Development of the centralized heat supply system in Partizánske

Pre-feasibility study

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Summary of the study

The study is divided into three parts, which form separate units with interrelationships.

In the first part (chapter 2) the current state of the city's heat management is mapped Partizánske as well as the potential of using renewable energy sources in the wider city.

In the second part (chapter 3) the further development of the SCZT in Partizánske is assessed. Three scenarios for future development are compared:

- Option 0 - maintaining the status quo,
- Southern connection of the Šípok - Luhy areas,
- Northern connection of the Šípok - Luhy areas.

In order to objectively compare the resulting heat prices of the individual options, we consider their implementation over a 10-year horizon, i.e. until 2034.

In Option 0, we estimate retaining the current heat sources that would supply heat to the current supply areas with the necessary upgrades.

In the variant of the southern connection we consider building a heat feeder from the biomass boiler house Šípok to boiler house B in Luhy and the subsequent connection with boiler houses D, 11 and E. We are considering extending the circuits of boiler houses E and 11 with adjacent small block and house boiler houses. For boiler houses D and E we estimate the installation of heat pumps using low-potential heat of geothermal water from nearby boreholes (FGTz-2 and HGTP-1).

In the variant of the northern interconnection we consider the same operations with the difference that the heat feeder will be led from the Šípok boiler house parallel along the railway track in the north of the town towards the D boiler house. The northern feeder would still branch off in front of KD in the direction of boiler houses K11 and KE. A link would be constructed between the KD and KB boiler houses similar to the southern variant.

A comparison of the unit heat prices of all options shows that the unit heat price would be cheaper for both the southern and northern interconnection options. The higher investment intensity of both the southern and northern interconnection variants is reflected in an increased fixed component of the maximum heat price, but these variants are operationally cheaper. In addition, the implementation of both the southern and northern interconnection options opens up the possibility of drawing on subsidies to create efficient CHP and increase the share of renewable sources in the CHP system. If the subsidy for the reconstruction and construction of heat distribution systems and heat pumps is used at 50% of the total investment, the price of heat could be cheaper by EUR 20,518/MWh in the case of the southern interconnection variant and by up to EUR 24,542/MWh in the case of the northern interconnection variant. The implementation of the southern or northern interconnection option is

however, is significantly more demanding in terms of design and administration and does not do without the need for
external expertise.
The southern interconnection variant is characterised by the highest investment intensity of all variants and higher heat losses of the heat feeder compared to the northern route (longer length of the heat feeder). However, the route runs alongside the planned residential area of River Star and there is also the potential to connect the areas around the K7 and K6 boiler house (by completing the footbridge over the Nitra river). If the heat feeder is routed from the Šípok boiler house through the city centre or along Družstevná Street, there could be significant capital cost savings (estimated up to the level of the northern connection option).

The northern interconnection option can achieve the most favourable unit heat price, which is due to lower operating costs compared to Option 0 and lower investment costs compared to the southern interconnection option. The biggest disadvantage of the northern interconnection option is the routing in the railway protection zone, which requires negotiation with the railway owner.

In the third part (Chapter 4), the connection of other objects to the circuit of boiler house E, whose heat output is significantly oversized in its current state, is considered. The chapter examines the possibilities of connecting adjacent house and small block boiler houses from both a technical and an economic point of view (the impact on the price of heat is quantified). Although all the considered options will increase the current heat price, the implementation of the connection will save the costs for the reconstruction of the boiler rooms of the connected objects, which in turn may be reflected in a decrease of the unit heat price in the future. In addition, the extension of boiler house E will ensure easier connection of more objects to the envisaged larger SCZT unit.

1 Home

The main task of this study was to assess the potential of interconnecting the two main heat units of the centralized heat supply system in the town of Partizánske. The study evaluates the proposed interconnection options from different aspects and also briefly analyses the phasing of these options (Chapter 3). In Chapter 4, the connection of additional objects to the circuit of boiler house E is considered. The introductory chapter (Chapter 2) maps the current state of the heat management of the city of Partizánske as well as the potential for the use of renewable energy sources in the broader city circuit.

1.1 List of abbreviations and terms used

Table 1: List of abbreviations

Shortcut	Explanation of the abbreviation
SCZT	central/centralised heat supply system/system
SZT	heat supply system/system[1]
CZT	Central/centralised heat supply
CTZ	central heat source[2]
PK	gas boiler room
K	boiler
ÚK	central heating
TV	hot (drinking/utility) water
RES	renewable energy sources
SPF	seasonal performance number of the heat pump
TC	heat pump, heat pumps
NFP	non-repayable financial contribution
electricity	electricity; electricity
TSM	Technical services of the city of Partizánske
OST	heat transfer station
BONE	compact heat transfer station at the foot of the customer's building
BS	residential compact heat transfer station
ZP	natural gas
OM	the customer's place of consumption of heat
ks	piece; pieces

[1] Proper designation for all systems where heat is not produced only from one or two dominant heat sources, but the heat supply to the connected objects is provided from different sources according to the actual conditions.

[2] The abbreviation occurs in the abbreviation of the source of the warmth of the settlement - CTZŠípok.

2 Characteristics of the current state of the SCZT in Partizánske

Heat supply in Partizánske is provided by two entities:

- Technical Services of the City of Partizánske (hereinafter referred to as TSM Partizánske),
- ESCO Servis s.r.o. (heat supply for the industrial park).

Tab. 2: Current heat prices of entities operating in the thermal energy sector in the territory of the town of Partizánske

Subjects	Heat price [EUR without VAT]		
	Variable component [EUR excluding VAT/kWh]	Fixed component [EUR without VAT/kW]	Approximate total price [EUR without VAT/kWh]
Technical services of the city of Partizánske	0,0899	223,7943	132,125
ESCO Servis s.r.o.	0,1968	365,3589	265,736

In the framework of this study, we will give priority to facilities that are under the management of Technical services of the city of Partizánske.

TSM Partizánske is a limited liability company, whose sole shareholder is the city of Partizánske.

TSM Partizánske currently operates CTZ Šípok (woodchip boiler house), 20 gas boiler houses and several block OST and KOST. Heat is supplied by heat distribution pipelines with a total developed length of almost 30 km. The total installed capacity of the heat generation facilities is nearly 35 MW. The fuel base consists of natural gas and wood chips[3, 4].

2.1 Evaluation of existing heat sources

The heat management managed by TSM Partizánske could be divided into two large units according to the areas supplied with heat:

- Šípok - area supplied with heat produced from fuel chips by the CTZ Šípok boiler house,
- Luhy, Centrum - Batovany, Štrkovec - area supplied with heat produced from natural gas in block or house boiler rooms.

[3] Information extracted from e-mail communications and documents provided by the city management.

[4] NOVACO s.r.o. Update of the concept of the development of the town of Partizánske in the area of thermal energy.

In addition to the areas described above, TSM Partizánske also manages the gas boiler room in Veľké Bielice and the gas boiler room in the municipal hospital in Malé Kršteňany (K24).

The biomass boiler house in the Šípok district is operated in the area in the northern part of the housing estate. The boiler house has two wood chip boilers installed with a total rated thermal output of 9 MW.

Tab. 3: Biomass boilers of Šípok boiler house

Designation of boilers:	**K1**	**K2**
Type	Hot water conventional	Hot water conventional
Power [MWt]	6	3
Label efficiency	85 %	85 %
Year of manufacture	2008	2010

The age of the boilers is already slightly advanced, but with adequate regular maintenance it is possible to consider operating these boilers for another 5 to 10 years.

The level of oversizing of heat sources in the Šípok boiler house is approximately 40%, which practically means that the K1 boiler is sufficient to cover the peak demand. With optimum use of instantaneous storage, the required peak output of the boiler plant can be even lower. On the basis of this argument, it is then advisable to look for other buildings within the city to which heat from the Šípok biomass boiler plant could be supplied.

Other boilers operated by TSM Partizánske use natural gas as a fuel source. The properties of these boilers have been analysed in Table 4.

Table 4: Gas boilers

Gas boiler room	Boilers					Reported efficiency of the boiler plant[5] [%]	Stocked streets/objects	The level of pre-dimension. [%]	Reliability operations
	Mark.	Heat. performance [MW]	Year of manufacture	Status based on lifetime	Tagged Efficiency [%]				
house PK06	K1	0,08	2005	good condition	93	88,3	Skultéty's 173	153 %	Low
	K2	0,125	1993	For lifetime limit	89				
	K3	0,024	2005	good condition	92				
block PK07	K1	0,25	1994	For lifetime limit	89	87	Komenský 216, Engineering 196, School 191	224 %	critically low
	K2	0,25	1994	For lifetime limit	89				
	K3	0,125	1994	For lifetime limit	89				

[5] Under the budget proposal for the year 2022. Available on the website of the DSO.

block PK09	K1	0,2	1997	For lifetime limit	92	90	October 682, 675, 661	39 %	critically low
	K2	0,25	1995	For lifetime limit	92				
	K3	0,25	1997	For lifetime limit	92				
Block K11	K1	0,62	2013	very good condition	92	92	Družstevná, Nádražná, Makarenkova	64 %	high
	K2	0,62	2013	very good condition	92				
	K3	0,62	2013	very good condition	92				
house PK12	K1	0,045	1996	For lifetime limit	91	88	Rudolph Jasika 160	107 %	critically low
	K2	0,045	1996	For lifetime limit	91				
	K3	0,045	1996	For border lifetime	91				
	K4	0,045	1996	For lifetime limit	91				
house PK13	K1	0,045	1996	For lifetime limit	91	88	Februárova 152	117 %	critically low
	K2	0,045	1996	For border lifetime	91				
	K3	0,045	1996	For lifetime limit	91				
	K4	0,045	1996	For lifetime limit	91				
house PK14	K1	0,045	1996	For border lifetime	91	88	Rudolph Jasika 156	91 %	critically low
	K2	0,045	1996	For lifetime limit	91				
	K3	0,045	1996	For lifetime limit	91				
	K4	0,045	1996	For lifetime limit	91				
house K15	K1	0,043	2004	good condition	94	92	Hrnčírikova 222/6	71 %	Good
	K2	0,043	2004	good condition	94				
house K16	K1	0,045	2005	good condition	97,2	94,2	Hrnčírikova 219	38 %	Good
	K2	0,045	2005	good condition	97,2				
house PK18[6]	K1	0,17	2005	good condition	94	91,9	SNP Square 212/4 Makarenkova 213	3 %	Good[7]
	K2	0,13	2005	good condition	94				
	K3	0,044	2005	good condition	94				

Home	K1	0,105	2005	good condition	94	91,6	Square. SNP 220	69 %	Good

[6] The boiler house connects two buildings (the Municipal Tax Office), but the divisions are internal, as the buildings share a wall.

[7] According to the declaration of the operator of the municipal authority, the boiler house is in disrepair and it is necessary to consider the revitalisation of the heating source.

PK19	K2	0,105	2005	good condition	94				
	K3	0,06	2005	good condition	94				
	K4	0,06	2005	good condition	94				
house PK20	K1	0,2	2006	good condition	93	91	February 945	78 %	Good
	K2	0,2	2006	good condition	93				
house PK21	K1	0,047	2005	good condition	92	89	Rudolph Jasik 652	55 %	Good
	K2	0,047	2005	good condition	92				
	K3	0,047	2005	good condition	92				
Block PK22 (two objects)	K1	0,06	2007	good condition	95	92	1 May 220/1	103 %	Good
	K2	0,06	2007	good condition	95				
	K3	0,06	2007	good condition	95				
	K4	0,06	2007	good condition	95				
block K24 (wiring within the premises hospitals)	K1	0,05	2007	good condition	90	87	New Hospital 169, Malé Kršteňany	93 %	Good
	K2	0,05	2007	good condition	90				
	K3	0,05	2007	good condition	90				
	K4	0,05	2007	good condition	90				
	K5	0,05	2007	good condition	90				
house PK Veľké Bielice	K1	0,026	2016	very good condition	93	90	Victory 476	155 %	high
	K2	0,026	2016	very good condition	93				
house PK ALFA	K1	0,2	1996	For border lifetime	92	89,9	February 1478/2	461 %	Low
	K2	0,2	1996	For lifetime limit	92				
	K3	0,2	2005	good condition	92				
Block PK B	K1	1,45	2019	very good condition	94	89,6	Big roundabout, Small roundabout	4 %	high
	K2	1,45	2021	very good condition	92				
	K3	1,45	2021	very good condition	90				
Block PK D	K1	2,65	1993	For border lifetime	90	88	General Svobodu Small roundabout Railway station Makarenkova	131 %	critically low
	K2	2,65	1993	For lifetime limit	90				
	K3	2,65	1993	For border lifetime	90				
	K4	2,65	1993	For lifetime limit	90				

	K5	1,7	1992	For lifetime limit	90				
Block PK E	K1	0,95	2009	good condition	92	92	Makarenkova Družstevná Februárová	102 %	Good
	K2	0,95	2009	good condition	92				
	K3	0,95	2009	good condition	92				

The value of 15 years is commonly given as the lifetime of gas boilers from manufacturers of small, medium and even larger equipment, when their full functionality is still guaranteed when carrying out routine maintenance. If thorough maintenance is carried out, it is possible to extend the lifetime of gas boilers up to 25 years, but the operating efficiency of these appliances is no longer does not reach the same values as in the early years. After 25 years of operation, a gas boiler is considered to be an energy and economically inefficient device, and, in addition, considerable recurrent investment in spare parts is required to ensure its safe operation.

On the basis of the classification described above, the boilers of the individual boiler houses in question were classified into three groups:

- Boilers in very good condition (less than 15 years in operation),
- Boilers in good condition (from 15 to 25 years in operation),
- Boilers beyond their useful life (more than 25 years in operation).

The classification of the boilers alone may not represent the actual condition of the boilers, as the number of operating hours, mode of operation and other aspects also influence their actual condition.

As can be seen from Table 4, many of the boilers are already well advanced in age and past their life limit.

