Výsledek výzkumu a vývoje projektu TN01000024

ID a název: TN01000024/18-V2 Výzkumná zpráva

Abstrakt: Studie popisuje stav a relevantní podmínky českého teplárenství za účelem přechodu na nízkouhlíkovou energetiku a naplnění klimatických cílů České republiky. Cílem je identifikovat vhodné technologie a postupy pro modernizaci výroby a rozvodu tepelné energie v teplárenství a průmyslu, které efektivně a udržitelně přispějí k potřebné transformaci celého sektoru a dosažení ambiciózního snížení emisí skleníkových plynů. Studie prokazuje vhodnost navržených opatření prostřednictvím kalkulace investičních a provozních nákladů a zejména konkrétními přínosy na jednotku investice. Zaměření studie bylo zpracované výhradně pro poskytnutí doplňujících informací k dotačním programům financovaným z Modernizačního fondu. Ukazuje, že teplárenství a průmysl v České republice představují významný podíl na emisích CO2, a proto představují prioritní oblast, kterou je potřebné řešit v rámci Modernizačního fondu a v souladu s Rámcem pro oblast klimatu a energetiky do roku 2030 a v rámci dodržování Green Deal EU.

Autoři: Beran, H., Gavor, J., Jeník, P., Kalaš, P.J., Mařík, V., Pačes, V. and coll.

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Modernisation of heat sources in the heating and industrial sectors in the Czech Republic

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A B S T R A C T

The study describes the state and relevant conditions of the Czech heating industry in order to transform to low-carbon energy and meet the climate goals of the Czech Republic. The aim is to identify suitable technologies and procedures for modernising the production and distribution of thermal energy in the heating and industrial sectors, which will effectively and sustainably contribute to the necessary transformation of the entire sector and to achieve ambitious GHG emissions reduction. The study demonstrates the suitability of the proposed measures through calculations of investment and operating costs and especially the specific benefits per unit of investment.

The selection from the study was prepared exclusively to provide complementary information to subsidy programmes financed from the Modernisation Fund. It illustrates that the heating and industrial sectors in the Czech Republic represents an important share of the CO_2 emissions and therefore constitutes a priority area to be addressed in the framework of the Modernisation Fund and in line with the National Energy-Climate Plan 2030 and within the compliance with the EU Green Deal.

1. Introduction

Whereas the substantial transformation of the Czech economy during last 30 years has led to a significant reduction of the CO_2 emissions (-34%) compared to the year 1990, the Czech Republic still belongs to the top EU countries measured in terms of per capita emissions (12.4t CO_2/cap). The largest share of GHG emissions (35%) belongs to the energy sector (electricity and heat), followed by the industry (28%), transport (14%), buildings (10%) and others (12%). It should be noted that the emission share of energy sector in the Czech Republic (35%) is much higher than the EU average (24%). It is given by the prevailing and traditional sectoral scope and the role of domestic coal in both electricity and heat production.

In contrast to the electricity sector where the ongoing decarbonisation process contains a few large coal fired power plants that will be mostly decommissioned by 2030, the GHG emission reduction in the heating sector represents manifold challenges. It is given by its specific features that significantly differentiate this sector from most EU countries, including its historical role with high share of the district heating (over 40%) in the country‘s total heat supply, large number of heating plants (over 350) with composition of large production facilities in all large cities and many dozens of smaller and locally specific heating plants in all mid-sized towns and even smaller municipalities. Unlike the electricity production with the current 60% share of emission-free production (combination of nuclear and renewable energy), the largely prevailing fuel in the district heating systems is coal with roughly 2/3 share complemented by natural gas (less than 1/3). The current share of renewable energy in the heating sector is still rather marginal (about 10%) with a few individual, predominantly large heating plants co-firing biomass with coal.

The Study contains the array of available and new technologies that would potentially make the future heat production more efficient and less emitting. The list of technological options contains characteristics of technologies such as combined heat-electricity systems, purely heating production installations, boilers for multiple fuel burning, biogas plants, heat pumps, electric boilers and some others.

