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REPLACEMENT OF EMISSION HEATING SOURCES WITH HEAT AND ELECTRICITY FROM CHP STATIONS. THE IDEA OF ECOLOGICAL ECONOMIC SYSTEM SOLUTION

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Abstract: The elimination of low-emission sources harmful to human health, mainly domestic boilers, has recently grown into a nation-wide problem in Poland. Emissions of harmful substances from power plants are many times lower than from domestic coal furnaces and are subject to strict regulatory regimes. Hence, companies of the professional and thermal power industry can play an important part in the process of liquidation of low emissions by offering to replace the combustion of coal in home furnaces with the use of it for the production of electricity and system heat in electrical cogeneration, which can then be used for home heating purposes. In addition, it is essential for the professional power industry to maintain a constant daily load of power units, so that the loss of efficiency in regulatory work, increased failure frequency or the need for frequent commissioning does not negatively affect the economy of production. Therefore, the selection of the part of the dispersed heat market that can be replaced with system heat and the use of electricity for heating purposes, while contributing to the elimination of low emissions and improving the economy of new energy units by increase their work in the night low demand periods, must be carried out properly.
Keywords: low emission, heating and heat sources, efficiency of use, program.

1. Introduction

In today's Poland, the main reason for the low-emissions that are harmful for health is the burning of low-quality fuels in outdated and ineffective domestic boilers (Jonek-Kowalska, Turek, 2013, pp. 727-740). Figure 1 outlines the main sources of heating in single-family houses in Poland, and at the same time indicates the origin of low-emission foci. The figure indicates that municipal system heat (MSC) holds a small share in the heating of individual buildings.

The last two crossed out pictograms of the same figure represent areas that require radical actions, because they account for almost 60% of all emission cases. It is not the purpose of this publication to comprehensively analyze the phenomenon of smog and projects aimed at its elimination. A current review of the state of affairs can be found in other papers (Turek, 2017b). The following is the concept of replacing coal combustion in home furnaces and using it to produce heat and electricity in power plants and combined heat and power (CHP) stations, and then using electricity for heating purposes where it is not possible to provide district heat, gas or other permitted (low-emission) sources.

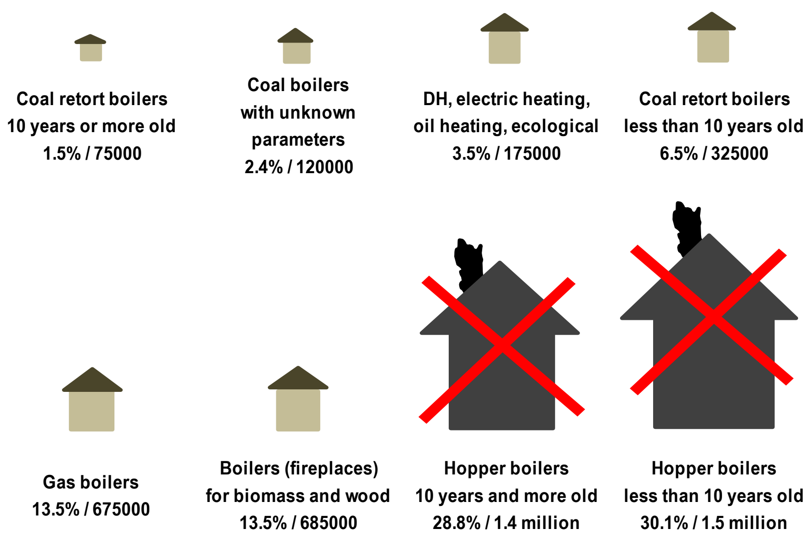

Figure 1. The main sources of heating in single-family houses in Poland. Source: Energy effectiveness in Poland, Review 2013. Institute of Environmental Economics, Kraków, 2014.

Effective elimination of low emission sources requires organizational (a program), legislative and educational activities coordinated throughout the country. In the technological dimension, this requires replacement of obsolete coal-fired home boilers with low-emission sources, including the use of electricity for heating purposes where it is not possible to supply district, gas or other allowed sources of heat generation (Turek, 2017a, pp. 1000-1003).

The figure below shows the technology options that can be implemented as part of the national low-emission liquidation plan.

The question that should be asked is how much coal, from the range of 10-12 million tons, used in home heating furnaces, can be moved to power plants and CHP stations that can produce steam and electricity for heating purposes?