However, the installed thermal capacities of some boiler plants are considerably oversized due to the reduction of the heat demand due to the increase of thermal protection of the connected buildings and also to the year-on-year increase of the average outdoor air temperatures in the heating season. For some boiler houses with boilers of different installation years, it is therefore appropriate to analyse whether safe operation would be ensured even after the retirement of older equipment. The operational reliability parameter in Table 4 provides an indicative assessment of how reliable a given boiler house is in terms of the lifetime of its boilers and the oversizing of the installed heat output of the boiler house taking into account the heat extraction over the last four calendar years[8]. On the basis of the operating reliability parameter, the boiler plants were divided into 4 groups: critically low, low, good and high.

Tab. 5: Principle of classification of boiler plants into groups according to the reliability of operation

Operational Reliability Group	X - Oversized heat sources [%]		
	X < 0 %	0 % < X < 30 %	X > 30 %
	Groups based on boiler lifetime (VD - very good condition, D - good condition)		
High	-	The entire rated output of the boiler house is formed only by the boilers in VD	The boilers in the DH provide at least 75% or more of the boiler plant output
Good	-	Boilers in VD and D provide at least 75% or more of the boiler plant output	VD and D boilers provide at least 50 % or more of the boiler plant output
Low	-	VD and D boilers provide at least 50% or more of the output	VD and D boilers provide at least 25% or more of the output

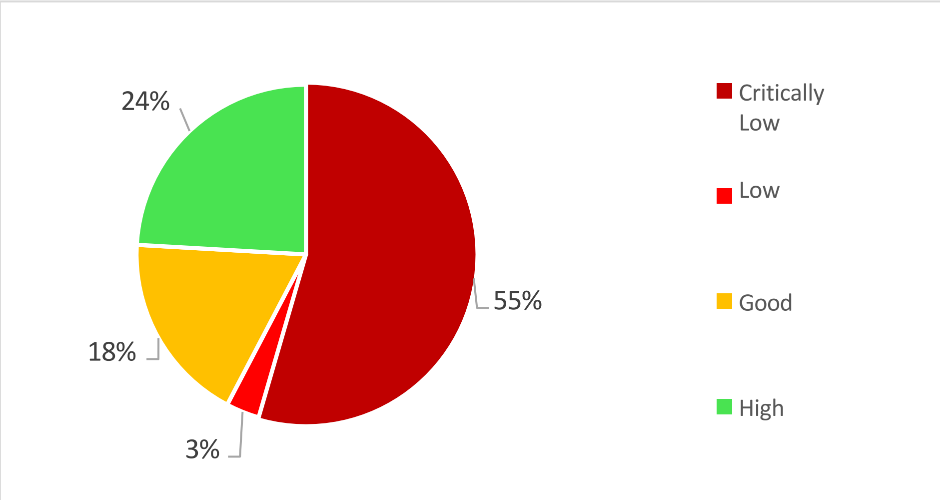
[8] All boilers have not been considered with a power reserve for cases where the heat is not taken into account (e.g. due to changes in the demography of the consumers etc. or a colder heating period). The reserve was considered at 15 % of the calculated heat input of the specific building. For block boiler houses, the assumed heat losses from the external heat distribution (determined on the basis of their geometry and condition) were also considered.

Critically low	Regardless of the boilers' lifetime condition (undersized heat source)	Sum of boiler outputs in VD and D make up to 50 % of the rated power boiler rooms	Boilers in VD and D make up to 25 % of rated power boiler rooms

If a boiler plant had a negative oversized rating, it was classified as having critically low operating reliability regardless of the age of the boilers. It should be noted that the classification of boiler plants into operational reliability groups is only an indicative assessment of the state of operation and does not necessarily represent reality. For a realistic assessment of the condition of individual boilers, expert opinions are needed (e.g. the boiler house of the Municipal Office (PK18) is, according to the operator, in a very poor condition, but the parameter of operational reliability was found to be good).

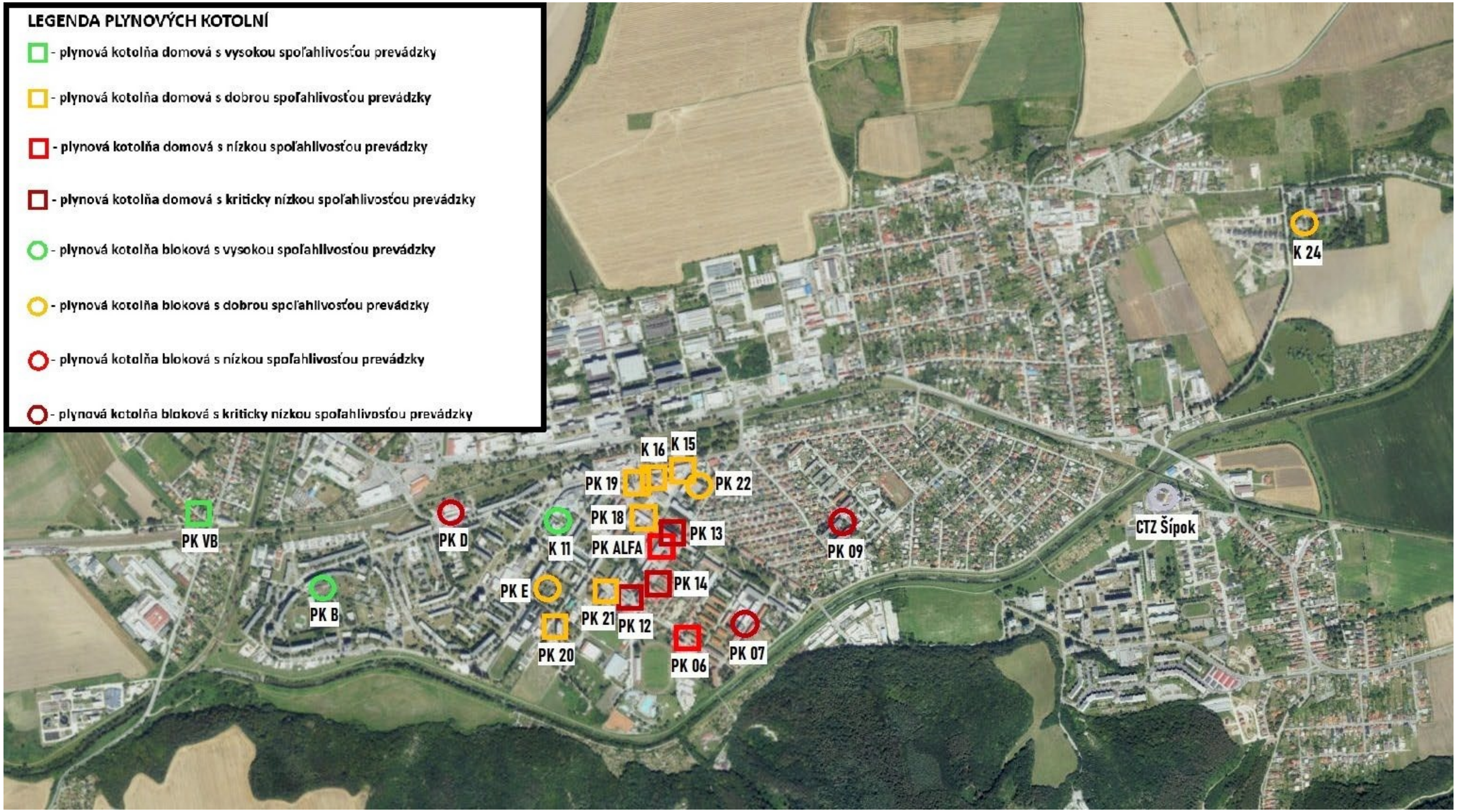
On the basis of the indicative parameter reliability of operation (see Table 4), it can be stated that 6 boiler plants are in the worst (critical) condition (with the total installed capacity at the level of 14.1 MW), 2 boiler plants (0.8 MW) are in the condition of low reliability of operation, 9 boiler plants (4.7 MW) are in a good condition, and the operation of 3 boiler plants can be considered as highly reliable (6.3 MW).

Fig. 1: Percentage assessment of the reliability status of gas boiler plants by installed capacity



It follows that a relatively large number of boiler houses have boilers installed which, in certain conditions, may not ensure reliable operation and in the event of a breakdown, the supply of heat to customers may be at risk. For this reason it is also advisable to look for measures to ensure greater reliability of heat supply, either in the form of installing new heat sources or by using the spare installed capacity of existing sources, e.g. by interconnecting several circuits.

Fig. 2: Localization of SCZT heat sources in Partizánske



2.2 Evaluation of existing heat distribution systems

TSM Partizánske within its heat management operate house and block gas boiler rooms and larger CZT units. In terms of heat distribution analysis, we are interested only in external heat distribution.

The heat distribution systems in the Šípok housing estate (biomass boiler house CTZ Šípok) underwent a significant reconstruction around 2010. The distribution network here is made up of 2-pipe pre-insulated pipelines, which lead the heat to compact transfer stations located at each consumption point (at the foot of the buildings). The age of the pipelines is about 14 years.

In the case of the distribution network of block gas boiler houses, it is in all cases a 4-pipe heat distribution system, in which heating water and hot (service) water is led from the boiler house site (or from the external OST) to the customer in separate pipelines (inlet and return to the central heating system, respectively inlet and circulation to the TV). The age of the pipelines often varies not only when comparing the heat distribution systems of different boiler plants with each other, but also often in sections within the circuit of a single boiler plant. These are mostly small diameter pipelines, which TSM Partizánske often reconstruct at their own expense in the form of replacing damaged or obsolete sections with new pre-insulated plastic pipes. Although this method of reconstruction is efficient in terms of investment costs, it creates a slight confusion in the available documentation, which complicates the task of defining the current state of the heat distribution systems. The heat distribution systems of the individual boiler houses were therefore not considered in detail in the study (the exception was the analysis of the boiler house E circuit, see Chapter 4).

Table 6: Heat distribution of block gas boiler houses

Gas boiler room	Heat distribution and insulation material	Method of storage	Length of section [m]	Age of section [years]	Reported efficiency of heat distribution systems
block PK07	Steel pipes with mineral insulation (hr. 40 mm)	Underground in the canal	225	27	94 %
block PK09	Steel pipes with mineral insulation (40 mm thick)	Underground in the canal	200	19 (approx. 130 m) 42 (approx. 70 m)	94 %
Block K11	Pre-insulated plastic pipes	Buried under by	500	11	94 %
block PK22	Steel pipes with mineral insulation (40 mm thick)	Underground in the canal	25	17	98,3 %
block K24	Pre-insulated plastic pipes	Buried under by	55	12	97,2 %

PK B	Pre-insulated plastic pipes	Buried under by	2200	2,5	94 %
PK D	Steel pipes with mineral insulation (40 mm thick) and pre-insulated plastic pipes	Underground in the canal and buried under by	5700	4 (about 200 m) 27 (about 500 m) 31 (about 700 m) 49 (about 4500)	87,8%[9]
PK E	Pre-insulated plastic pipes	Buried under by	3600	13	94 %

2.3 Evaluation of heat appliances

TSM Partizánske currently supplies heat to 177 customer locations. In most of them it is a simultaneous supply of heat for heating and hot water supply, only 13 points of consumption take only heating water.

The breakdown of appliances by building category is tabulated below.

Table 7: Distribution of consumption points based on building category

Building category (OM)	Central heating consumption (MWh/year)	TV consumption (MWh/year)	Total consumption (MWh/year)	Morning peak demand (kW)	Evening peak demand (kW)	Heat Engineering peak (kW)	Max. peak (kW)
BD	18 376,60	12 591,85	30 968,45	14 013,81	13 613,83	13 977,71	14 253,78
AB	826,00	49,13	875,13	487,95	356,41	401,15	487,95
BN	515,43	376,65	892,08	399,51	393,45	402,36	402,36
BS	2 196,69	188,37	2 385,06	1 313,51	976,37	1 092,20	1 313,51
BVaMS	296,89	6,00	302,89	172,18	122,34	139,06	172,18
BHAR	4,59	0,00	4,59	2,64	1,85	2,11	2,64
Other objects	378,31	22,13	400,44	223,38	163,05	183,56	223,38
Total	22 594,50	13 234,14	35 828,64	16 612,97	15 627,28	16 198,16	16 855,80

Residential buildings (BD) represent the most dominant consumption, accounting for almost 87 % of the total
heat extraction. School buildings (BS) are another significant representation.

Table 8: Share of total heat consumption by building category

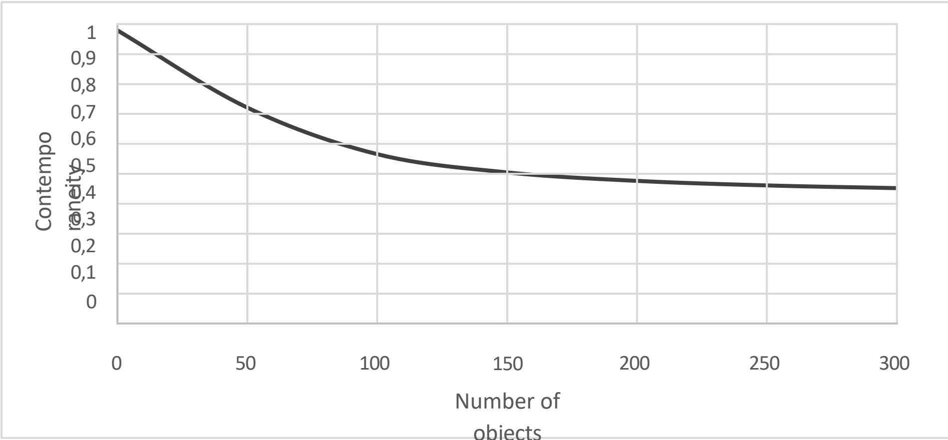
Category of building	Share of total consumption
BD	86,43%

[9] Secondary distribution efficiency94 %and primary distribution efficiency93,4 %

AB	2,44%
BN	2,49%
BS	6,66%
BVaMS	0,85%
BHAR	0,01%
Other objects	1,12%

For individual building categories, only partial coincidence of consumption can be considered at peak demand. The dependence of the coincidence of heat demand and the number of connected buildings is shown in the following graph.

Fig. 3: Heat extraction times for different number of objects in the district heating system



Source: based on data from the study - Untersuchungen der Gleichzeitigkeit in kleinen und mittleren Nahwärmenetzen [10]

The numbers of OM of individual buildings by heat source and building category are s h o w n in the table below.