The Study deals with important and specific systemic feature of the heat sector given by interlink to the electricity production as a by-product of heat production and its integration into the electrical grid by significant amount of electric production.

The Study further illustrates comparative investment and operational costs of technology implementation in the heating and industrial sectors and their impacts on the prices of heat delivered to consumers.

2. Methodology for calculating capital and operating intensity of CO_2 emissions reduction and primary energy savings

To evaluate the benefits of the proposed technologies, it is necessary to calculate the capital and operating intensities in relation to GHG and primary energy emission savings by the following quantities:

(i) *Load factor (LF)*, determines the period of use of the source. This is stipulated by the amendment to the Act on Supported Energy Sources and by the Energy Regulatory Office price decision for 2022, in the regime of 3000 or 4400 hours/year. To calculate the investment intensity, the LF 3000 hours/year is selected for the heating industry and 4400 hours/year for heat modernisation in industry.

(ii) *Emission factor (EF)*, values that relate to the energy supplied in the fuel (power input), not values related to energy production (power). The values do not include energy conversion efficiency.

(iii) *Energy Efficiency (E),* values given in the methodology demonstrating the new technologies, and possibly further updated by confronting BAT.

The technologies and savings are determined on the basis of the same output value of thermal energy (MWh or GJ). *Emission intensity of new investment* in tCO_2/year is then given by formula:

$$\frac{P}{E} \times EF \times LF$$

To be compared with the initial state, where the heat is generated by the old heating lignite-fired boiler, the *Emission intensity of the initial state* in tCO_2/year is given by:

$$\frac{P}{E(L)} \times EF(L) \times LF$$

The *total savings of tCO_2 per year* are then achieved by comparison:

$$\left(\frac{P}{E(L)} \times EF(L) - \frac{P}{E} \times EF\right) \times LF$$

The resulting *primary energy savings* are then obtained by deducting the basic primary energy consumption and the primary energy consumption of the new investment:

$$\left(\frac{P}{E(L)} - \frac{P}{E}\right) \times LF$$

The *capital intensity of CO_2 and primary energy savings* is then simply determined by the relationships:

$$\frac{CAPEX}{\left(\frac{P}{E(L)} \times EF(L) - \frac{P}{E(NG)} \times EF\right) \times LF}$$

$$\frac{CAPEX}{\left(\frac{P}{E(L)} - \frac{P}{E}\right) \times LF}$$

CAPEX values always lie in a certain interval depending on the following parameters:

- resource performance (in general, specific investment costs decrease with increasing output),
- specific technological arrangement (steam production is more demanding than hot water production),
- development of inflation (in 2021 supplier prices increased significantly due to rising prices of basic materials).

In addition to the capital intensity of the conversion to emission-free or less emission-intensive technologies, it is also necessary to deal with the *operational (OPEX) intensity* of this conversion. The total annual operating costs consist of the following main items:

- fuel costs,
- cost of CO_2 allowances (for sources above 20 MWt only),
- operation and maintenance costs,
- personal expenses,
- financial costs (insurance, etc.),

when the *Annual fuel cost (FC)* of a new investment is given by:

$$FC = \frac{P}{E} \times LF \times C$$

where C is the *unit price of the commodity* and consists of several items:

$$C = C\ (commodity) + C\ (capacity) + C\ (taxes)$$

Operating and Maintenance Costs (OM) depend on the technology and range from 2% of the CAPEX, as the Personnel and financial expenses (PFE), which amount to approximately 1 to 2%.