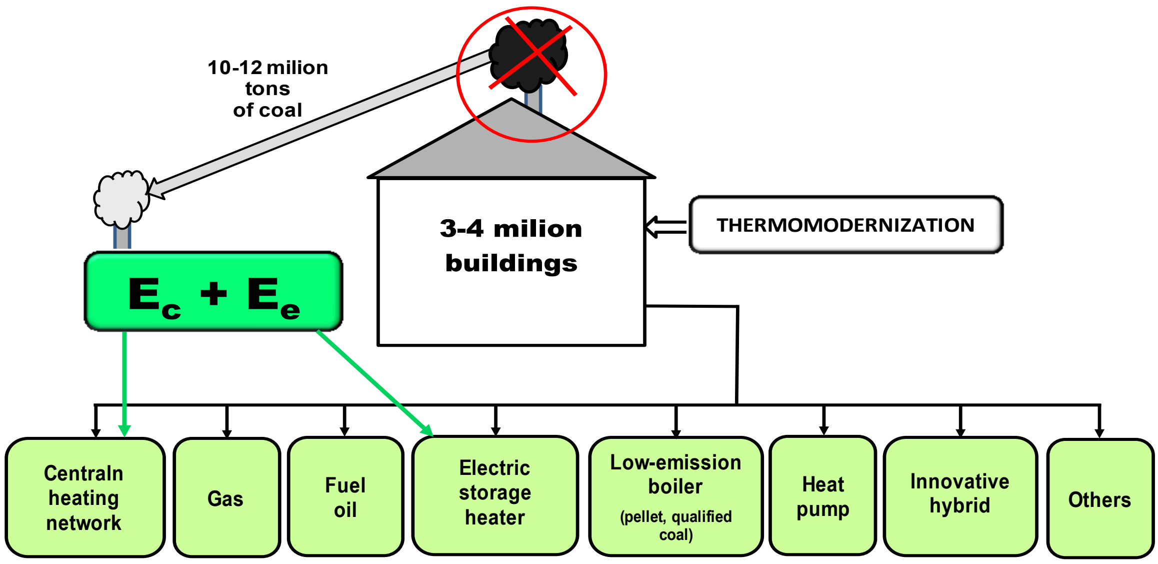

Figure 2. Variants of technical and organizational projects of the national plan for the liquidation of low emissions. Turek, 2017a, pp. 1000-1003.

2. Energy demand in the National Power System

The work of the National Power System (NPS) is characterized by high volatility. Increasing wind generation and the negative impact of weather conditions (freezing rivers in winter, or drought in the summer, which affect the availability of cooling water for thermal power plants) and increased failure rate of ageing coal units has brought about a situation wherein ensuring power system stability is becoming more and more difficult. In 2017, there were two record energy demand peaks in the Polish Power System, in the winter and summer seasons, namely:

- January 19, 2017, at 17:30, the demand of the National Power System amounted to 26.231 MW. The wind farms operating in Poland delivered about 500 MW of power at that time. The balance of international exchange was negative and amounted to around 900-1000 MW.
- August 11, 2017, two years after the introduction of restrictions for electricity consumption in Poland for the first time after 1989, at 13:00, the NPS demand amounted to 22.990 MW, while wind farms at noon delivered only 200 MW of power. There were limitations in energy production due to river water temperature. Energy prices on the balancing market increased to the level of PLN 1,500/MWh.

In both cases, the National Power System reserves remained at the safety limit.

The figure below shows the demand for power in the National Electricity System during the heating season, on example days in October 2016, January and April 2017.