Tab. Table 9: Distribution of consumption points by heat source and building category

Heat source	**Total subscriptions locations**	**BD**	**AB**	**BN**	**BS**	**BVaMS**	**BHAR**	**Other objects**
CTZ Arrow	43	40	0	0	2	1	0	0
boiler room B	36	32	0	0	2	0	1	1
boiler room D	47	41	0	1	3	1	0	1
boiler room E	16	15	0	0	1	0	0	0
ALFA boiler room	1	0	0	0	0	1	0	0
boiler house Veľké Bielice	1	1	0	0	0	0	0	0
boiler room 1	0	0	0	0	0	0	0	0

[10] Winter, W., T. Haslauer & I. Obernberger (2001). Euroheat & Power, Bd. 09&10/2001: S. 1-17

boiler room 2	0	0	0	0	0	0	0	0
boiler room 3	0	0	0	0	0	0	0	0
boiler room 4	0	0	0	0	0	0	0	0
boiler room 5	0	0	0	0	0	0	0	0
boiler room 6	1	1	0	0	0	0	0	0
boiler room 7	3	3	0	0	0	0	0	0
boiler room 8	0	0	0	0	0	0	0	0
boiler room 9	4	4	0	0	0	0	0	0
boiler room 10	0	0	0	0	0	0	0	0
boiler room 11	11	7	2	1	0	0	0	1
boiler room 12	1	1	0	0	0	0	0	0
boiler room 13	1	1	0	0	0	0	0	0
boiler room 14	1	1	0	0	0	0	0	0
boiler room 15	1	0	0	0	0	0	0	1
boiler room 16	1	1	0	0	0	0	0	0
boiler room 18	2	0	2	0	0	0	0	0
boiler room 19	1	0	0	0	1	0	0	0
boiler room 20	1	1	0	0	0	0	0	0
boiler room 21	1	1	0	0	0	0	0	0
boiler room 22	2	0	1	0	0	1	0	0
boiler room 24	2	2	0	0	0	0	0	0
Total	**177**	**152**	**5**	**2**	**9**	**4**	**1**	**4**

The savings potential of buildings connected to one of the CHP circuits is quite large. Based on the methodology from the study Options for the development of the heat management in Partizánske towards a low-temperature heat supply system[11] the potential for heat savings for central heating is up to 35,6 % and savings for TV up to 27,3 %.

For the purpose of the design of the interconnection of the supplied areas (see Chapter 3), which is envisaged to be implemented within 10 years, a more conservative approach to the determination of the savings potential was chosen based on a field survey of the external envelope of the buildings. In-depth renovation of buildings that are currently without external wall insulation and whose current energy class for the point of consumption for heating falls in energy class D or worse was considered. 34 buildings were identified in this way.

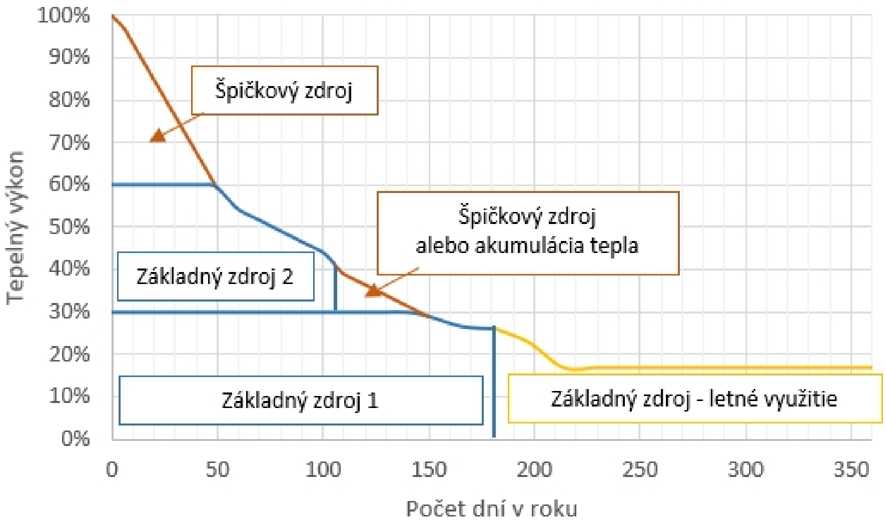
After the implementation of the in-depth renovation of the buildings, savings on heating, but also on the preparation of TV were considered. After the in-depth renovation of the buildings, it is assumed that the buildings will fall into energy class A for the place of consumption heating (for apartment buildings - the majority category of connected objects - this amounted to 27 kWh/m^2) and into energy class B for the place of consumption TV preparation (for apartment buildings - the majority category of connected objects - this amounted to 26 kWh/m^2).

[11] Available here: https://zivotpouhli.sk/novinky/item/353-moznosti-rozvoja-tepelneho-hospodarstva-v-meste-partizanske-smerom-k-nizkoteplotnemu- procurement-system-teplom

2.4 Renewable energy and waste heat potential

When sizing and using renewable heat sources, it is necessary to decide what function the individual sources will fulfil in terms of annual heat demand, what is the potential of the heat sources in the locality and what is their complexity. The distribution of heat sources within the heat demand duration diagram is shown in the following chart.

Fig. 4: Illustrative diagram of the duration of heat demand with the distribution of heat demand coverage by different sources.



Source: own elaboration

Possible use of renewable sources in terms of their availability and technical design within the thermal system is as follows.

Basic heat source:

waste heat, geothermal energy, biomass boiler, heat pumps

Basic heat source - summer use:

solar systems with instantaneous or seasonal accumulation

Top heat source:

biomass boiler

2.4.1 Solar energy

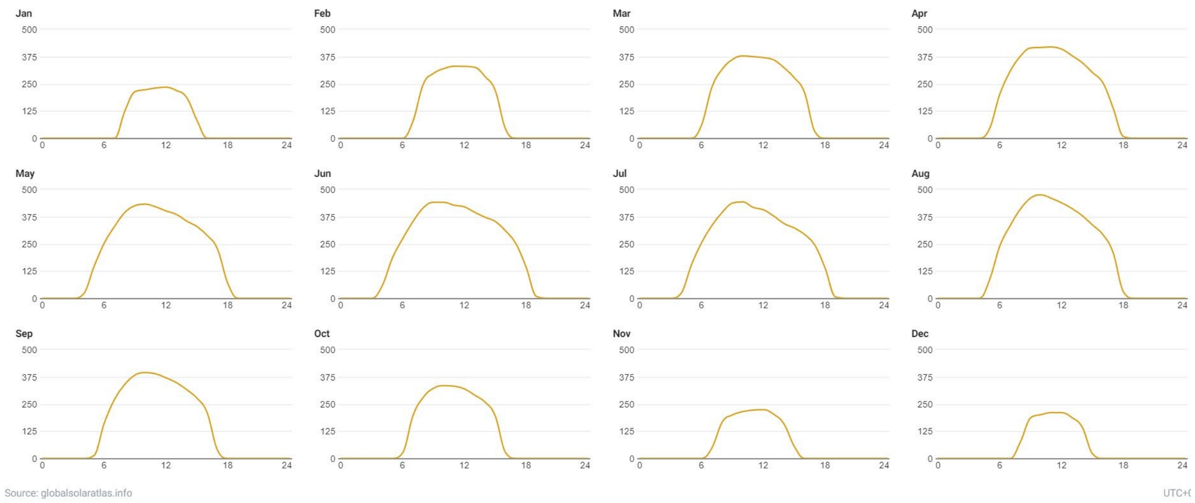
In terms of annual use, it is possible to envisage significant use of solar energy during the summer period and, if seasonal storage is used, also during the transition periods. The two most well-known forms of solar energy conversion are the conversion of solar energy into electrical energy and the conversion of solar energy into thermal energy.

The conversion of solar energy into electrical energy is carried out by the impact of sunlight on the photovoltaic cell due to the so-called internal photoelectric phenomenon. The efficiency of this conversion in today's systems reaches a level of about 20%.

For the direct conversion of solar energy into thermal energy, flat-plate collectors with a typical temperature range of 30 to 80 °C and an average annual efficiency of 30 to 40% are used in practice.

The site has relatively favourable conditions for the use of solar energy, with an average daily global radiation value of 3.37 kWh/m2 , which is approximately 1231 kWh/ m^2 in annual cumulative terms.

Fig. 5: Availability of solar energy in the locality



Source: Global Solar Atlas 2.0 by Solargis

Within the territory, suitable areas have been identified for the use of solar energy. The criteria for selecting potential areas were as follows:

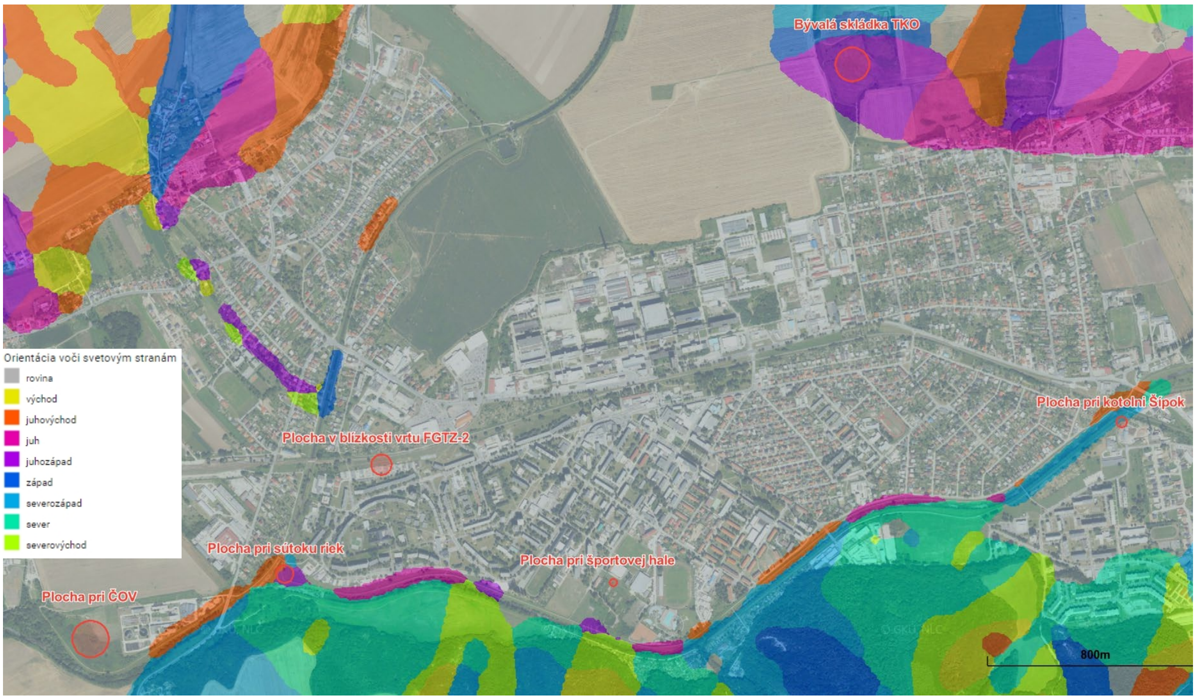
- area without agricultural use,
- area owned by the city,
- state-owned area.

The areas identified as suitable for solar energy use are indicated in the maps below. Retrieved from there are different layers of maps to better clarify the status of individual areas.

Fig. 6: Identified suitable areas for the use of solar energy around the city - layer of cultural works

Source: zBGIS.sk

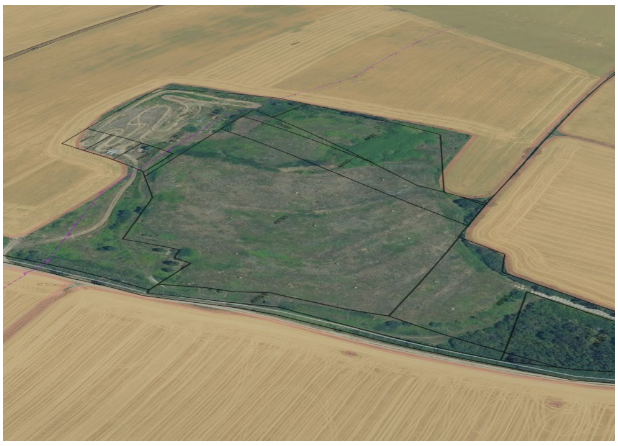
Fig. 7: Identified suitable areas for solar energy around the city - terrain orientation layer



Source: zBGIS.sk

Fig. 8: Identified suitable areas for solar energy around the city - terrain orientation layer

Source: zBGIS.sk



Former landfill site
Area: 28 328 m2
Type of land: Other area Owner:
City of Partizánske Year of landfill
creation: 1976 Year of landfill
closure: 2008

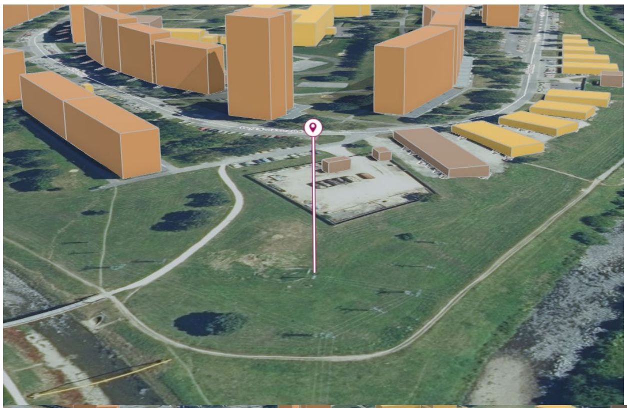
Potential of FTVE
Installed capacity: 1 300 kWp
Estimated annual production: 1 430 MWhe

