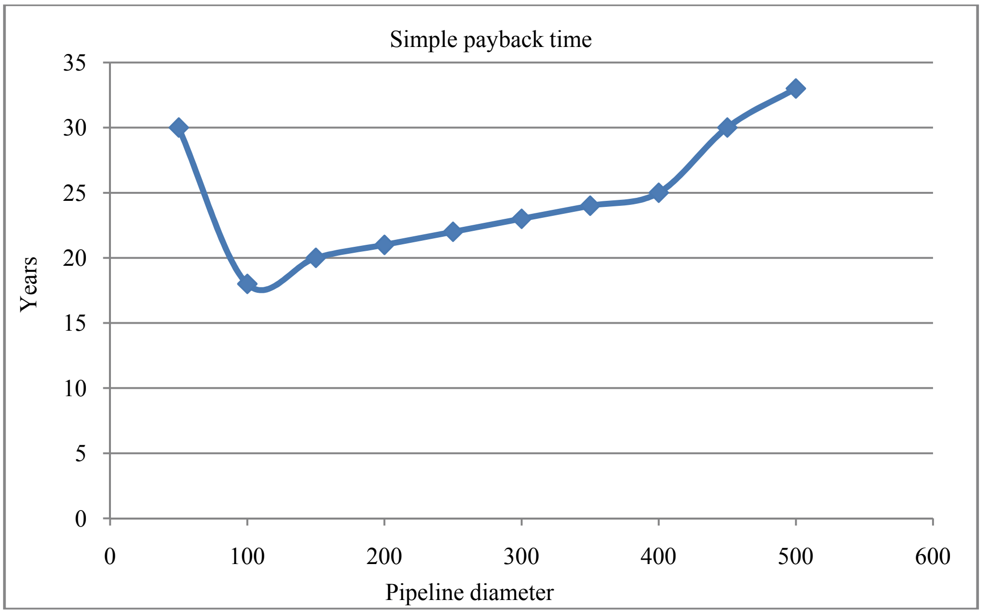

Fig. 6 Simple playback time of outlays for replacement of a DH system.

tightness is a necessary condition of high quality of functioning of all system components, such as heat sources, DH networks and substations, especially heat exchangers, elements of automatic regulation, circulation pumps etc. Moreover, system tightness has great influence, on the one hand, on working water quality (with all its consequences) and, on the other hand, on maintenance costs and, in an indirect way, on investment and renovation costs. A consequence of lower DH system tightness is the increase in the number of network failures, costs of their removal and removal of accompanying damage, as well as, in some cases, possibility of civil and criminal liability connected with public hazard, for example. In tight DH systems of EU countries, the number ranges from 0.1 to 1.0. Polish DH systems at the beginning of the 1980s had tightness of 25 to even 60 replacements per year, which means lack of their reliability. At present, it is estimated that the average number of replacements in Polish DH systems in relation to their technical condition ranges from 3.0 to 12. Still, however, the number of nine working water replacements in a DH system per year is too high in relation to European standards. An important and new issue connected with increasing DH system tightness (occurring with less than 4~5 annual replacements) is the need to introduce water reservoirs which may also serve as heat reservoirs. System tightness at this level results in natural regulatory changes of working water temperature, which is connected with changes in the liquid volume. Then, there are subsequent processes of removing and adding water in sources in order to avoid excessive pressure rises or drops in networks. If there are no reservoirs, the process results in an increase of the amount of treated working water lost and the resulting increase of the costs of the process of water addition.

4. Forecast of Heat Demand in DH Systems

Forecasts of heat demand by 2030 show that over the next years heat demand will remain the same and falls in heat demand will be compensated with connections of new recipients to DH systems. Heat demand in Poland will be influenced by two phenomena. First of all, increase in industrial production and also higher standard of living will result in greater energy demand.

The most important factor influencing heat demand is the number of buildings heated, along with the energy standard, which influences the heat demand of a building [9]. In accordance with Polish regulations, unit heat demand should be 100 kWh/m^2/year for single-family houses and 90 kWh/m^2/year for multi-family houses. It is expected that in near future, the index will fall to 60 kWh/m^2/year. It is also possible that heat demand will fall even further. Poland is implementing EU directives on energy efficiency and energy performance of buildings. Maybe after 2020, only passive buildings will be constructed and thus annual heat demand will not be greater than 15 kWh/m^2. Existing buildings which have not undergone thermomodernisation yet will be insulated, which will result in a decrease in heat demand.

The industry may also see a significant fall in heat demand. An index of energy efficiency of industry in a country is energy intensity in one kilogram of oil equivalent per 1,000 EUR of GDP (gross domestic product). Comparison of the pace of changes in highly developed EU countries with changes in Poland may suggest the extent of possible energy use reduction in the next 15 years. And so, for example, final energy demand for 28 EU member countries in 1993~2006 fell by 30% from 240 kgoe/1,000 EUR to 160 kgoe/1,000 EUR. At the same time, in Poland the fall was much greater—by 60% but energy intensity in Poland is still higher than the EU average (142 kgoe/1,000 EUR for EU, 295 kgoe/1,000 EUR for Poland) [14]. Among EU countries, the best example is Denmark with 87 kgoe/1,000 EUR of GDP. In the next 10~15 years, further reduction of the index is possible to the level less than 200 kgoe/1,000 EUR. This means that annual decrease in energy use should be 1%. This is in line with the European Parliament and Council Directive 2006/32/EC on energy end-use efficiency and energy services, which assumes that over nine years energy consumption should fall by 9%. Such energy use reduction will not be possible without decreasing energy consumption for community purposes and for industrial production.