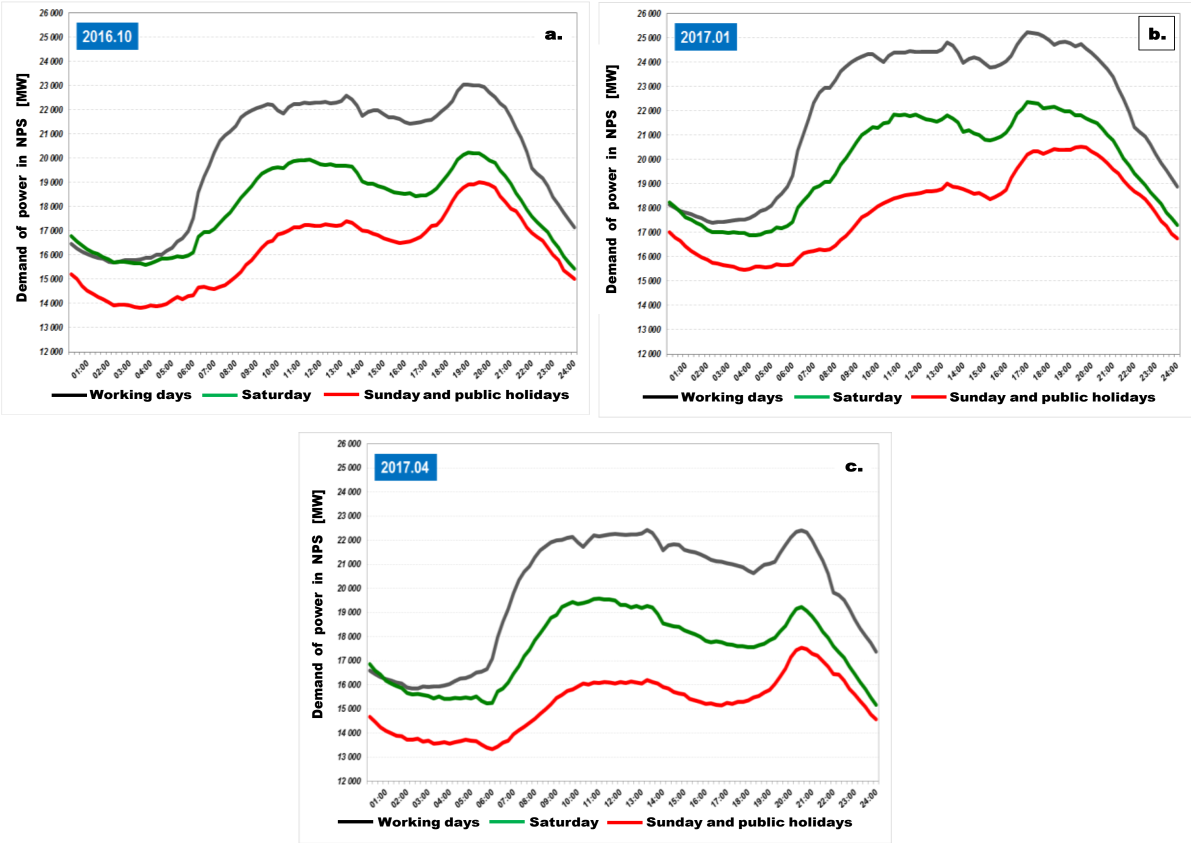

Figure 3. Volatility of power demand in the National Power System: 1a – October 2016, 1b – January 2017, 1c – April 2017. Source: PTPiREE Problem Materials.

The graphs show that periods of lower power demand occur from 22:00 to 6:00. What should be underlined is that the difference in demand in the working days of the heating season reaches 30% difference between the peak and the night low demand periods. Hence, a hypothesis should be made that the use of electricity for heating purposes in the night low demand periods is beneficial for the system, because it balances the load curve of power units or prevents their frequent withdrawals.

3. The use of electricity for heating purposes, current status

In the current legal status (Act of 10 April 1997) and the resulting solutions, electricity can be used for heating purposes in households and institutions such as orphanages, hospices or facilities used by other private and public organizations. In this regard, electricity trading companies offer a special tariff with a lower electricity price in certain time zones and at weekends. In G12 tariff, a 24-hour 'day' is divided into two time zones, in which the price of electricity depends on the time of consumption. The lower rate is valid for 10 hours during the day: 22:00-6:00 (night low demand period), 13:00-15:00 (day low demand period).

For the remaining 12 hours, in the so-called peaks, the rate for electricity consumption remains higher. Time zones can be moved. It is also possible to modify tariffs taking into account weekend offers and extended night zone. Customers who have concluded a contract for the supply of electricity and are not included in the tariff by the President of the Energy Regulatory Office (ERO) may also use the tariff for electric heating. The energy recipients in the G12 tariff have a two-zone counter, thanks to which electricity is supplied to heating devices (storage heater, hot water boiler), at cheaper tariff hours, accumulated in these devices and used for the remainder of the day. It is estimated that out of 13 million households, a two-tariff counter is installed in about 3 million houses and facilities.

The table below presents average offers of energy companies offering electricity for heating purposes in tariffs G12 and G12w (weekend).

Table 1.
Rates for electricity and transmission services for G12 and G12w tariffs, PLN/kWh, in energy groups, based on data from websites and PTPiREE, I quarter, 2017.

Trading companies	Tariff	Day-time period	Night-time period	Average rate
Electricity price PLN/kWh				
Enea SA	G12	0.303	0.140	0.189
	G12w	0.348	0.155	0.193
TAURON SA	G12	0.306	0.177	0.218
	G12w	0.319	0.177	0.208
PGE Dystrybucja SA	G12	0.280	0.177	0.208
	G12w	0.303	0.195	0.216
Energa SA	G12	0.282	0.183	0.212
	G12w	0.295	0.192	0.212
Innogy	G12	0.293	0.259	0.283
	G12w	0.303	0.265	0.290
Sellers in total	G12	0.291	0.182	0.217
	G12w	0.311	0.192	0.218
Distribution fee PLN/kWh				
Enea Operator SA	G12	0.199	0.076	0.127
	G12w	0.193	0.070	0.113
TAURON Dystrybucja SA	G12	0.196	0.057	0.113
	G12w	0.227	0.050	0.100
PGE Dystrybucja SA	G12	0.252	0.074	0.143
	G12w	0.258	0.072	0.125
Energa Operator SA	G12	0.267	0.074	0.149
	G12w	0.280	0.076	0.133
Innogy Stoen Operator	G12	0.164	0.049	0.098
	G12w	0.166	0.079	0.111
Distributors in total	G12	0.225	0.057	0.130
	G12w	0.237	0.067	0.116

The table shows that for a consumer with an annual electricity consumption (including that for heating purposes) in the amount of 15000 kWh, the average cost of electricity purchase is 0.426 PLN/1kWh gross. The annual electricity bill will, therefore, amount to PLN 6,390.