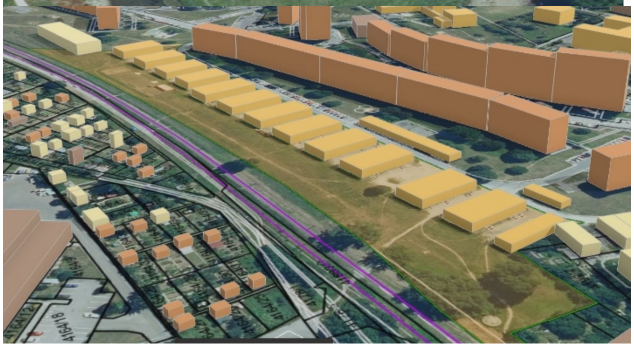
Potential Thermal Panels:
Solar panel area: 5 830 m^2
Estimated annual production: 2 040 MWht Storage
volume required: 700 m^3

Area near the wastewater treatment plant
Area: 27 320 m2
Type of land: Permanent grassland Owner:
Slovak Republic

Potential of FTVE
Installed power: 1 210 kWp
Estimated annual production: 1 330 MWhe

Potential Thermal panels: solar panel
area: 5 460 m^2
Estimated annual production: 1 910 MWht Storage
volume required: 660 m^3





Area at the confluence of rivers
Usable: approx. 7 600 m2
Type of land: Built-up area and courtyard Owner: City of Partizánske

Potential of FTVE
Installed power: 420 kWp
Estimated annual production: 462 MWhe

Potential Thermal panels: solar panel area: 1 900 m^2
Estimated annual production: 670 MWht Storage volume required: 230 m^3

Area near the FGTZ-2 borehole
Area: 15 627 m2
Usable: approx. 4 500 m2
Type of land: Other area Owner: City of Partizánske

Potential of FTVE
Installed power: 250 kWp
Estimated annual production: 275 MWhe

Potential Thermal panels: solar panel area: 1 130 m^2
Estimated annual production: 400 MWht Storage volume required: 140 m^3

Area near the sports hall
Usable: approx. 4 300 m2
Type of land: Other area Owner: City of Partizánske

Potential of FTVE
Installed power: 240 kWp
Estimated annual production: 264 MWhe

Potential Thermal panels: solar panel area: 1 080 m^2
Estimated annual production: 380 MWht Storage volume required: 130 m^3

Area near the Šípok boiler house
Area: 3 857 m2
Type of land: Built-up area and courtyard
Owner: City of Partizánske

Potential of FTVE
Installed power: 240 kWp
Estimated annual production: 264 MWhe

Potential Thermal panels: solar panel area: 580 m^2
Estimated annual production: 200 MWht Storage volume required: 70 m^3

The most promising area appears to be **the former MSW landfill**. The slope of the terrain here reaches 7° - 12° with an orientation to the south-west. Installing approximately 2 600 photovoltaic panels[12] it would be possible to generate approximately 1 430 $_{MWhe}$ of electricity. Approximately 70 % of this production is usable between April and September.

Installing approximately 565 thermal panels [13] it would be possible to obtain thermal energy at a level of approximately 2 040 $_{MWht}$. Approximately 90 % of this production is usable between April and September. In order to use this thermal energy in this period, it would be necessary to install a storage of 700 m^3 (D = 8,5 m, h = 12,5 m). The design of the accumulation could be in the form of a steel storage tank. In order to use the heat energy generated, a connection pipe to the heat network would have to be built, which is a separate issue.

2.4.2 Biomass

As regards the use of biomass for energy purposes, it is mainly woody biomass and the main source of wood is forestry and the wood processing industry.

The part of the harvested timber that is not suitable for the timber industry in terms of quality, unprocessed residues after harvesting (tops, branches and twigs, thinning of trees), calamitous timber and prunings can be considered as the energy-using component.

When sizing biomass boilers, it is necessary to take into account the required output, but also the space requirements for technological equipment and fuel storage. The fuel storage requirements are analysed in the table below. Approximately 14 times more space is required for the storage of wood chips compared to the storage of fuel oil. Due to the space requirements and the associated higher investment costs of biomass combustion plants, these plants are predominantly used as a baseload resource with a higher number of operating hours.

Table 1: Energy parameters and space requirement analysis of the storage of selected fuels

Fuel	Water content	Heating value	Volumetric weight	Energy Content	Difficulty storage
	(%)	(kWh/kg)	(kg/m)³	(kWh/m)³	(-)
Sawdust	30%	3,5	130	455	22
Wood chips	30%	3,5	200	700	14
Herb pellet	10%	4,5	600	2700	4
Wood pellets	10%	4,7	650	3100	3
Heating oil	0%	11,8	850	10 000	1

Source: elaboration based on data - www.topin.cz 14; Handbook on Planning of District Heating Networks 15

[12] Considered 500 W and one photovoltaic panel

[13] Considered 2m^2 natermic panel

[14] https://www.topin.cz/clanky/kolik-kilogramu-pevneho-paliva-je-zapotrebi-k-vyrobe-gj-tepla-detail-6786

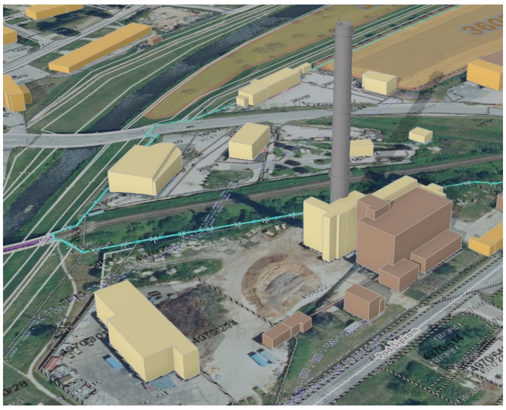
[15] NUSSBAUMER, Thomas, StefanTHALMANN, Andres JENNIand Joachim KÖDEL. Handbookon Planningof District Heating Networks. 2020. ISBN 3-908705-39-8.

The storage capacity should be designed to provide for the heat demand during the coldest period of the year. Due to the high fuel storage requirements, it is important to ensure a continuous supply of fuel throughout the year.

Currently, there is a biomass boiler house in the Šípok district, operated in the area in the northern part of the housing estate. The total rated thermal output of the boiler plant is at the level of 9 (6 + 3) MW. The level of oversizing of the heat sources in the Šípok boiler house is approximately 40 %. Due to the unused installed capacity of the boiler house, the utilisation of this boiler house can be further increased with a proper interconnection of the heat system.

The coldest month is January, when the biomass boiler plant could provide a maximum of 6 600 MWh of heat with the current installed capacity in that month, which represents a consumption of approximately 11 thousand MWh. m^3 of wood chips weighing 2 200 tonnes.[16] The current storage area for wood chips is approximately 1 000 m^2 , which is sufficient storage capacity for several days at maximum boiler plant utilisation. Logistically, approximately 6 trucks per day with a load capacity of 12 tonnes would be required for this maximum consumption.

Fig. 9: Satellite and 3D view of the biomass boiler house



2.4.3 Geothermal energy

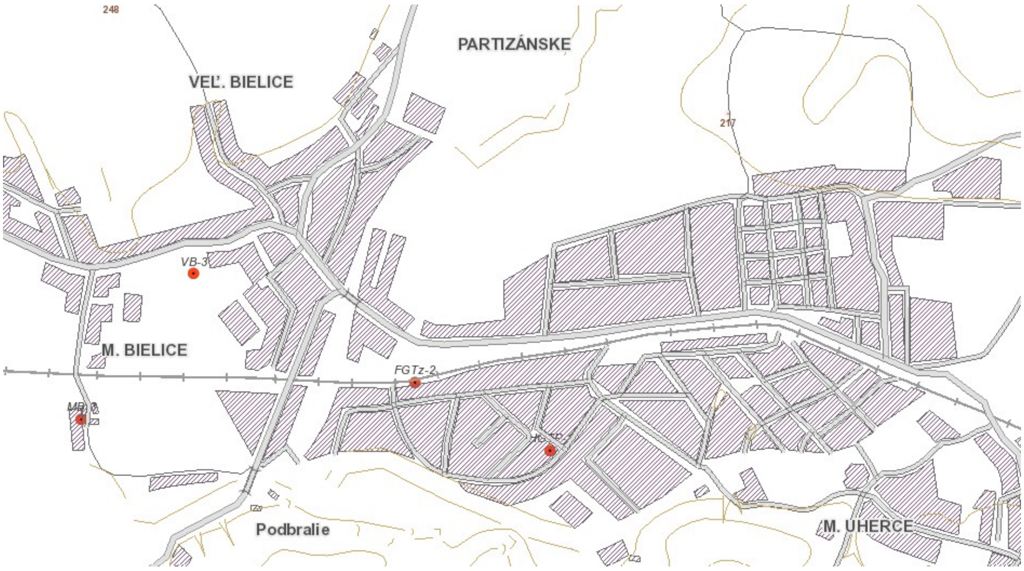
The use of geothermal resources takes place through different media removing heat from dry rocks - closed systems, or by using groundwater - open systems. Nowadays, with the development and popularisation of the introduction of CHP and due to the economic difficulty of deep boreholes, it is also possible to efficiently use low-potential geothermal energy from shallower boreholes and transform it to a higher, usable temperature level.

The Partizánske locality is part of the more broadly defined geothermal water formation Bánovská kotlina (Bánov Basin). Boreholes HGTP-1 and FGTz-2 have been drilled directly in the locality of the town, which have verified the potential of geothermal energy exploitation. In the vicinity of the town there are also boreholes MB-3 Malé

[16] Taking into account the times of sintering of the chip in the source of the heat

Bielice, MB-4 Malé Bielice and VB-3 Veľké Bielice, which fall into the same reservoir environment. The only well currently in use is the MB-3 Malé Bielice well.

Fig. 10: Boreholes with geothermal measurements at the site



Source: geothermal energy application of Slovakia, ŠGÚDŠ

The energy potential of the hydrogeothermal wells HGTP-1 and FGTz-2 directly in the Partizánske locality was calculated from the yield of the wells ($_{Qwh}$), the temperature at the mouth of the production well ($_{Twh}$) and the reference temperature ($_{Tref}$) to which the geothermal water would be cooled when using low-potential heat by means of heat pumps.

The evaluation of the energy potential of the hydrogeothermal wells HGTP-1 and FGTz-2 is listed in the table below.

parameter	symbol	unit	HGTP-1	FGTz-2
proven productivity	Q_{wh}	$l.s^{-1}$	12,8	12,5
proven productivity	Q_{wh}	$kg.s^{-1}$	12,5	12,2
heat capacity	c_{wh}	$J.kg^{-1}.K^{-1}$	4118	4118
temperature of the GT water produced	T_{wh}	°C	20	33
reference temperature	T_{ref}	°C	10	10
GT installed power	$Pth_{,inst}$	MWt	0,515	1,156
Total installed power	**$Pth_{,inst, celk.}$**	**MWt**	**1,670**	
Number of operating hours	t_{ref}	Throw.	8760	
Total installed power	**$Qh_{, celk.}$**	**MWh/year**	**14 630**	

According to the hydrogeological borehole data, the installed capacity of the HGTP- 1 geothermal borehole would be 0.515 MWt and the installed capacity of the FGTz-2 geothermal borehole would be 1.156 MWt. Geothermal sources are classified as baseload sources with the longest possible operating life in terms of annual production due to their stability of performance and investment intensity.

during the year. The annual energy potential from proven geothermal wells at the site is approximately 14 630 MWh per year. It should be stressed that this is low-potential heat that can be used, for example, in conjunction with heat pump technology.

However, the productivity of both wells has not yet been verified by a joint hydrodynamic test assuming their simultaneous production, i.e. there has been no verification of their realistic ability to produce long-term proven yields. Therefore, the results of the energy balance can be considered as indicative and for further steps it is necessary to carry out validation, operational hydrodynamic tests and production monitoring with the necessary interaction and reservoir response modelling.

2.4.4 Energy of the environment

The use of ambient heat represents a special case that is applicable to different heat networks, even without the availability of a specific low-potential heat source (thermal water, waste heat from industry, etc.). Conventional air-to-water heat pumps can achieve output temperatures in the range of 60-70 °C[17] depending on the refrigerant used. For higher outlet temperatures, the use of high temperature heat pumps is necessary. However, when using air-to-water heat pumps, the specificities of this source must be taken into account, in particular the variability of the available power and the decrease in efficiency with decreasing outdoor temperature. As a simplification, an outdoor temperature of -5 °C can be considered as a bivalent point, below which it is appropriate to connect a peak heat source, either in a bivalent alternative mode of operation (below - 5 °C the peak source provides full thermal output) or in a bivalent parallel mode (below - 5 °C a peak source is connected to help the heat pump to achieve the required thermal output).

The potential of using the energy of the environment depends not only on the number of cold days in the locality, when the ambient temperature is below the bivalent point, but also on the parameters of the heat network. The higher the grid temperature, the more electricity is needed to exploit the low-potential heat of the environment.

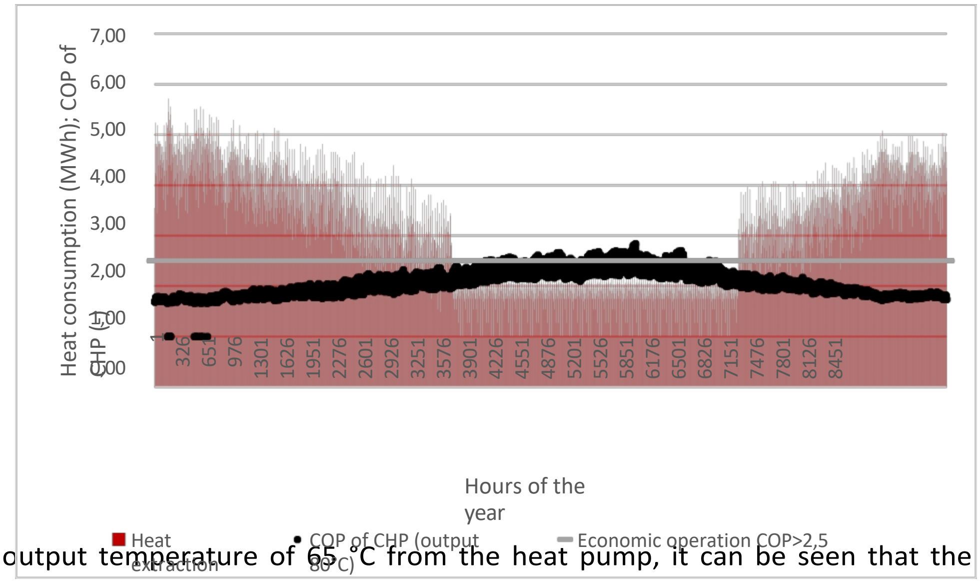
Proper integration of air-to-water heat pumps in terms of function in terms of annual heat demand is key to the use of this specific heat source.