The annual cost of (CCO_2) allowances can be calculated as a multiple of the amount of emissions and the unit price of emissions:

$$CCO_2 = \frac{P}{E} \times EF \times LF \times C_{allowance}$$

Total annual OPEX costs then represent:

$$OPEX = FC + OM + PFE + CCO_2$$

The operational demands of CO2 and primary energy savings can then be determined analogously to the capital intensity (see above) relationships:

$$\frac{OPEX}{\left(\frac{P}{E(L)} \times EF(L) - \frac{P}{E} \times EF\right) \times LF}$$

$$\frac{OPEX}{\left(\frac{P}{E(L)} - \frac{P}{E}\right) \times LF}$$

Comprehensive economic evaluation of investment efficiency

Individual applications are based on a detailed knowledge of the current and target state and thus allow a more comprehensive assessment of the effectiveness of the proposed investments. The internationally accepted methodology of investment evaluation on the basis of discounted financial flows is regulated in Czech legislation by Annex No. 7 to Decree No. 140/2021 Coll.

The economic evaluation is performed according to the following criteria, with the main decision criterion for selecting the optimal variant being the net present value (NPV) criterion, the additional criteria for information to the energy assessment client are the internal rate of return (IRR) criterion and the real payback period (T_d) criterion.

Cash flow (CF_t) in year t:

$$CF_t = V - N_p - IN_{r,t}$$

Net present value over the period of evaluation (NPV_{Te}):

$NPV_{Te} = \sum_{t=1}^{T_e} CF_t \times (1+r)^{-t} - IN + \sum_{x=1}^{n} N_{rex,Te}$

The *Internal rate of return (IRR)* is then calculated from the condition:

$$0 = \sum_{t=1}^{T_h} CF_t \times (1+IRR)^{-t} - IN + \sum_{x=1}^{n} N_{rex,Te}$$

The real *Payback period* T_d, the repayment period of the investment assuming a discount rate is calculated from the condition:

$$I_p = \sum_{t=1}^{T_d} CF_t \times (1 + r)^{-t} \text{ (years)}$$

For cases where the lifetime T_L of the technology or construction coincides with the evaluation time T_e of the project, it holds that *Residual value of equipment at the end of the evaluation period* $N_{ru,Te} = 0$. In the case of evaluation of projects with different lifetime T_L from the evaluation time T_e, the residual value of the technology or construction is determined according to the following formula:

$$N_{ru,Te} = \frac{IN_r \,.\, (T_L - T_{ru})}{T_L} \times (1 + r)^{(-T_e)}$$

where:

CF_t	*cash flows after project implementation in tEUR,*
r	*discount rate specified dimensionlessly (e.g.: r = 3% = 0.03),*
T_d	*real (discounted) payback period in years,*
I_p	*total planned investments in tEUR,*
V	*revenues (revenues, sales, savings), which result from the implementation of the evaluated project in the year t in tEUR,*
IN	*costs for implementation (investment funds from own resources) of the evaluated technology or construction in year 0 in tEUR,*
$IN_{r,t}$	*reinvestment and one-off renewal expenses in year t in tEUR, corresponds to a renewal investment in technology or construction in the year* $T_L + 1$*,*
IN_r	*last calculated reinvestment INr, t of assessed technology or construction in tEUR,*
N_p	*operating expenses without depreciation (overheads, materials, fuel, energy, water, repairs, maintenance, service, wages, others) in year t in tEUR,*
$N_{rex,Te}$	*residual value of individual parts of technology or construction at the end of the evaluation time* T_e *in tEUR, x = 1 .. n*th *technology,*
t	*year of project evaluation from the beginning of the evaluation,*
T_L	*lifetime of the evaluated technology or construction or their parts,*
T_e	*project evaluation time,*
T_{ru}	*time from the last calculated reinvestment* IN_r *of the assessed technology or construction to the end of the evaluation period* T_h*. For the case when the evaluation time of the project* T_h *is shorter than the lifetime of the technology* T_L *(i.e. there is no reinvestment in the technology during the whole time of the value) it holds that* $T_{ru} = T_e$*.*

3. Modernisation of heat sources in the heating sector

The desirable goal is to maintain to the extent possible the current structure, roles and manifold benefits of the well-developed national district heating infrastructure including non-replaceable heat supply to large conglomeration of consumers in cities, environmentally friendlier heat production in well-equipped anti-pollution devices, and still affordable process with important social impacts.