The basis for the district heat demand forecast by 2030 is source data from 2007 to 2011. The calculations take into account the influence of actions towards greater energy efficiency in existing and new houses [15]. Existing buildings which have not undergone thermomodernisation yet will be insulated with time, which will result in lower energy demand. It is assumed that, after 2010, the resulting fall in heat demand will be 1% annually. Then, it is assumed that costs connected with implementation of the directive 2009/29/EC amending the directive 2003/87/EC (ETS (Emission Trade System)) on carbon dioxide emissions will result in a rise in heat prices and a fall in the number of district heat recipients. Additional costs of CO_2 limit allocation have also been taken into consideration after 2013. After 2023, and actually by

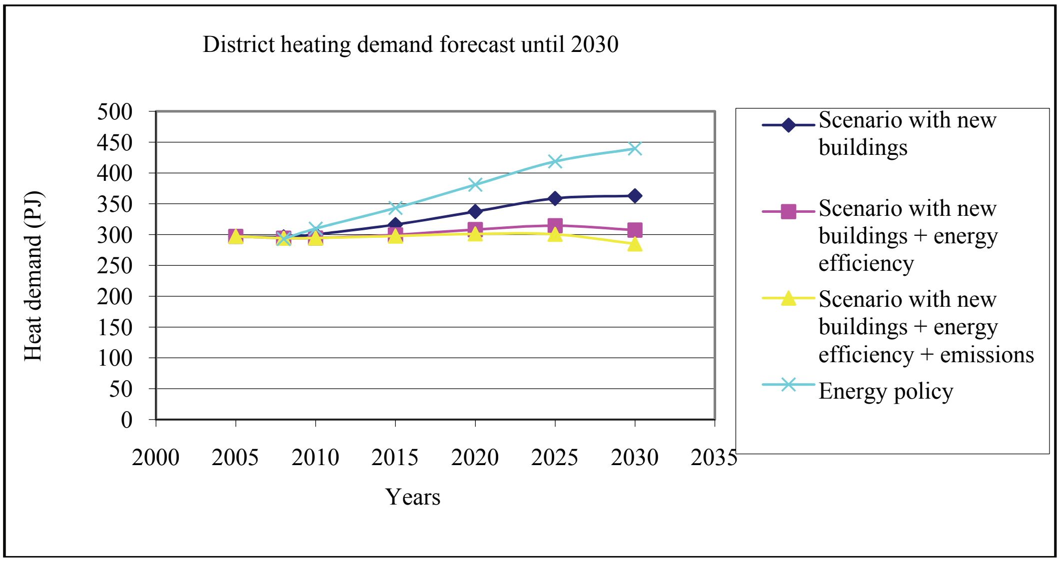

Fig. 7 Forecast of heat demand in DH systems [11].

2020, it will be necessary to incur additional costs on modernization of combustion installations to conform to the IED directive on gas pollution emissions (SO_2, NO_x, CO and other particulate matter) to the atmosphere. This will result in a rise in heat generation costs and then, in a significant increase of heat prices for recipients. This may be especially difficult in small and medium district heating systems. Fig. 7 shows a forecast of district heat demand in a few variants.

This trend is confirmed by fall of heat production and sales visible in the last 10 years; Heat production in 2002 was 467.5 PJ, and in 2011, it fell to 392 PJ. Probably in the next years, there will be a fall in heat demand, though a small one [11].

5. Conclusions

What next with district heating systems, will they still be developing? In the perspective of a few dozen of years, existing DH systems in cities will be developing, new recipients will be connected, though it is possible that heat demand of new buildings will be much lower than that of the existing ones. Development of a district heating system will be preceded by detailed economic and technical analyses. In case when the investment in development of a DH system is deemed unprofitable, densely built-up areas will develop local district heating networks powered from trigeneration sources, which will contribute to better comfort of living, as well as lower costs of heat supply. In the long term (50~100 years) in low-energy or passive buildings, the only source of energy will be electricity and the energy demand will be at a very low level.

The task for today is modernization of heat sources by replacing old used facilities whose long lifespan results in small heat generation efficiency and a high level of pollution emissions. According to data of the Euro-heat and Power Association, in 2011, carbon dioxide emission in Polish district heating was 103 Mg/TJ, compared to 39~56 Mg/TJ in countries, such as Denmark or Finland. Basic actions that may improve heat production efficiency include using the fuel for which a boiler was designed, correct separation of primary air into zones, use of systems of automatic combustion process control taking into account readings of exhaust fumes analysers, tightness of the combustion chamber, proper boiler maintenance and, in particular, removal of pollution from heated surfaces of boilers, and control of temperature of exhaust gases let out of the boiler.

Thanks to its developed and centralised heat supply system, Poland is ideal for cogeneration. A vital element of Poland's energy policy is increasing electricity and heat cogeneration. Support for high-efficiency CHP economy based on usable heat demand is a priority for the European community and brings potential benefits connected with saving primary energy. An ambitious aim set in "Poland's energy policy by 2030" (of doubling electricity cogeneration) seems realistic. This would allow to significantly decrease carbon dioxide emissions and improve Poland's energy security. Large sources that generate heat for district heating systems are usually equipped with high-efficiency facilities that limit the emissions of combustion products to the atmosphere. Pollution emission from small local dispersed sources that burn worse types of fuels are greater than from centralised sources. Thanks to relatively large DH systems, it is possible to introduce generation units of sufficient powers, and also to have smaller unit costs.

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