The economic operation of an air-to-water heat pump depends on several factors, such as the price of electricity on the market, investment intensity, etc. As a rough guide, we can consider this threshold at COP 2.5. For illustration, the heat demand graphs of the site are plotted with the corresponding COP figures of the air-to-water heat pump at a given moment in time, taking into account the temperature at the site.

[17] The maximum outlet temperature is that of the ash pumps and the condensing temperature of the fuel. R410 refrigerant has a condensing temperature of 62,5 °C and an outlet temperature of 60 °C can be reached at the inlet, taking into account a heat exchanger temperature gradient of about 5 K. The natural refrigerant R290 has a higher condensingtemperature and a temperature outlet of 70 °C.

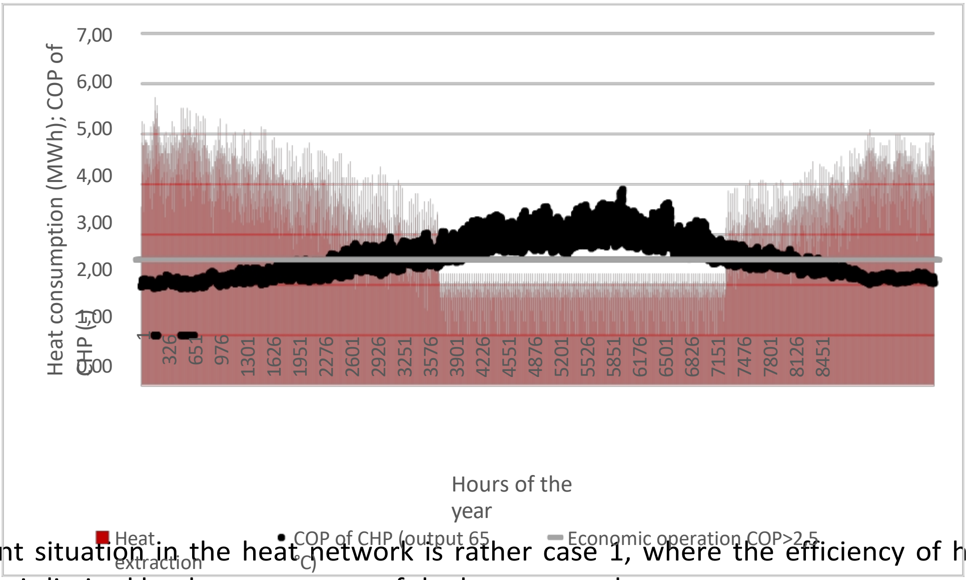
With an output temperature of 80 °C from the heat pump, it can be seen that the economic operation is only a few hours per year, which significantly limits the efficiency of the use of this source.

Fig. 11: Comparison of heat extraction and COP of the CHP at an outlet temperature of 80 °C



With an output temperature of 65 °C from the heat pump, it can be seen that the economic operation is significantly extended and the correct integration of the heat pump within the annual use can be efficient and beneficial.

Fig. 12: Comparison of heat extraction and COP of the CHP at an outlet temperature of 65 °C



The current situation in the heat network is rather case 1, where the efficiency of heat pump integration is limited by the parameters of the heat network.

2.4.5 Wind energy

Favourable conditions for wind energy are especially on the ridges of the Slovak mountains and in some larger valleys such as the Podunajská and Východoslovenská lowlands, where the average wind speed reaches values of at least 5 m/s. The average wind speed of the whole territory of Slovakia at a height of 10 m reaches 2.93 m/s and only about 2% of the territory reaches 5 m/s. Achieving an average wind speed of at least 5 m/s at a height of 10 m above the terrain is an established condition for assessing the economics of wind turbine operation.

The windiest areas in the site outside the built-up area and forest are above northeastern part of the city.

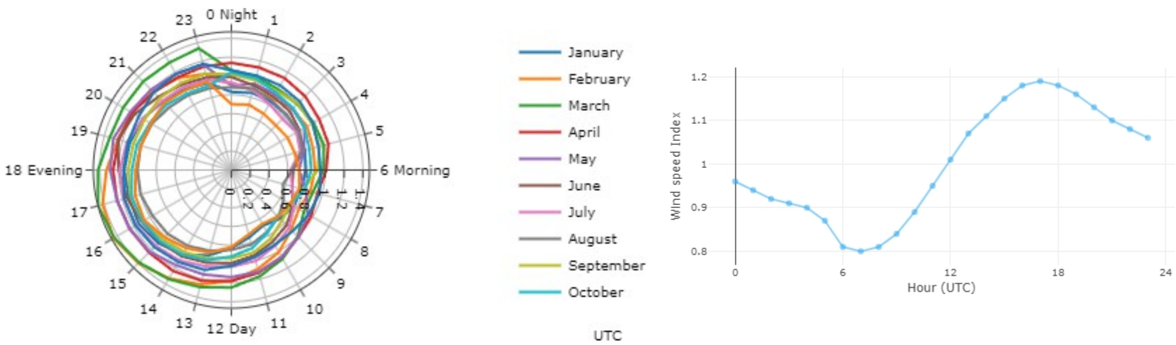
Fig. 13: Identified suitable area for wind energy in the vicinity of the city

Fig. 14:Identified suitable area for wind energy in the vicinity of the city - 3D view

The increased windiness of this area is mainly due to the relief. The average wind speed at 10 m above the ground is 3.3 m/s, at 50 m it is 4.11 m/s and at 100 m it is 4.7 m/s. The energy density at 100 m above the ground ranges from 167 to 197 W/m .[2]

The electricity generation profile of the assessment area is shown in the following figure.

Fig. 15: Wind turbine electricity generation profile at the site under consideration



The windiest months are February, March and April. On the other hand, the lowest windiness is in June, July and August. During the day, the highest prospect of electricity production is between 2 pm and 9 pm.

The potential annual electricity production from this area is projected to be approximately 45,300 MWhe/year. Using wind turbines with a rotor diameter of 50 m (propeller blade span), approximately 35 wind turbines could be sited in this area. The installed capacity of the wind farm would be approximately 22,8 MWe.

3 Proposal for interconnection of the centralized heat supply system in Partizánske

The connection of the current smaller circuits of block boiler houses and the Šípok CTZ circuit into a larger unit will ensure more efficient use of future RES-based heat sources and at the same time improve the usability of existing fuel heat sources (natural gas, wood chips), whose boiler houses often have oversized heat outputs. The interconnection of the main supply areas and the different energy sources will improve the variability of heat production and supply, which can also translate into more economically efficient and safer operation.

3.1 Design assumptions

The study considers three proposals for a centralised supply system
heat in Partizánske:

- Option 0 - maintaining the status quo,
- Southern connection of the Šípok - Luhy areas,
- Northern connection of the Šípok - Luhy areas.

The basic assumptions considered in the proposals are summarised in chapters 3.2.1 and 3.2.2.

In order to objectively compare the resulting heat prices of the individual options, we consider their implementation over a 10-year horizon, i.e. until 2034.

All variants were designed for a slightly reduced heat demand. The reduction was based on a conservative savings potential due to measures to improve the thermal protection of buildings and the reconstruction of TV preparation, which we consider for the selected buildings. In-depth renovation of buildings that are currently without external wall insulation and whose current energy class for the point of consumption for heating falls in energy class D or worse was considered. 34 buildings were identified in this way. A more detailed description is given in Chapter 2.3.

Table 10: Overview of the actions considered in the different options over a 10-year horizon

Variant	Heat demand	Heat distribution	Heat sources
Maintaining the status quo	Slightly reduced due to the impact of the envisaged renovation of buildings CHP = 18.56 GWh/year TV = 12.57 GWh/year	Reconstruction of block boiler room wiring in advanced age - boiler room D wiring, boiler room PK7 wiring and partly boiler room PK9 wiring. The total heat losses of all heat distribution systems were determined to be 3.515 GWh/year (approx. 10.14%). Heat losses of individual circuits of block boiler houses and CTZ Šípok were determined after the considered reconstructions.	Reconstruction of the boiler house D[18]. Reconstruction of boiler rooms PK6, PK7, PK9, PK12, PK13, PK14, K15, K16, PK18, PK19, PK20, PK21, PK22, K24 and PK_Alpha for optimized performance. The total installed capacity is 25.9 MWt.
Southern link SCZT	Slightly reduced due to the impact of the envisaged renovation of buildings CHP = 18.56 GWh/year TV = 12.57 GWh/year	Connection of supplied areas (Šípok, Luhy, city centre) according to the southern variant. Connection of objects to the boiler house circuit E. Connection of objects to the boiler house circuit 11. Reconstruction of block boiler room wiring in advanced age - boiler room D wiring, boiler room PK7 wiring and partly boiler room PK9 wiring. The total heat losses of all heat distribution systems were determined to be 5.128 GWh/year (approx. 14.15%). Heat losses of individual circuits of block boiler houses and CTZ Šípok were determined after the considered reconstructions.	Boiler Room D Reconstruction .[18] Reconstruction of boiler rooms PK9, PK24, PK6 and PK7 for optimised performance. Commissioning of the FGTZ-2 geothermal borehole and heat pump installation. Commissioning of the HGTP-1 geothermal borehole and installation of a heat pump. The total installed capacity is 27.4 MWt.
North SCZT link	Slightly reduced due to the impact of the envisaged renovation of buildings CHP = 18.56 GWh/year TV = 12.57 GWh/year	Connection of supplied areas (Šípok, Luhy, city centre) according to the northern variant. Connection of objects to the boiler house circuit E. Connection of objects to the boiler house circuit 11.	Boiler Room D Reconstruction .[18] Reconstruction of boiler rooms PK9, PK24, PK6 and PK7 for optimised performance. Commissioning of the FGTZ-2 geothermal borehole and

[18] I am consideringmetrin gas boiler with optimized performance for the currentheat consumption.

		Reconstruction of block boiler room wiring in advanced age - boiler room D wiring, boiler room PK7 wiring and partly boiler room PK9 wiring. The total heat losses of all heat distribution systems were determined to be 4.838 GWh/year (approx. 13.45%). Heat losses of individual circuits of block boiler houses and CTZ Šípok were determined after the considered reconstructions.	heat pump installation. Commissioning of the HGTP-1 geothermal borehole and installation of a heat pump. The total installed capacity is 27.4 MWt.

3.2 Analysis of supply areas, pipelines and heat sources

3.2.1 Option 0 - Maintaining the status quo

For the status quo option, we estimate the retention of the current heat sources, which would supply heat to properties in the current supply areas.

However, maintaining the current form of the CZT system will require a comprehensive reconstruction of boiler houses D, PK6, PK7, PK9, PK12, PK13, PK14, K15, K16, PK18, PK19, PK20, PK21,
PK22, K24 and PK_Alpha, as they will be of advanced age in the timeframe considered. For these boiler houses, the installation of natural gas condensing boilers has been considered[19]whose installed heat outputs would not be oversized and would be adapted to the current heat demand. For this purpose, the simple methodology described i n Chapter 2.1 was used.

Under Option 0, we also foresee the reconstruction of the heat distribution circuits of the block boiler house D (the condition of the distribution is already critical), the block boiler house PK7 and partly also the boiler house PK9 circuit (part of the heat distribution should already be revitalized according to the provided materials).

3.2.2 Southern and northern link options

For both the southern and northern design options, we consider a slight redesign of the supplied areas. The areas considered for both options are defined in the table below. The optimisation operations considered for interconnection purposes can also be seen in the following figures. An explanation of the necessary optimisation steps as well as the choice of heat sources is given in the text below the figures.

Table 11: Considered supply areas and heat sources in the southern and northern interconnection option

Stocked area	Status	Heat extraction		Heat sources	Description of optimization
		ÚK (GWh/year)	TV (GWh/year)		
Boiler room area Arrow	Current	5,739	3,511	Biomass boiler room	No expansion of the area served.
	Optimization of the area	5,739	3,511	Biomass boiler room	
	Optimisation of the area and renovation of buildings	5,610	3,485	Biomass boiler room	
Meadows 1, Meadows 2, Meadows 3 (area boiler rooms B)	Current	4,575	3,345	Boiler room B	No expansion of the area served.
	Optimization of the area	4,575	3,345	Boiler room B	
	Area optimisation and building renovation	4,216	3,226	Boiler room B	
Luhy 4 and Luhy 5 (area of boiler house D)	Current	6,053	3,869	Boiler room D	Prospective assignment of a new geothermal heat source.
	Optimization of the area	6,053	3,869	Boiler room D + geothermal FGTZ-2 borehole	
	Optimisation of the area and renovation of buildings	5,618	3,869	Boiler room D + geothermal FGTZ-2 borehole	

[19] Except for boiler room D, for which we are considering the installation of three thermal gas boilers with a condenser (total output 5,55MW).

Boiler room area E	Current	1,627	1,012	Boiler room E	Connection of boiler house objects K12, K13, K14, K18, K20,K21, K ALFA. Prospective assignment of a new geothermal heat source.
	Optimization of the area	3,021	1,330	Boiler room E + geothermal HGTP-1 borehole	
	Area optimisation and building renovation	1,859	1,263	Boiler room E + geothermal HGTP-1 borehole	
Area of boiler rooms K12, K13, K14, K18, K20,K21, K ALFA	Current	1,394	0,318	Boiler rooms P6, K16, K15 and K22	assignment to boiler room E.
	Optimization of the area	-	-	-	
	Optimisation of the area and renovation of buildings	-	-	-	
Boiler room area 11	Current	1,363	0,704	Boiler room 11	Connection of boiler house objects K19, K16, K15, K22.
	Optimization of the area	1,693	0,755	Boiler room 11	
	Optimisation of the area and renovation of buildings	0,704	0,387	Boiler room 11	
K19, K16, K15 and K22 boiler room area	Current	0,329	0,051	Boiler rooms K19, K16, K15 and K22	Considered assignment to boiler room 11.
	Optimization of the area	-	-	-	
	Optimisation of the area and renovation of buildings	-	-	-	

Fig. 16: Areas supplied - current status

Fig. 17: Supplied areas - after optimisation

Biomass boiler house Šípok

The interconnection of the CZT system circuits will increase the usability of heat from fuel chips also outside the Šípok housing estate. The expected use of the biomass boiler house during the year is given in chapters 3.3.2 and 3.3.3.