The major challenges for the sectors lie in the:

(i) economic need of urgent transformation of the large number of heating plants as soon as possible from coal to less and/or no-emitting heat production manner. This is caused by the pressure of high prices of current and future emission allowances to avoid the danger of disconnections caused by excessive prices of heat (currently lies this upper limit of the heat process by some 26 EUR (650 CZK) / GJ),

(ii) environmentally based need to significantly mitigate GHG emissions from the heating sector (in % totally and in % of the energy sector) in order to cope with the national decarbonisation goals in 2030 by transformation of the coal-based heat production to alternative fuel and/or technologies.

Particularly important is the role of heating plants in curbing local emissions of particles and thus positively addressing our challenge of improving the local air quality.

(iii) time constraint of the decarbonisation process limited to this decade given the key role of the Modernisation Fund and its timely availability in assurance of maintaining the heat prices after transformation within the limit of their social affordability.

In addressing the decarbonisation strategy of the national heat system transformation, the Study illustrates the available and viable options, both in terms of alternative fuels and technologies.

Fuel alternatives as a source leading to the transformation of the sector

Whereas the highest priority in switching from the coal use is given to renewable energy of ***biomass***, its limited total availability and local character due to the high transport costs would restrict its share to some 30% of the total coal replacement with preferred role in the local community/municipality energy area. As the transition to biomass represents a 100% of CO_2 emission reduction in comparison to lignite sources, it is an environmentally beneficial technology in this respect. The expected assumption of the capital intensity of CO_2 emissions reduction for proposed technologies (as Annex 1) represents 4,224 tCO2/mEUR per year.

In view of the inherent limits regarding the transition share of biomass, the important role to switching from coal has to be assigned to ***natural gas***. Although its role is temporary in the long-run towards the carbon neutral economy by 2050, its mid-term role is indispensable to transform the bulk of heating plants to lower GHG emission level in line with the EU emission taxonomy. In comparison to lignite sources, the expected assumption of the capital intensity of CO_2 emissions reduction for proposed technologies (as Annex 1) represents 5,290 tCO2/mEUR per year. The average CO_2 reduction thus exceeds 50%.