Electric heating costs using the G12 tariff remain relatively higher compared to that supplied by such utilities as network heat or gas. Is it possible, therefore, to replace coal-fired home heating with heat or electricity from the CHP stations? Is it possible to introduce an anti-smog tariff for electric heating where there is no other option of eliminating emission coal furnaces, but in such a way that the cost of heating electricity remains at the level of district heating? By Ordinance of December 26, 2017 (Regulation of the Minister of Energy…), the Minister of Energy introduced a new tariff group for increasing energy consumption in the hours between 22:00 and 6:00, the so-called 'anti-smog tariff'. Pursuant to the Regulation, the President of the Energy Regulatory Office approved the tariffs of distribution companies in the part related to the transmission fee. Energy trading companies have prepared offers for customers consisting of a tariffed transmission part and a product in the form of energy. These offers are available at least in price lists on websites of energy companies. The proposals of energy groups in this respect contain significantly lower energy prices, but the overall assessment of the attractiveness of offers depends on the energy collection profile and the tariff possessed so far.

4. Selective electrification program for district heating

Effective, cost-effective and time-limited elimination of low-emissions harmful to health requires the preparation of a government program and coordinated actions on a national scale that apply the same standards. On the day of commencement of the Program, it must be prohibited to install furnaces for solid fuels in newly-built houses and public and private facilities. With regard to existing heating systems, the replacement time horizon must be defined, including the specification of technical requirements and sources of financing for the exchange of furnaces for system sources, gas heating, heat pumps, liquid fuels, and other permitted sources, and in the absence of such possibilities, to utilize electricity for heating, after a special tariff. Such a Program is intended for municipal customers.

a) Detailed assumptions

1. On the day of commencement of the Program, restrictions on installing furnaces for solid fuels for heating and domestic hot water preparation in newly-built single-family houses and multi-family residential buildings or other private and public facilities are introduced.
2. At the stage of building design, an analysis of the availability of heating media in the form of system heat, natural gas, heat pumps and other authorized sources is to be carried out. If it is not possible to provide an economically effective source for heating purposes, electricity is to be taken as the main source of heat supply.

3. The quantitative demand for electricity for heating and hot water preparation, which must be delivered to the facility, is to be determined in accordance with the requirements

of the Act of 29 August 2014 on the energy performance of buildings (Act of 29 August 2014).

4. For existing heating systems, within the framework of the National Low Emissions Liquidation Program, coordinated with local government initiatives, an analysis is to be done of the possibility of connecting the facility to system heat, gas or other permissible source. If there is no possibility of such connection, the owner may apply for the conditions of connection to the power grid for heating and hot water preparation under special tariff.
5. A special tariff for electricity is to be established, the so-called **anti-smog tariff** for heating purposes and hot water supply for the recipients described above.
6. Due to the existing restrictions on the capacity of the power network, as well as the possibilities of financing the anti-smog tariff, the process of replacing emission heat sources, in particular, low-efficiency coal stoves, is to be spread over time and implemented at the local government level.
7. It is assumed that owners of houses and facilities that have exchanged carbon-fired heating systems for electricity, receive the right to use a special anti-smog tariff at the level of equivalent heating costs of district heating from heat and power plants producing high-efficiency cogeneration.
8. The dedicated tariff is to be financed by the anti-smog fee in the tariff of the transmission system operator, or by reducing the costs of energy purchase for heating purposes (by way of liquidation of color fee (co-generation support charge) or reduction of excise duty).
9. The anti-smog tariff is to be introduced regardless of the existing night or weekend tariff. It is to be financed through an anti-smog fee in the tariff of the transmission system operator and can be offered by all electricity sellers in a time horizon ensuring financial stability of the solution for users.
10. Heating of buildings with the use of electricity is to be preceded by thermo-modernization meeting the energy efficiency criteria, in accordance with the requirements of the Act of 29 August 2014 on building energy performance.
11. The replacement of the coal furnace feeding the heating system or heating domestic hot water, by relevant electrical equipment is to be carried out under the supervision of an authorized body and is to be durable.
12. The Program is not to be intended for entrepreneurs. A special tariff for electricity use can be obtained only for domestic heating, hot water preparation and social purposes.

b) Economic and financial aspects of the Program

1. Electric heating in terms of cost for the consumer must remain at the level of heating with system heat coming from a combined heat and power plant producing electricity and heat via high-efficiency cogeneration (CHP). A benchmark related to coal-fired CHP stations production cost should be considered.
2. Comparing the heat network price, at a high parameter, before the domestic heat exchanger, at the level of 60 to 70 PLN for 1 GJ gross, to the price 1 GJ of heat coming from the use of electricity, which is in G12 tariff (for a sample recipient in this tariff in 2016: the cost of electricity purchase will amount to: PLN 0.217, distribution service: 0.130 PLN, VAT: 0.079 PLN, in total: 0.426 PLN/kWh) about 118 PLN for 1 GJ, the cost of this second medium is almost twice as high. Considering that the purchase price of 1 kWh of electricity is about 0.55 PLN/kWh in the G11 tariff, while 0.43 PLN in the G12 tariff, the anti-smog tariff for heating purposes would have to amount to approx. PLN 0.24 per 1 kWh gross.
3. A household in a single-family home that consumes about 50 GJ of heat annually would cover the difference between the cost of heating electricity and the cost of district heating via a special tariff for electricity by the amount of approx. PLN 2650 per year.
4. The anti-smog tariff may be financed in the form of a fee in the tariff of the transmission system operator and settled through distribution system operators. If electricity for heating purposes is released from the cogeneration support charge (the so-called color fee) or is subject to excise tax reduction, the anti-smog fee in the tariff of the transmission system operator may not be necessary.
5. Choosing a selective electrification program for heating 100,000 recipients with the heating profile described above, would require the involvement of funds in the amount of 265 million PLN per year.
6. Co-financing of thermo-modernization and costs of replacing domestic coal-fired heating/cooking appliances will be carried out through local environmental and anti-smog programs.
7. The implementation of the Program should be preceded by a pilot initiative in the selected city/area in order to identify problems and determine the consequences of regulation.