Geothermal boreholes FGTZ-2 and HGTP-1

For both the southern and northern variants of the interconnection, we consider the assumption of the operation of the geothermal wells FGTZ-2 and HGTP-1. Despite the fact that hydrodynamic tests have been carried out on both wells, it is necessary to carry out a joint hydrodynamic test of both wells at the same time to determine the degree of their hydraulic interaction as well as to evaluate their productivity. We estimate that the HDS results of both boreholes will be positive in terms of their application in the CZT system. The installed capacity of the geothermal boreholes in synergy with the heat pump technology is at the level of 1.73 MWt for the FGTZ-2 borehole and 0.85 MWt for the HGTP-1 borehole. The output temperature from the heat pumps is considered to be 80 °C and the geothermal water temperature is considered to be cooled to 10 °C.

Alternatively, an outlet temperature of 65 °C could be considered. In summer this temperature should be sufficient to provide TV at all consumption points[20]. In the heating season, water at this temperature would be used to preheat the return water in the gas boiler system (boiler room D or boiler room E). This option would improve

[20] It is advisable to verify the temperature drop of the water in the thermal power plant when the heat in summer mode will be produced only in geothermal sources. The temperature of the water at the outlet of the heat source should be sufficient to ensure that the temperature of the water at the inlet to the consumer is less than 45 °C. The most critical in this respect will be the abstraction points in the Šípok settlement (the greatest distance from the geothermal boreholes).

efficiency of CHP, however, due to cascading with gas sources, the proportion of heat produced from fossil fuel would increase slightly.

To maximize the use of thermal energy from boreholes, it is advisable to consider having sufficient instantaneous heat storage capacity.

Table 12: Considered parameters of the geothermal borehole

Garden	Tep. borehole performance (MWt)	El. power input (MWe)	Tep. CH output (MWt)	SPF (-)
HGTP-1	0,515	0,330	0,850	2,6
FGTZ-2	1,156	0,570	1,730	3,0

The construction of a heat exchange station and a machine room for low-potential heat from the FGTZ-2 borehole is considered in the premises of boiler room D, where the geothermal water feeder would be connected. The engine room of the CH with heat exchanger for low-potential heat from the borehole HGTP-1 would be built in the boiler room E, where the geothermal water supply from the borehole would be coated. A receiver for the cooled geothermal borehole water was not considered as part of the study. Costs for the feeders of geothermal water from the boreholes to the respective boiler house facilities were included in the investment costs of the overall interconnections (Chapter 3.4).

Boilers and distribution circuits of boiler house B and boiler house D

Boiler house districts B and D are among the largest areas supplied with heat from the CZT system in the city. Their connection to the overall district heating system is therefore extremely important.

Boiler house B has recently undergone a reconstruction of the heat sources (chapter 2.1) and heat distribution (chapter 2.2) and therefore we are considering its use in its current form.

Boiler house D is in a critically poor condition both in terms of heat sources and the distribution network (see Chapters 2.1 and 2.2). Similarly to Option 0, Boiler House D and the distribution system need to be completely reconstructed in the interconnection options. For the heat sources, the study envisages the installation of three low-temperature gas boilers with three thermocondensers with a total installed thermal output of 5.55 MW. Other heat sources can also be considered and these options are examined in detail in another study[21]. The heat distribution systems of boiler house D are largely obsolete and should be completely reconstructed (estimated budget for the reconstruction of the distribution network in the economic evaluation of options in chapter 3.4).

Extension of the circuit of boiler house E and boiler house 11

[21] Study Application of different approaches in the reconstruction of a block gas boiler house. Available here: https://zivotpouhli.sk/novinky/item/370-studia-uplatnenie- different-approaches-in-reconstruction-of-block-gas-boiler-house

For the purpose of connecting the fuel source of the Šípok housing estate and the areas in Luhoch and in the city centre, it is advisable to look for possibilities to connect the distribution networks also within the circuits of small block and house boiler houses, which could partially solve the problem of oversizing their installed heat outputs. Within the framework of the study, we estimate extensions of the circuits of block boiler house E and block boiler house 11. The extended circuits of these boiler houses are then considered to be connected to the overall district heating system.

The reasons for the expansion of boiler house E and boiler house 11 were as follows:

- Both boiler plants are in relatively good condition and are among the best in terms of operational reliability (see Chapter 2.1),
- Both boiler houses are among the larger block boiler houses in the eastern part of Luhov and the wider
  in the city centre and only smaller boiler houses would be connected.
- Connecting other objects to the circuits of these boiler houses will simplify the process of connecting these areas with other larger units of the CHP system, as it will be sufficient to run a supply line for two connection points (boiler house E and boiler house 11).
- The addition of the facilities will also significantly reduce the high oversizing of the total heat output of the boiler plants and ensure that a significant number of small block and house gas boilers in poor condition can be retired and will not have to be replaced with new natural gas fired boilers.

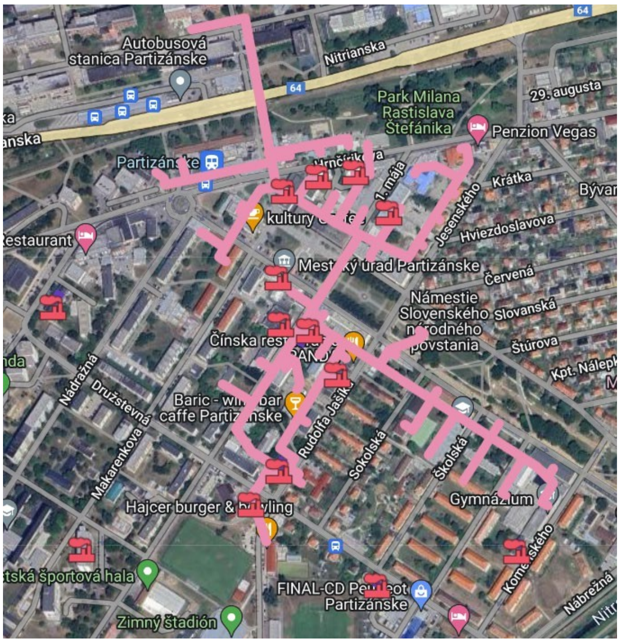
For the extension of the block boiler house E we consider the variant that is analysed in detail in the second part of this study (chapter 4.2.8). We consider connecting the boiler houses PK18, PK Alfa, PK13, PK14, PK12, PK21 and PK20 to the boiler house circuit. As the boiler house E circuit will be part of a larger unit, ensuring a reliable heat supply will not be a problem.

Fig. 18: Extended circuit of boiler house E

Source: own processing in Thermos and image editor

For the extension of block boiler house 11 we are considering the connection of boiler houses PK19, PK16, PK15 and PK22. Most of the boiler houses will be of advanced age in the period under consideration and their connection to the K11 circuit would be an appropriate step. As the possible extended circuit of boiler house 11 would be part of a larger unit, ensuring a reliable heat supply should not be a problem. The existing ducts of the former steam pipelines could theoretically be used to connect the buildings to the K11 circuit (these routes need to be investigated). Alternatively, it is also possible to envisage the ringing of boiler houses PK19, PK16, PK15 and PK22 together, with one of the boiler houses becoming a block boiler house after the reconstruction. Given the oversized boiler outputs in the current state, we do not foresee a space problem in the boiler room. Consequently, an interconnection would be built to this boiler house from the main feeder of the southern or northern variant. However, for the purposes of this study, we are considering that these boiler houses will be connected to the circuit of boiler house 11, which will also become a connection point within the Southern or Northern Interconnector Option.

Fig. 19: Assumed routes of former steam heat distribution lines



Unconsidered and potential areas

The areas of boiler houses K6, K7, K9, K24 and the boiler house Veľké Bielice are considered in the study to remain decentralised as at present (within the individual budgets, however, we consider the necessary revitalisation of the heat sources or the distribution network, see Chapter 3.4).

Block boiler room K7 can connect the boiler room K6 or other unconnected objects in the vicinity to its distribution circuit.

In the future, in case of applying the southern connection variant, it is possible to consider connecting this area to the southern heat feeder connecting the Šípok boiler house with boiler house B (necessity to build a footbridge over the river or to use the existing cycle bridge). In the case of the northern option, the most viable option for connecting this area seems to be to use the routes of the former steam pipelines (the routes need to be investigated).

Table 13: Existing supply areas not considered for connection to the larger unit

K06 and K07 boiler room area	Current	0,381	0,100	Boiler rooms K06 and K07	Potential interconnection of boiler houses K06 and K07. The study does not consider interconnection.
	Area optimisation and building renovation	0,146	0,078	Boiler room K07	
Remote boiler room area K09, K Large Bielice and K24	Current	1,100	0,324	Boiler rooms K09, K19 and K24	Great distance from other supplied areas. We're not considering a link.
	Renovation of buildings	0,405	0,259	Boiler rooms K09, K19 and K24	

The most economically effective would be the expansion of the area of boiler house K7 and K6 by other objects on Nábrežná, Komenského, Strojárenská, Školská, Sokolská streets up to Rudofla Jašíka street, where the considered area of the expanded boiler house E already starts. The potential of this area in terms of heat demand was tentatively estimated at 2.3 GWh/year for central heating and 0.75 GWh/year for TV. The possible connection of private owners who currently provide their heat in a decentralised way outside the heat management of TSM Partizánske has to start with a complicated negotiation process, which may not end successfully and for this reason we have not considered this area in the design options.

The area around boiler house 9 also has potential to be connected to the larger SCZT. However, the location of the boiler house is in an unfavourable location in terms of the considered routing of the main feeder for both options. Alternatively, the construction of a diversion from the south or north (depending on the variant) would require significant excavation and crossings, including across private land. Such a connection would not be economically viable for the area as it stands. The attractiveness of the area to connect could be enhanced by extending the area to include adjacent buildings. Within easy reach are the schools belonging to the town - the Obuvnícka Kindergarten and the Rudolf Jasik Primary School and several other suitable residential buildings (privately owned). For the school buildings there is a high probability of annexation due to the ownership, but for the apartment buildings the negotiation process would have to start. For these reasons we have not considered this area within the design options.

The Veľké Bielice boiler house and the K24 boiler house are too far away and their inclusion in the overall CHP system is not considered in the future.

For the purposes of the study, no other potential areas have been considered that would could theoretically be part of a larger SCZT unit.

Currently, the construction of the River Star residential area near the Šípok housing estate is planned. The new buildings generally have a low specific heat demand for central heating and TV preparation and heating is provided by a low-temperature system. However, if the southern connection option were to be constructed, the location of the residential area would be virtually immediately below the heat feeder and the possibility of a connection may not be unrealistic. However, potential connections would require synchronisation of the construction of the southern heat feeder with the residential development project.

A potential customer and theoretically also a supplier of heat (waste heat) is the industrial district in the northern part of the city. However, this area has not been considered in the proposals, as currently the heat supplier in this part is a private company and it is not clear how many customers and with what heat demand would be interested in the potential heat from the newly built district heating system.

Potential heat sources

There is a relatively large potential for additional heat sources in the vicinity of the wider area of Partizánske (see Chapter 2.4 for more information). In terms of possible heat supply to the SCZT network, the most realistic option seems to be the use of waste heat from the local wastewater treatment plant (hereafter referred to as WWTP). The eventual connection point from this heat source would be boiler house B in both design options. The assessment of the suitability of using the waste heat from the WWTP needs to be analysed in a separate study.

3.2.2.1 Routing of the link - southern variant

The preliminary design of the southern connection route considered the construction of the main heat feeder from the Šípok biomass boiler house to the B boiler house. The route could run parallel to the existing cycle path. The land on the south bank of the river Nitra is owned by the Slovak Republic for its entire length. The option subsequently envisaged the construction of a footbridge over the River Nitra. The subsequent connection to boiler house B as well as the other interconnection lines (KB to KD, KD to K11 and K11 to KE) were chosen so that the route would run through land owned by the city and through as few roads as possible (only under-drilling and over-pressurisation of the heat distribution system is considered), while at the same time crossing as few utility lines as possible.[22]or utilities for which crossing conditions are more benevolent. Regulatory protection zones have been considered for the intersection of utilities with the eventual heat pipeline. The possible crossing of utility lines must be carried out in accordance with STN 73 6005. The considered routing of the southern connection variant can be seen in Figure 20. Information on land and utilities can be found in the annexes in Chapter 5.1.

Initially, a bridge connection on Za riekou Nitrou Street was considered, but the city management was not in favour of this solution due to the alleged gas pipeline running under the

[22] Analyzedon the basis of the drawing and engineeringnetworksobtained by the drainage of the city.

by this bridge. Connection to the other boiler circuits (Boiler House E and Boiler House 11) would also be quite complicated, requiring excavation in the wider town centre. In addition, in terms of heat feeder diameters, the pipes with the largest dimensions (wide excavations) would be laid here, as the main areas served by Luhov are only the boiler house D and B circuits, to which an adequate diameter heat distribution pipe would need to be routed.