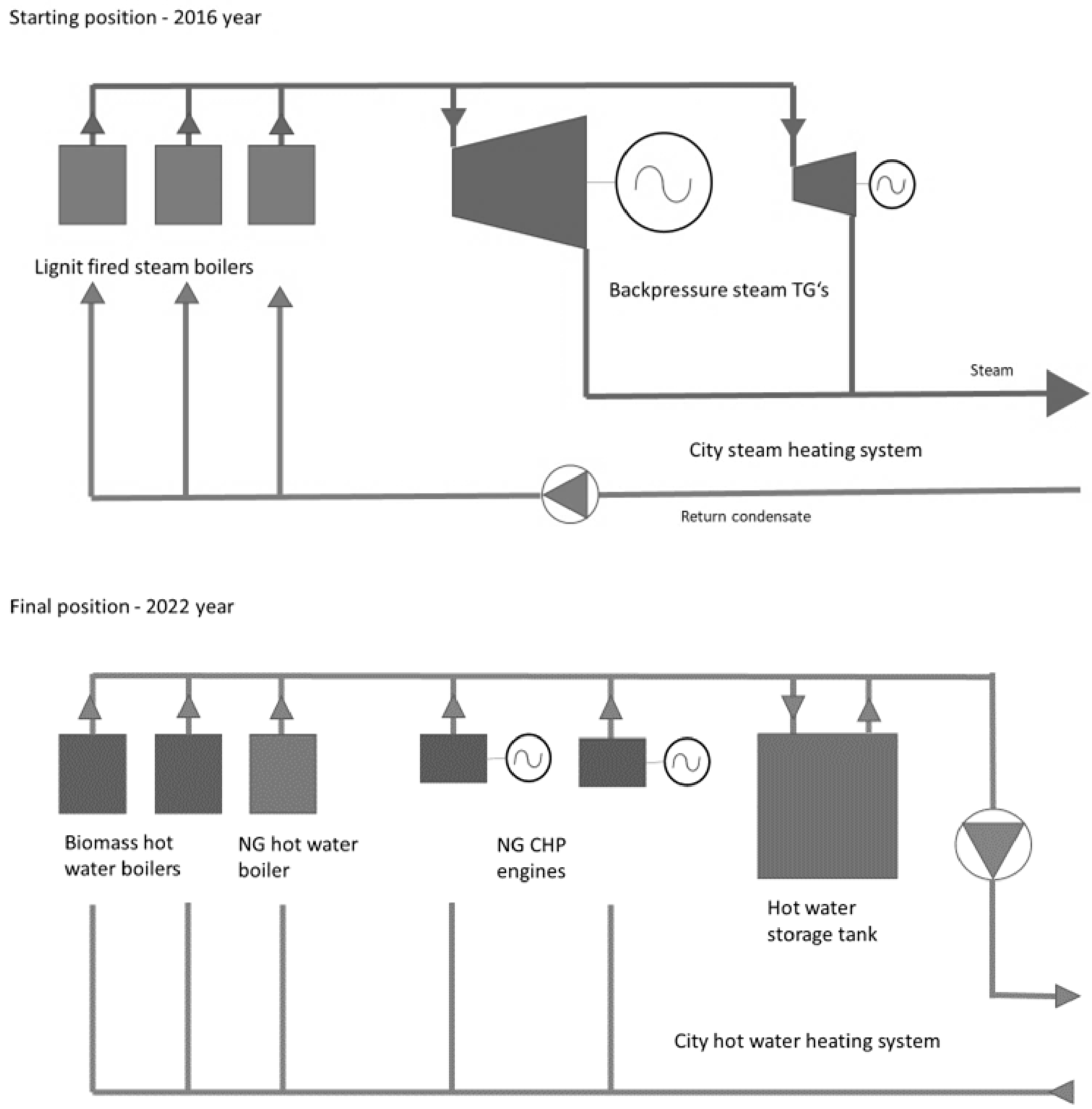
The use of natural gas is very closely related to the use of a more environmentally friendly alternative to ***biogas*** and also, with regard to its transformation potential, it is planned to use this technology for a more substantial use of ***hydrogen*** in the sector.

With regard to the large share of emission-free electricity in the Czech Republic (app. 2/3 in terms of net consumption), the use of ***electricity*** for heat production appears to be beneficial as well. In comparison to lignite sources, the expected assumption of the capital intensity of CO_2 emissions reduction for proposed technologies (as Annex 1) represents 3,309 tCO2/mEUR per year. The average CO_2 reduction thus stands around 33%.

Largely still unused-thought limited by availability and so in its share in the heat sector fuel transformation is the ***municipal waste***. Its future role is foreseen mostly at the local municipality energy context.

The list of suitable technologies, their contribution to the reduction of GHG emissions in comparison with the investment intensity of this reduction, is listed in Annex 1 to the study, and proves their maturity for the future transformation of the sector.

Figure 1: *Example of modernisation of power and heat plant (starting and final position)*



4. Modernisation of heat sources in the industrial sector

There are about 240 industrial plants for heat production in the Czech republic, but many of them are direct heating, such as cement plants, lime plants, glassworks, brickyards, etc., and gas storage facilities and gas plants. These are technologies and facilities similar to those in the conventional heating industry (technology using the classic Clausius-Rankin cycle), that mean heating water to steam for direct use or in conjunction with a steam turbine to generate electricity and then to supply steam or hot water.

The need for measures to convert the primary fuel (boiler) producing ***hot steam*** prevails. However, the steam is not suitable for long-distance transport for heating, especially in the summer, when losses in steam pipelines are up to 40%.

The key to the technological considerations of source modernisation is the size of the source and the form of heat utilization.