The intended district heating electrification program is selective in nature and is intended for cities/municipalities particularly at risk of smog, or parts thereof, to which it is not possible to provide district heating, gas or other permitted heating sources. The effect of the Program will be to shift coal combustion to large sources and reduce, and ultimately eliminate smog coming from home furnaces. A detailed description of the Program is presented by S. Tokarski (Tokarski, 2017).

c) Comparative analysis of the efficiency of primary energy use in a CHP station to domestic boilers – the use of alternative heating methods

Many Polish towns have an extensive heating system, and cities with a larger population and urban agglomerations are supplied with heat from a combined heat and power plant.

Examples of cities with heating networks are Warsaw, Łódź, Wrocław, Kraków, Poznań and the Silesian and Gdańsk agglomerations. In 2016, 234,700 TJ were produced in Poland via the cogeneration systems of CHP stations. This accounted for 61% of all heat generated in enterprises subject to concession (Buńczyk, 2017).

Generation of electricity and heat in one process (cogeneration production) is one of the most effective ways of using fuels. With this form of production, more than 80% of the energy of the original fuel can be used. The Sankey diagram below presents a comparison of the fuel savings in CHP stations and power plant and heat generating plant to generate the same amount of electricity and heat units.

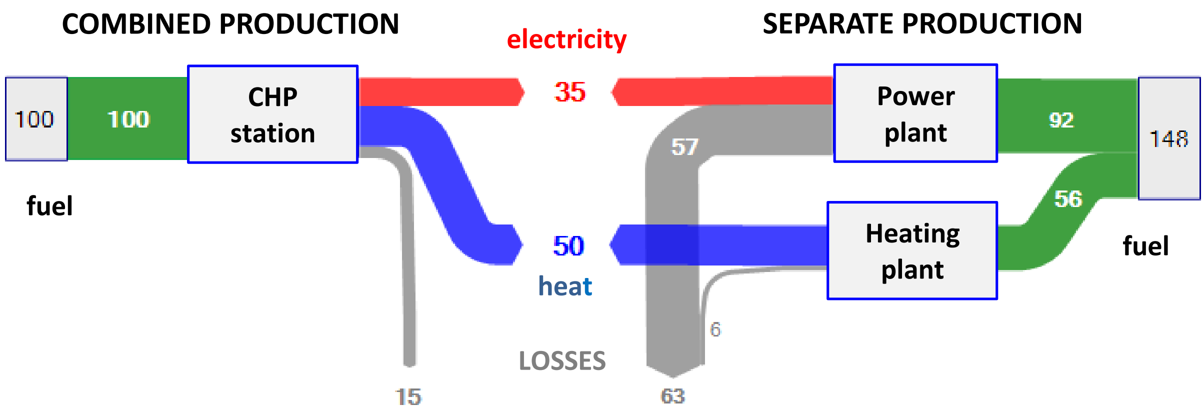

Figure 4. Sankey diagram – production fuel consumption in a CHP station compared to power plants and heating plants.

The efficiency of individual processes in a CHP station is illustrated by the following relations (Szargut, Ziębik, 1998):

$$\eta_{E\,el\,ec} = \eta_{E\,ek} \frac{\eta'_{tp}}{(1-\varepsilon)\,\eta_{tp}} \quad (1)$$

$$\eta_{Ec\,ec} = \frac{Q}{PW_d - \frac{N_{el}\,\eta_{tp}\,(1-\varepsilon)}{\eta_{ek}\,\eta'_{tp}}} \quad (2)$$

where:

$\eta_{E\,el\,ec}$ – the gross efficiency of electricity generation,

$\eta_{Ec\,ec}$ – the gross efficiency of heat generation,

$\eta_{E\,ek}$ – energy efficiency of the border power plant,

η'_{tp}, η_{tp} – efficiency of transformation and transmission of electricity from the border power plant and CHP station,

ε – indicator of the share of own needs in the CHP station,
Q – the volume of produced heat,
P – amount of fuel consumed,
W_d – fuel heating value,
N_{el} –amount of electricity produced.