Fig. 20: Considered routing of the southern link option

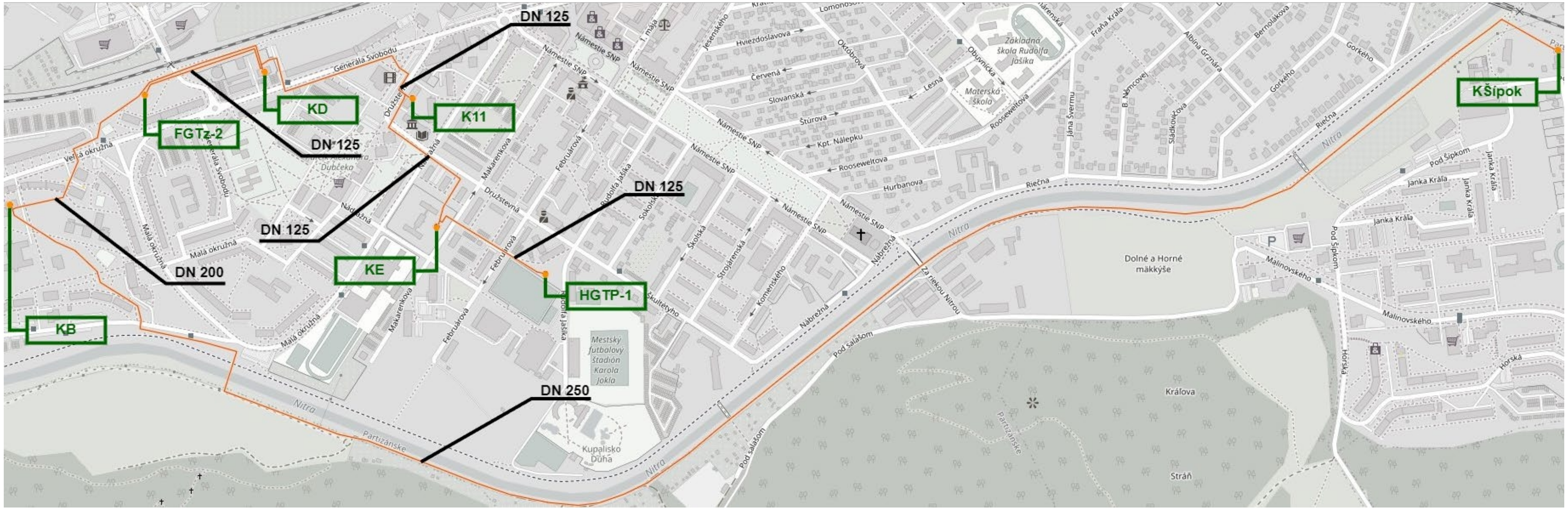


Table 14: Proposed diameters of the distribution sections - southern variant of the interconnection

Section	Max. design water velocity [m/s]	Max. power output (theoretical[23]) [MW]	DN designed	Length of section [m]		
				Through the greenery	Despite the hard surface	Total
Boiler room Šípok - KB	2,4	9,80	250	1560	1865,55	3425,55
KB - KD	2,2	5,75	200	592,06	55,00	647,06
FGTz2 - KD	1,6	1,88	125	250,00	13,22	263,22
KD - K11	1,8	2,65	150	250,00	160,74	410,74
K11 - KE	1,6	1,63	125	279,55	48,00	327,55
KE - HGTP1	1,6	0,82	125	159,07	70,00	229,07

[23] Soldtemperature gradient.

The internal diameters of the individual parts of the interconnection were chosen on the basis of simulation[24] different operating conditions of the interconnected CHP system with respect to possible future connection of other potential areas and decreasing temperature ratios in the SCZT (the DN diameter was increased by one dimension compared to the simulation). The main parameter in the design of the heat distribution system diameter was the maximum water flow velocity at peak withdrawal. Peak velocities are generally a function of pipe diameter and were defined according to SDHA material[25]which is relatively conservative compared to other standards. A conservative approach was also chosen for the temperature gradient (a temperature gradient of 20 °C was chosen), the height of which affects the pipe diameter. Too high a proposed temperature gradient when designing the pipe diameter compared to the actual temperature gradient (less cooling of the return water) may cause undersizing of the pipe diameter and consequent bottlenecks. With the trend of decreasing water temperature in SCZT, it is preferable to consider smaller temperature gradients in the design (4th generation SCZT). For the geothermal water connection sections to boiler house D (borehole FGTZ-2) and to boiler house E (borehole HGTP-1), the abstraction capacities were considered when the geothermal water cooled down to 10 °C (see chapter 3.2.2).

3.2.2.2 Routing of the link - northern variant

The preliminary design of the route of the northern link considered the construction of the main thermal feeder from the Šípok biomass boiler house along the main railway line passing through the town. Bridging of the feeder is considered using the existing railway bridge. If this is not possible, it is necessary to build a footbridge. We are considering that the main part of the route will run parallel to the existing railway. For the main feeder from the Šípok boiler house up to boiler house D, a concurrence with the railway line at a distance lower than allowed by the railway protection zone according to Act No. 513/2009 Coll. on railways is considered and in the case of the intention to build this variant of the interconnection of the areas, it is necessary to start negotiations with the company Railways of the Slovak Republic. The northern feeder would still branch in front of the KD in the direction of the K11 and KE sidings. A link would be built between the KD and KB boiler house, similar to the southern variant. The routing of the interconnectors at Luhy and in the town centre was chosen to cross as much of the town-owned land as possible and to cross as few roads as possible (only underdrilling and extrusion of the heat distribution system is considered). At the same time, consideration has been given to utilities[26] and routes were sought which intersected them as little as possible, or priority was given to crossing networks whose crossing conditions are more benevolent. Regulatory protection zones were considered for the intersection of utilities with a potential heat pipeline. The possible crossing of utility networks must be carried out in accordance with STN 73 6005. The considered routing of the northern connection variant can be seen in Figure 21. Information on land and utilities can be found in the appendices in Chapter 5.2.

[24] The Thermos programme was used for stimulation.

[25] Swedish District Heating Association

[26] Analyzedon the basis of the drawing and engineeringnetworksobtained by the drainage of the city.

Fig. 21: Considered routing of the northern link

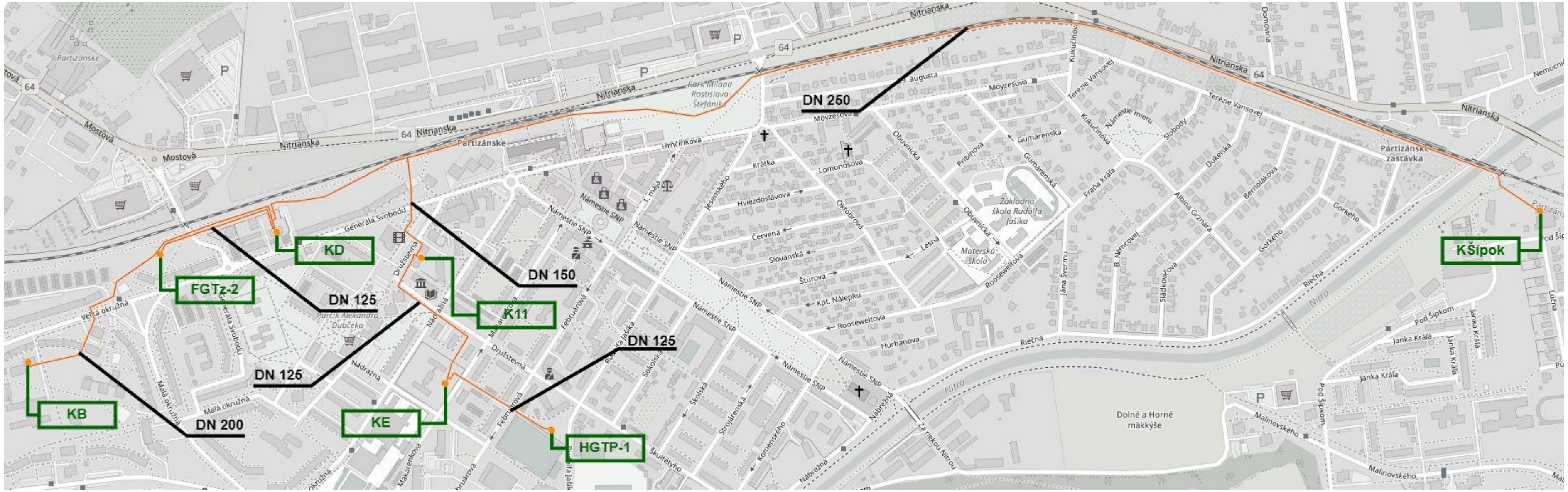


Table 15: Proposed diameters of the distribution sections - northern variant of the interconnection

Section	Max. design water velocity [m/s]	Max. power output (theoretical[27]) [MW]	DN designed	Length of section [m]		
				Through the greenery	Despite the hard surface	Total
Boiler room Šípok - KD	2,4	9,80	250	2462	132,27	2594,27
Tap from the feeder to K11	1,8	2,65	150	145,77	65,00	210,77
K11 - KE	1,6	1,63	125	283,02	48,00	331,02
KE - HGTP1	1,6	0,82	125	159,07	70,00	229,07
FGTz2 - KD	1,6	1,88	125	250,00	13,22	263,22
KD - KB	2,2	5,75	200	592,06	55,00	647,06

[27] Soldtemperature gradient.

The internal diameters of the individual parts of the interconnection were chosen on the basis of simulation[28] different operating conditions of the interconnected CHP system with respect to possible future connection of other potential areas and decreasing temperature ratios in the SCZT (the DN diameter was increased by one dimension compared to the simulation). The main parameter in the design of the heat distribution system diameter was the maximum water flow velocity at peak withdrawal. Peak velocities are generally a function of pipe diameter and were defined according to SDHA material[29]which is relatively conservative compared to other standards. A conservative approach was also chosen for the temperature gradient (a temperature gradient of 20 °C was chosen), the height of which affects the pipe diameter. Too high a proposed temperature gradient when designing the pipe diameter compared to the actual temperature gradient (less cooling of the return water) may cause undersizing of the pipe diameter and consequent bottlenecks. With the trend of decreasing water temperature in SCZT, it is preferable to consider smaller temperature gradients in the design (4th generation SCZT). For the geothermal water connection sections to boiler house D (borehole FGTZ-2) and to boiler house E (borehole HGTP-1), the abstraction capacities were considered when the geothermal water cooled down to 10 °C (see chapter 3.2.2).

[28] The Thermos programme was used for stimulation.

[29] Swedish District Heating Association

3.3 Energy assessment

3.3.1 Option 0 - Maintaining the status quo

<table>
<tr>
<td>
Heat sales: 31,126 GWh/year Heat production: 34,671 GWh/year

Biomass consumption: 12,591 GWh/year (5,945 tonnes/year) Natural gas consumption: 27,150 GWh/year

Biomass boiler room
Share of annual heat production [%] 34
Considered efficiency [%] 83

Gas boilers
Share of annual heat production [%] 66
Considered efficiency In accordance with Table 4
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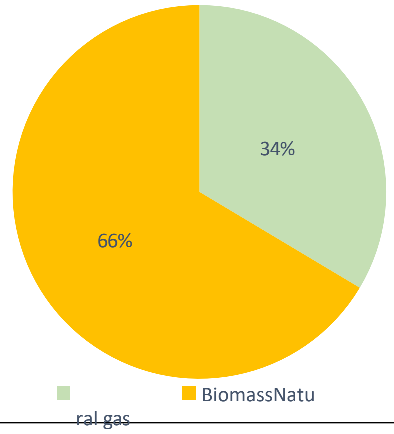

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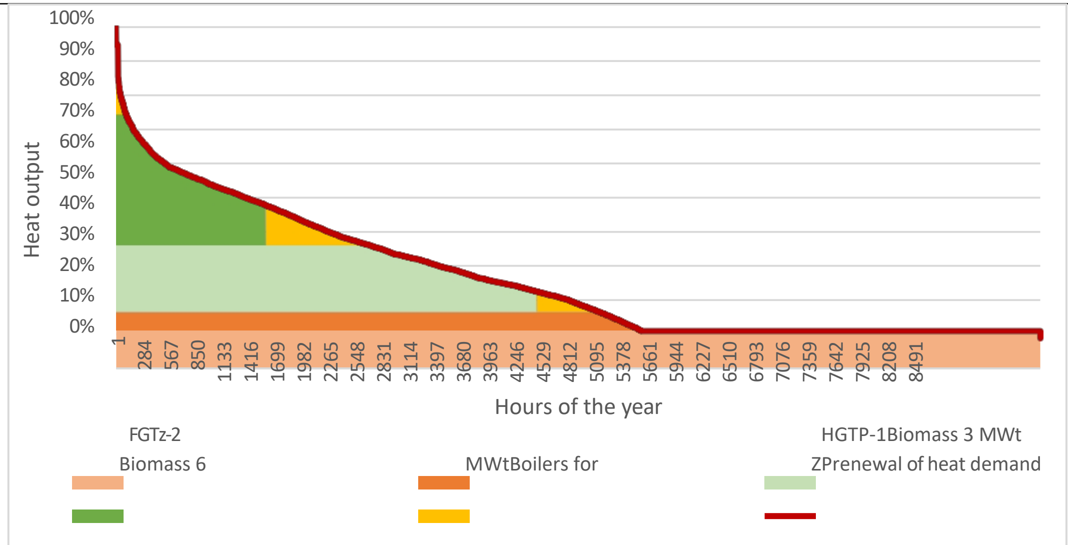
For Option 0, there is no change in the fuel mix, which is based on fossil natural gas. A reduction in sales can be expected heat due to the renovation of buildings.