Biomass and possibly ***solid alternative fuels*** are not fully suitable for the production of industrial steam, are highly storage capacity intensive because of low energy density, and therefore are difficult to compete due to high load factor needed in industrial technologies. Nevertheless, biomass technologies are environmentally friendly and the expected assumption of the capital intensity of CO_2 emissions reduction for these technologies (as Annex 1) represents 5,808 tCO2/mEUR per year.

On the contrary, ***natural gas*** provides similar technological parameters and slightly higher efficiency in the absence of slag and fly ash and is able to develop the same technological parameters as coal. In addition, the support of this technology can ensure a high transformation potential after a more significant development of ***hydrogen technologies*** and their eminent use in production technologies. In comparison to lignite sources, the expected assumption of the capital intensity of CO_2 emissions reduction for proposed natural gas technologies (as Annex 1) represents 5,433 tCO2/mEUR per year. The average CO_2 reduction thus stands around 50%.

The list of suitable technologies, their contribution to the reduction of GHG emissions in comparison with the investment intensity of this reduction, is listed in Annex 1 to the study, and proves their maturity for the future transformation of the sector.

5. Discussion and Conclusions

Although demanding, and perhaps in several specific instances even difficult, the necessary and ongoing transformation of the national heating sector to lower GHG emission level until 2030 is manageable with possible expected sectoral lower emissions outcomes. It will thus gradually pave the way to the long-term carbon-neutral heat production.

The reasoning regarding the aspects of the heating industry as a part of the Modernisation Fund puts a special requirement on the effective administration of the decarbonisation-based transformation of the heating sector. A significant part of the measures is considered as a multi-source approach needed for the ongoing transformation. This variability is important for maintaining and not endangering the whole process.

The technologies proposed by the study, or their combination and variability in particular, proves their economic and environmental benefits and the way to the necessary transformation of the sector.

Based on multiple factors explained in the study and verified by their economic and environmental assessment, the application of the heat and industrial sector transformation in the form of variable schemes (except large individual projects) appears as necessary.

R E F E R E N C E S

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ANNEX 1

Proposal of suitable technologies of the Czech Republic heat sector for the transition to low-carbon energy

A complete list of all technological variations to be considered as suitable for the transformation of the heat sector are further described. The technical parameters are set as standard for the conditions of the Czech heating and industrial sector. Investment costs are determined on the basis of an intensive analysis of the heat and industrial market, technological supply options and real implementations in recent years. The study also used data from pre-registration calls, launched by the State Environmental Fund of the Czech Republic at the turn of 2020 and 2021.

For all technological variants (if no stated otherwise in the text), installation into the existing boiler room building is considered, incl. external fuel management and modification of fuel storage space (in case of biomass), external gas management (in case of transition to natural gas), in relevant cases according to BAT conditions also flue gas cleaning with fabric filter and reduction of nitrogen oxide emissions (flue gas denitrification) DENOX (SNCR method - selective non-catalytic reduction).

Costs are determined at prices 2019/2020 (2021) and do not reflect the impact of high inflation rates and price increases caused by the situation following the COVID-19 pandemic. Real prices may thus reflect further developments in the market situation.

(the exchange rate of 25.5 CZK / EUR is used)

(var. 1) TRANSITION TO BIOMASS

1.1 Biomass fired grate steam boiler

Main parameters:	Power output	40 MWt (50 t/h)
	Steam output pressure	3.8 MPa
	Steam output temperature	320°C
	Boiler efficiency	86.5 %

price of the boiler (without turbine): 15.7 mil. EUR

Total CAPEX: 15.7 mil. EUR

1.1.1 Biomass fired grate steam boiler with back pressure steam turbine and basic heat exchanger for heat supply systems (usually 90/60°C)