The cumulative fuel savings expressed in reducing the amount of chemical energy units are calculated by comparing the fuel consumption in the heat and electricity production process in a CHP station in a combined process, to production via power plant and by heating plant for each of these products separately. The calculation of savings is made with the assumption of the same amounts of heat and electricity supplied to customers. The example described is illustrated in the graph in Figure 4.

The example presented in the diagram shows that 48 units less fuel are consumed in combined production in relation to the separate production of electricity and heat. In the example, 38% efficiency of power plant electricity generation and 89% efficiency of heating plant heat production was assumed. The example shown above reflects the efficiency obtained when using hard coal as fuel.

As production in the CHP station is more efficient, this results in a total reduction of fuel consumption, and the amount of fuel consumed translates directly to emissions reduction from fuel combustion, in particular, reduced CO_2 emissions. Conducting the process in the continuously monitored installations of CHP stations that are equipped with exhaust aftertreatment equipment also minimizes the emissions of other harmful substances such as CO, SO_2 , NO_X and dust.

When comparing the efficiency of energy management with the use of an associative process in relation to the separate generation of electricity, we can use an enumeration showing the fuel savings obtained by reducing the amount of chemical energy consumed in these processes:

$$\Delta E^*_{ch} = \frac{1}{\eta^*_d}\left[Q_o\left(\frac{1}{\eta_{E\,kc}\,\eta'_{pc}} - \frac{1}{\eta_{E\,ec}\,\eta_{pc}}\right) + E_{el\,o}\left(\frac{1}{\eta_{E\,ek}\,\eta'_{pt}} - \frac{1}{\eta_{E\,ec}\,\eta_{tp}\,(1-\varepsilon)}\right)\right] \quad (3)$$

where:
$\Delta E^*_{ch\,r}$ – cumulative fuel saving for combined and separated economy,
Q_o, $E_{el\,o}$ – heat and electricity demand loco recipient,
η^*_d – cumulative energy efficiency of fuel supply,
$\eta_{E\,kc}$ – average energy efficiency of boilers in heating plant,
η'_{pc} – heat transfer efficiency from heating plant,
$\eta_{E\,ec}$ – average energy efficiency of the entire heat and power plant,
η_{pc} – efficiency of heat transfer from the heat and power plant,
$\eta_{E\,ek}$, η'_{pt} – as in formula (2),
η_{tp}, ε – as in formula (1).

The various indicators included in the template take the following average indicators (Turek, 2017b; Act of 10 April 1997; Act of 29 August 2014):
$\eta^*_d = 1$ – the influence can be omitted due to small differences in comparable processes,
$\eta_{Ekc} = 0.82$ – assumed as efficiency for a typical WR-25 boiler,
$\eta'_{pc} = \eta_{pc} = 0.88$ – based on the reports of a medium-sized heating company,
$\eta_{E\ ec} = 0.85$ – for the average efficiency of CHP stations,
$\eta_{E\ ek} = 0.35$; $\eta'_{pt} = \eta_{tp} = 0.91$; $\varepsilon = 0.05$.

Despite the existence of a large number of environmentally sound heating systems, the problem of low emissions associated with the combustion of solid fuels in many Polish cities is a big challenge for local governments. In the group of cities for which emissions monitoring is conducted in Europe, Polish cities and towns are taking disgraceful places in the top of the ranking. This is due to individual installations equipped with old boilers for solid fuels with low energy efficiency of 50-60%, which do not have systems for regulating the amount of fuel feed and air for the combustion process. As a rule, high-emission combustion occurs on the outskirts of pre-settled housing estates, where the density of buildings and the ownership structure result in the lack of economic premises for running municipal heating networks. This problem also concerns a large part of the old (often nineteenth century and older) buildings of the central parts of cities, where the changes in the infrastructure of connections and internal installations are high-volume.

A method that quickly solves the problem of air pollution during the heating period in such areas is replacement with electric heating. The size and location of this form of heat production, however, requires an individual approach. Yet, the use of electricity at night for heating does not have to increase the consumption of primary fuels in many cases. It will also ensure the productivity of the environmentally sound energy production installations installed in combined heat and power plants and power plants.

The structure of supplying cities with energy and heat clearly indicate the inseparable connection between the consumption of electricity and heat in the same place. In the combined heat and power production of these two energy carriers, we see the additional effect of not having to tap and transform electricity from the overall high voltage national transmission network, limiting ourselves to local flows instead. With the use of electricity for the production of heat, this gives an additional effect of increasing efficiency.