Turbine parameters:	Power output	9 MWe
	Steam output pressure	0.2 MPa *(hot water heating)*
	Electric efficiency	23 %
	CHP efficiency	85 % *(total full CHP regime)*

price of the turbine: *6.3 mil. EUR*

Total CAPEX: 22 mil. EUR

1.1.2 Biomass grate steam boiler with condensing steam turbine with steam extraction

Main parameters:	Power output	10.5 MWe
	Steam output pressure	0.015 MPa *(condensation)*
	Electric efficiency	29% *(in full condensation regime)*

price of the turbine: *7.1 mil. EUR*

Total CAPEX: 22.7 mil. EUR

1.2 Biomass fired fluidized bed steam boiler

alternative to the previous technical solution and changes only the design of the boiler, which is more efficient, but also more expensive (increased efficiency of steam production on the boiler then leads to increased overall efficiency) the same production behind the boiler and turbine

Main parameters	Power output	40 MWt (50 t/h)
	Steam output pressure	3.8 MPa
	Steam output temperature	320°C
	Boiler efficiency	90%

price of the turbine: *17.6 mil. EUR*

Total CAPEX: 17.6 mil. EUR

1.2.1 Biomass fired fluidized bed steam boiler with back-pressure steam turbine together with basic heat exchanger for heat supply system (usually 90/60°C)

Turbine parameters	Power output	9 MWe
	Steam output pressure	0.2 MPa (hot water heating)
	Electric efficiency	23%
	CHP efficiency	85% (total full CHP regime)

price of the turbine: *6.3 mil. EUR*

Total CAPEX: 23.9 mil. EUR

1.2.2 Biomass fired fluidized bed steam boiler with condensing steam turbine with steam extraction for heat supply system

Main parameters	Power output	40 MWt (50 t/h)
	Steam output pressure	0.015 MPa (condensation)
	Electric efficiency	29% (in full condensation regime)

price of the turbine: *7.1 mil. EUR*

Total CAPEX: 24.7 mil. EUR

(var. 2) TRANSITION TO NATURAL GAS

2.1 Natural gas steam boiler

Main parameters:	Power output	40 MWt (50 t/h)
	Steam output pressure	9.4 MPa
	Steam output temperature	540°C
	Boiler efficiency	96 %

steam turbogenerator with an output of ca 9 MWe (back pressure) at a price of about 6.5 mil. EUR and 12 MWe (condensing) at a price of ca 7.3 mil. EUR remains original for most projects, as the same parameters are achieved as with the original lignite-fired boiler; turbine costs are therefore not included

price of the boiler: *6.7 mil. EUR*

Total CAPEX: 6.7 mil. EUR

2.2 Steam-gas unit with back-pressure steam turbine consisting of:

- gas turbine with generator
- steam boiler for waste heat (flue gases from the gas turbine outlet), or with reheating by gas burner
- steam turbogenerator with back-pressure steam turbine and basic heat exchanger for heat supply system (usually 90/60°C)

Main parameters:	2 × GT (gas turbine) Power output	2x15 MWe
	2 × HRSG (heat recovery steam generator - flue gas boiler)	
	1 × ST (steam turbine – back pressure)	1x3 MWe
	Efficiency	ca 75%

Total CAPEX: 27.5 mil. EUR *(exceptionally construction on a greenfield site)*

2.3 Steam-gas unit with condensing steam turbine, consisting of:

- gas turbine with generator
- steam boiler for waste heat (flue gases from the gas turbine outlet), or with reheating by gas burner
- steam turbogenerator with condensing steam turbine with regulated steam extractions for heat supply system, or for technological needs

Main parameters:	2 × GT Power output	2 × 15 MWe
	2 × HRSG	
	1 × ST (condensing steam turbine)	1 × 5 MWe
	Efficiency	ca 75%

Total CAPEX: 28.2 mil. EUR *(exceptionally construction on a greenfield site)*

2.4 Cogeneration engine consisting of:

- gas piston engine with generator
- engine cooling system composed of a system of exchangers transferring the removed heat to the heating water of the heat supply system

Main parameters:	Electric power output	31 MWe
	Thermal power output	30 MWt
	Electric efficiency	48,7%
	Thermal efficiency	45,3%
	Total efficiency	94%

Total CAPEX: 25.5 mil. EUR *(exceptionally construction on a greenfield site)*

(var. 3) TRANSITION TO BIOMASS WITHOUT ELECTRICAL ENERGY PRODUCTION

3.1 Biomass fired hot water grate boiler

directly heating the heat supply system heating water

Main parameters:	Power output	40 MWt
	Efficiency	90.0%

Total CAPEX: 11.8 mil. EUR

3.2 Biomass fired steam grate boiler

(industrial use lower parameters than for electric energy production, for electric energy production see 1.1)

Main parameters:	Power output	40 MWt (50 t/h)
	Steam output pressure	2.6 MPa
	Steam output temperature	240°C
	Boiler efficiency	88%

Total CAPEX: 12.5 mil. EUR

3.3 Biomass fired fluidized bed hot water boiler

directly heating the heat supply system heating water

Main parameters:	Power output	40 MWt
	Efficiency	92.0%

Total CAPEX: 13.3 mil. EUR

3.4 Biomass fired fluidized bed steam boiler

(industrial use lower parameters than for electric energy production, for electric energy production see 1.2)

Main parameters:	Power output	40 MWt (50 t/h)
	Steam output pressure	2.6 MPa
	Steam output temperature	240°C
	Boiler efficiency	91%

Total CAPEX: 14.1 mil. EUR

(var. 4) TRANSITION TO NATURAL GAS WITHOUT ELECTRICAL ENERGY PRODUCTION

4.1 Natural gas fired hot water boiler

directly heating the heat supply system heating water

Main parameters:	Power output	40 MWt
	Efficiency	96.5%

Total CAPEX: 3.1 mil. EUR

4.2 Natural gas fired steam boiler (industrial use)

Main parameters:	Power output	40 MWt (50 t/h)
	Steam output pressure	9.4 MPa
	Steam output temperature	540°C
	Boiler efficiency	96%

Total CAPEX: 6.7 mil. EUR

(var. 5) TRANSITION TO ELECTRIC ENERGY USE FOR HEAT PRODUCTION

5.1 Hot water electric boiler,

directly heating the heat supply system heating water (high voltage electrode boiler with accessories on a greenfield site)

Main parameters:	Power output	15 MWe
	Efficiency	99.0%

Total CAPEX: 1.4 mil. EUR

5.2 Hot water electric boiler with accumulation of thermal energy

heating the water of the heat supply system (high-voltage electrode boiler with accessories on a green field and a hot water accumulator 45MWh with engine room on a greenfield site)

Price of the hot water accumulator: 2.2 mil. EUR

Main parameters:	Power output	15 MWe
	Boiler efficiency	99% (no accumulation losses)
	Accumulation capacity	45 MWh

Total CAPEX: 3.5 mil. EUR

5.2.2 Hot water electric boiler with accumulation of thermal energy heating the heating water of the heat supply system (high-voltage electrode boiler with accessories and hot water accumulator 22MWh without engine room connected to the existing system)

Price of the hot water accumulator: 0.6 mil. EUR

Main parameters:	Power output	15 MWe
	Boiler efficiency	99% (no accumulation losses)
	Accumulation capacity	22 MWh

Total CAPEX: 2.0 mil. EUR

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Czech Technical University in Prague, in close cooperation with representatives of professional associations and other experts, led the discussion on the benefits of modernisation of the heat production sector in the Czech Republic. The result is a study, which aims to identify technologies contributing to the necessary transformation of the whole sector in the coming period, as a detachment of the Czech economy from solid fossil fuels and help to move towards ambitious climate goals of the Czech Republic as well as the whole of Europe.

The study dealt with the detailed structure of the economic and environmental benefits of appropriate measures, therefore we firmly believe that the conclusions of this study will support to find the necessary resources, without which the whole process of transformation would be endangered.

Dr. Ondřej Velek
CIIRC Director