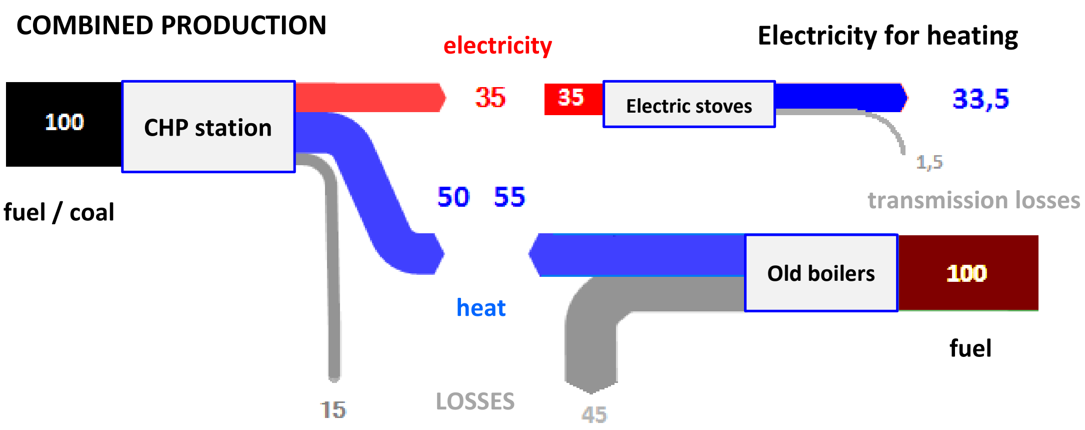

Figure 5. Sankey diagram of using electricity and heat from a combined heat and power plant for heating purposes.

The Sankey diagram placed above (Figure 5) illustrates the possibility of a more ecologically effective way of processing fuel, assuming that high-emission carbon is the fuel.

The question is whether the use of electricity for heating has ecological and economic advantages in the Polish power system based on solid fuels. The presented case shows that it is possible to obtain 83.5 equivalents of heat from 100 units of fuel. From a low-efficiency heating boiler, the same amount of fuel will generate 28.5 heat units less. There will also be the previously described effect of emission of additional harmful substances. Due to the nature of low emissions, these substances will be emitted in close proximity to places of human presence.

The issue of ecological effects is not in doubt. It can be clearly defined by calculating the reduction of dust emissions, NO_X, SO_2, CO_2 and other dangerous compounds generated when burning low-quality fuels in installations that are unsuitable, such as domestic solid fuel furnaces.

If we assume that in order to improve the environmental effect we need to eliminate in the next few years, emissions from coal combustion in domestic solid fuel boilers, it is necessary to replace the heat produced with cogeneration (which is characterized by the highest process efficiency) of electricity for which there is the greatest affordability and ease of delivery to recipients. Other high-efficiency installations generating heat and limiting the consumption of primary fuels (solar collectors, heat pumps, installations for biomass fuels) or using gaseous and liquid fuels can mitigate the problem as well. However, recent methods of obtaining heat are expensive due to high investment costs or fuel costs.

The graph below presents the structure of conversion of electric energy to heat under the current system conditions at night, assuming that for the production of heat we use energy produced via cogeneration and by dedicated electrical power plants in equal proportions. The energy production efficiency in the power plant is assumed to be 35%.

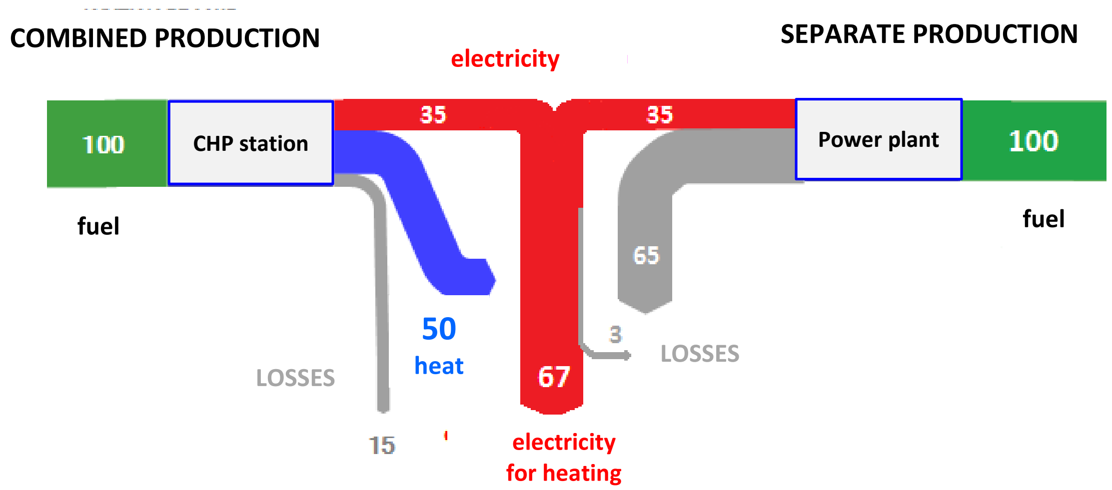

Figure 6. Sankey diagram for heating use using electricity via CHP stations and local electrical production (50% CHP station and 50% local power system supply).

This system gives almost 60% efficiency of heat production.

One more example should be considered, in which the amount of heat produced in old furnace hopper style boilers is replaced with equal proportions of electricity from the power system and from CHP station production (heat and electricity). Assuming that half of the 12 million tonnes of hard coal consumed in old low-efficiency (55%) furnace hopper boilers will be replaced by the production of heat in the way presented in the diagram, a balance in the amount of fuel used is obtained when power system energy is produced at an efficiency of about 46%. Under such conditions, an absolutely beneficial effect for the environment takes place.

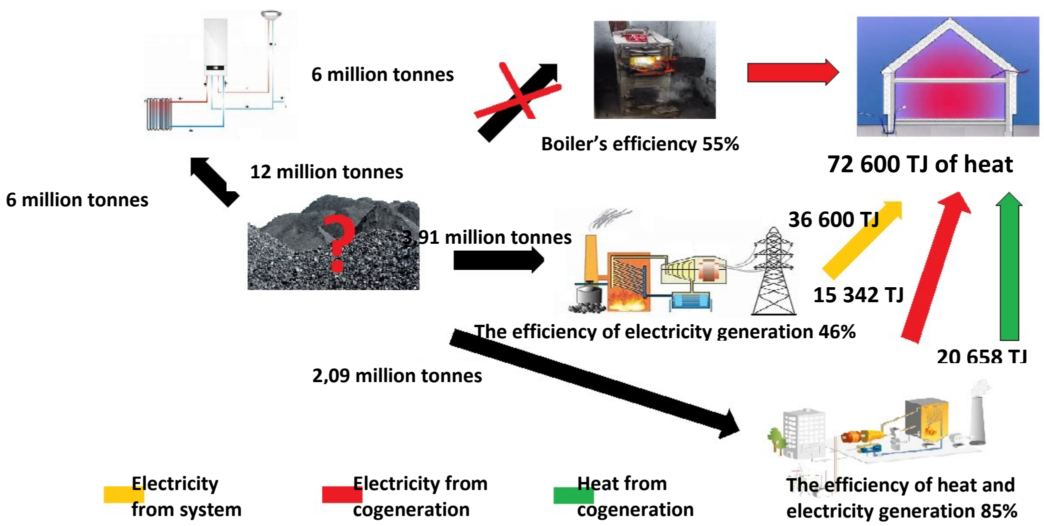

Figure 7. Coal redirecting (assumed for example Wd=22 MJ/Mg) from boilers with a spreader for combustion in power installations.

The 200 MW and 360 MW energy blocks currently operating in the Polish power system generate electricity with an efficiency of 32-35%. However, it is necessary to take into account the commissioning of 45% successive coal-fired units in the coming years, as well as gas and steam units whose efficiency exceeds 55%, and an increase in the share of renewable energy from wind and sun for which 100% generation efficiency with respect to fuel consumption is assumed. According to the forecasts of the transmission system operator at night, this is how the energy mix that also includes cogeneration will give an average efficiency of electricity generation of more than 50%. This means that heating with electricity will not increase fuel consumption, which means an absolutely positive environmental impact. Coal used to produce heat in households in old low-power boilers, according to the example shown in Fig. 2, will change the place of its use being burned instead in adapted energy installations guaranteeing low-emission heat generation.

5. Conclusions and proposed next steps

- Conduct pilot programs for selected areas, for example: selected districts of Krakow, selected locations in Silesia, towns with health resorts that are particularly vulnerable to smog phenomena.
- Pilot programs on a scale of up to several hundred houses, and supported on the boiler exchange side by local governments, of special offers by energy companies. Such pilotage will allow verification of the Program assumptions and a real assessment of its costs.
- Correct the tariff G12AS (ANTI-SMOG) as part of the regulation for existing special tariffs in a way that ensures heating of comparable facilities at the benchmark level of district heating,
- Make changes to the Act of 29 August 2014 on the energy performance of buildings (Act of 29 August 2014) and accompanying legal acts that will allow the use of electricity as a source of heating.
- Launch work on the introduction of regulations prohibiting the construction of solid fuel furnaces in new homes and new public and private facilities. Moreover, introduce the principle that in the event that it is not possible to provide district heat, gas or other authorized heating sources, electricity is to be used as the basic heating medium after a special anti-smog tariff is put into practice.
- For existing heating systems, under the national Low Emission Efficiency Program, coordinated with local government initiatives, introduce regulations that if it is not possible to connect the facility to system heat, gas or other permissible source, the owner

may apply for grid connection conditions for heating purposes and preparation of hot utility water, after a special tariff.

- In connection with the growing prices of CO_2 emission allowances, which translate directly into the costs of electricity production, introduce a mechanism to reimburse the purchase costs of allowances for a group of consumers using electricity for heating.

Assuming that from the volume of 10-12 million tonnes of coal combusted in domestic boilers, about half can be moved to produce heat and electricity in power plants and system heaters, than as a result, the electric power unit load in the night low demand periods will increase, this will significantly re-align the load curve of the national energy system, and, as mentioned above, will affect the level of its safety and efficiency by increasing the load on blocks operating at minimum efficiency in this period.

About 12.25 TWh more electricity introduced into the power system will be obtained for the examples discussed in Chart 3, which will increase electric load in the night hours by an average of 2,900 MWe in the heating period, i.e. October – April.

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