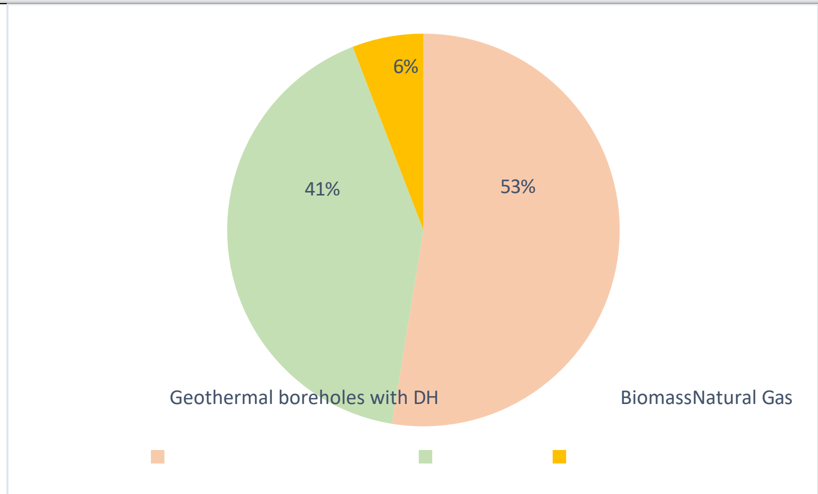
3.3.2 Southern link option

Heat sales: 31,126 GWh/year Heat production: 36, 240 GWh/year

Biomass consumption: 18,147 GWh/year (8,568 tonnes/year)
Electricity consumption: 7,453 GWh/year
Natural gas consumption: 2,312 GWh/year

Garden FGTz-2		
Number of establishments. Hours	[throws]	8 760
Share of annual heat production	[%]	41,42
SPF TC	[-]	3,0
Garden HGTP-1		
Number of establishments. Hours	[throws]	4 970
Share of annual heat production	[%]	11,15
SPF TC	[-]	2,7
Biomass boiler 3 MW		
Number of establishments. Hours	[throws]	3 985
Share of annual heat production	[%]	28,19
Considered efficiency	[%]	83
Biomass boiler 6 MW		
Number of establishments. Hours	[throws]	1 420
Share of annual heat production	[%]	13,37
Considered efficiency	[%]	83
Gas boilers		
Number of establishments. Hours	[throws]	1 660
Share of annual heat production	[%]	3,42
Considered efficiency	[%]	92
Local boiler houses K06,K07, K09, KVB and K24		
Share of annual heat production	[%]	2,45
Considered efficiency	[%]	92





In the case of the southern interconnection option, significant use of renewable energy sources is envisaged. The geothermal borehole FGTz-2 could be used as a basic heat source, which with a thermal output of 1.73 MWt would be able to cover the summer demand. In the heating season, the geothermal borehole HGTP-1 with a thermal output of 0.85 MWt could be used as an additional basic source. As the heating demand increases, the gradual integration of biomass boilers can be considered. For their connection, a minimum heat output of 30% of the rated output was considered as necessary. For better control, the use of natural gas boilers was considered during the start-up periods of the biomass boilers. The fuel mix of the CHP system is based on the use of renewable energy. In the diagram of the duration of the heat output demand, the local boiler houses K06, K07, K09, K Veľké Bielice and K24 are not shown, which were not considered in the hydraulic connection to the larger unit. The heat demand of these local boiler plants represents approximately 3% of the heat demand of the whole CHP system. As far as the fuel mix is concerned, the fuel consumption of these local boiler plants has also been taken into account.

3.3.3 Northern Link Option

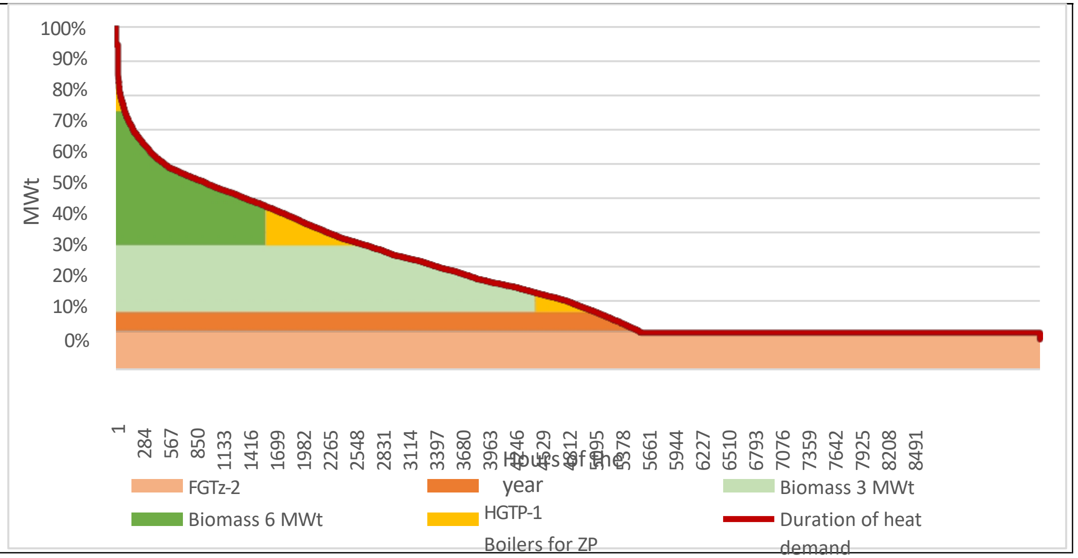
Heat sales: 31,126 GWh/year Heat production: 35, 950 GWh/year

Biomass consumption: 18,147 GWh/year (8,490 tonnes/year) Electricity consumption: 7,398 GWh/year

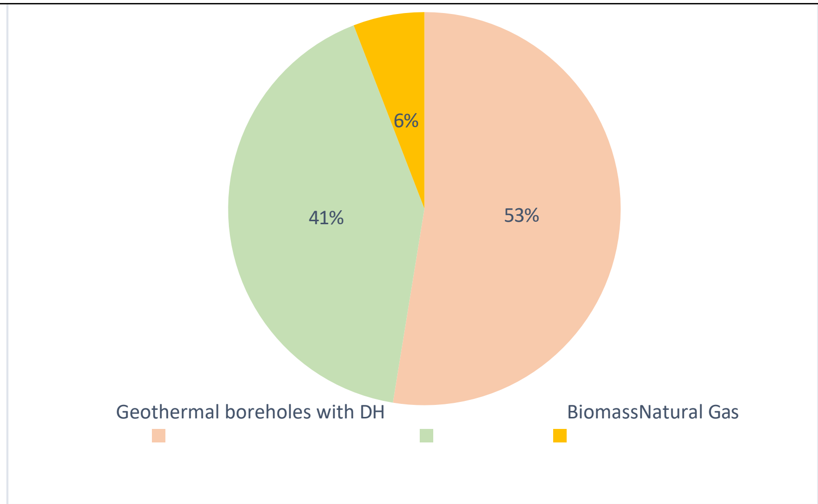
Natural gas consumption: 2,295 GWh/year

Garden FGTz-2		
Number of establishments. Hours	[throws]	8 760
Share of annual heat production	[%]	41,40
SPF TC	[-]	3,0
Garden HGTP-1		
Number of establishments. Hours	[throws]	4 960
Share of annual heat production	[%]	11,20
SPF TC	[-]	2,7

Biomass boiler 3 MW



Number of establishments. Hours	[throws]	3 960
Share of annual heat production	[%]	28,22
Considered efficiency	[%]	83
Biomass boiler 6 MW		
Number of operation. Hours	[throws]	1 410
	[%]	13,30
Share of annual heat production	[%]	83
Considered efficiency		
Gas boilers	[throws]	1 650
Number of establishments. Hours	[%]	3,40
Percentage of annual heat production	[%]	92
Considered efficiency	**B and K24**	
Local boiler houses K06,K07, K09, KV	[%]	2,47
Percentage of annual heat production	[%]	92
Considered efficiency		



In the case of the northern interconnection variant, the use of the FGTz-2 geothermal borehole as a base source with year-round operation is similarly envisaged. The HGTP-1 geothermal borehole is considered as the primary heat source during the heating period. A gradual integration of biomass boilers is envisaged as the heating demand increases. For better control, the use of natural gas boilers has been considered during the start-up periods of the biomass boilers. The fuel mix of the CHP system is based on the use of renewable energy.

3.4 Economic assessment

In the economic assessment, in order to objectively compare the resulting heat prices of the different options, we consider their implementation in the horizon 10 years, i.e. until 2034.

Investment and operating costs including fuel and energy prices (impact of emission permits, etc.) were also estimated for this term.
The individual costs are included in the capital and operating budgets in the respective subchapters of each option. Fuel and electricity

prices are considered at the following levels:

- Estimated price of natural gas: €67/MWh,
- Estimated price of wood chips: 38 eur/MWh[30] (80 Eur/tonne),
- Estimated electricity price: 220 EUR/MWh,
- Estimated price of an emission allowance: €70/tCO2

The unit prices of fuels and electricity quoted may be different in the reference period, which will affect the resulting heat price.

The interest was estimated simplistically as the total interest on an investment of 6% with an amortisation period of 15 years.

3.4.1 Option 0 - Maintaining the status quo

Table 16: Investment costs of Option 0

	Investment costs [EUR without VAT]	**Write-offs** [years]	**Annual depreciation** [years]
Reconstruction of pipelines/connection of objects in boiler house circuits			
Reconstruction of distribution lines in the KD circuit	5 107 089,70	20	255 354,48
Reconstruction of distribution lines in the circuit PK7 and partly PK9	262 615,02	20	13 130,75

[30] Calculated on the basis of the estimated moisture content of the fuel chips (50 %) and their calorific value (7,8 GJ/t).

Installation/refurbishment of heat sources			
Installation of 3 new gas boilers in KD	360 000,00	12	30 000,00
Reconstruction of boiler rooms PK6, PK7, PK9, PK12, PK13, PK14, K15, K16, PK18, PK19, PK20, PK21, PK22, K24, PK_Alpha	242 724,98	12	20 227,08
Interest on investment loan (6% p.a.)	3 099 346	15	206 623,07

The total investment costs for the implementation of Option 0 are **EUR 5 972 429,69 excluding VAT**. If the investment was financed by a loan, the total reimbursement on interest would amount to **EUR 3 099 346 excluding VAT.** The increase in annual depreciation would then be **EUR 525 335,28 excluding VAT.** In the case of Option 0, the possibility of financing the investment with a subsidy is not foreseen, since 66% of the heat produced is provided by fossil natural gas and the mentioned CHP system does not meet the condition of an efficient CHP.

3.4.2 Southern link option

Table 17: Investment costs of the southern link option

	Investment costs [EUR without VAT]	**Write-offs** [years]	**Annual depreciation -without subsidy** [years]	**Annual depreciation - subsidy for TC** [years]	**Annual depreciation - subsidy for heating and distribution** [years]
Linking areas					
Connection of supplied areas - southern variant	9 100 227,19	20	455 011,36	455 011,36	227 505,68
Reconstruction of pipelines/connection of objects in circuits Boiler					
Connection of objects to the KE circuit	556 125,92	20	27 806,30	27 806,30	13 903,15

Connection of objects to the K11 circuit	494 334,15	20	24 716,71	24 716,71	12 358,35

Reconstruction of distribution lines in the KD circuit	5 107 089,70	20	255 354,48	255 354,48	127 677,24
Reconstruction of distribution lines in the circuit PK7 and partly PK9	262 615,02	20	13 130,75	13 130,75	6 565,38
Installation/refurbishment of heat sources					
Heat pump installation for borehole HGTP-1	431 208,33	8	53 901,04	26 950,52	26 950,52
Heat pump installation for FGTZ-2 borehole	881 656,21	8	110 207,03	55 103,51	55 103,51
Installation of 3 new gas boilers in KD	360 000,00	12	30 000,00	30 000,00	30 000,00
Reconstruction of boiler rooms PK9, PK24, PK06, PK07	97 425,75	12	8 118,81	8 118,81	8 118,81
Interest on investment loan (6% p.a.) - without subsidy	8 972 866	15	598 191,07		
Interest on investment loan (6% p.a.) - subsidy for TC	8 632 215	15		575 481,00	
Interest on investment loan (6% p.a.) - subsidy for heating and distribution	4 605 122	15			307 008,12

The total investment costs for the implementation of the southern interconnection variant are **EUR 17 290 682,27 excluding VAT**. If the investment was financed through a loan, the total reimbursement on interest would amount to **EUR 8 972 866 excluding VAT.** The increase in annual depreciation would then be **EUR 1 576 437,55 excluding VAT.**

In the case of the southern interconnection variant, the possibility of financing the investment with a subsidy can also be assumed, as up to 94% of the heat produced is provided by heat pumps using the heat of geothermal boreholes and biomass, which would make the CHP system meet the condition of an efficient CHP system. If the subsidy amounting to 50% of the investment for heat pumps using low-potential heat of geothermal boreholes is used, the total investment costs would slightly decrease to **EUR 16,634,250.00 excluding VAT.** The total interest reimbursement would also be slightly lower at **EUR 8 632 215 excluding VAT.** The increase in annual depreciation would then be **EUR 1 471 673,45 excluding VAT.**

The highest investment burden is the construction of the interconnection of the supplied areas and the reconstruction of the distribution lines and the connection of the objects in the boiler house circuits. If the subsidy of 50 % of the investment for heat pumps and heat distribution systems is used, the total investment costs would fall to **EUR 8 874 054,01 excluding VAT.** The total interest reimbursement would also be lower, at **EUR 4 605 122 excluding VAT.** The increase in annual depreciation would then be **EUR 815 190,77 excluding VAT.** The impact of the subsidy can be seen at two levels, namely **the reduction in the investment intensity of the project and the significant reduction in the total interest reimbursement.**

3.4.3 Northern Link Option

Table 18: Investment costs of the northern link option

	Investment costs [EUR without VAT]	**Write-offs** [years]	**Annual depreciation -without subsidy** [years]	**Annual depreciation - subsidy for TC** [years]	**Annual depreciation - subsidy for heating and distribution** [years]
Linking areas					
Connection of supplied areas - northern variant	4 956 279,48	20	247 813,97	247 813,97	123 906,99
Reconstruction of pipelines/connection of objects in boiler house circuits					
Connection of objects to the KE circuit	556 125,92	20	27 806,30	27 806,30	13 903,15
Connection of objects to the K11 circuit	494 334,15	20	24 716,71	24 716,71	12 358,35
Reconstruction of distribution lines in the KD circuit	5 107 089,70	20	255 354,48	255 354,48	127 677,24
Reconstruction of distribution lines in the circuit PK7 and partly PK9	262 615,02	20	13 130,75	13 130,75	6 565,38
Installation/refurbishment of heat sources					
Heat pump installation for borehole HGTP-1	431 208,33	8	53 901,04	26 950,52	26 950,52
Heat pump installation for FGTZ-2 borehole	881 656,21	8	110 207,03	55 103,51	55 103,51
Installation of 3 new gas boilers in KD	360 000,00	12	30 000,00	30 000,00	30 000,00
Reconstruction of boiler rooms PK9, PK24, PK06, PK07	97 425,75	12	8 118,81	8 118,81	8 118,81
Interest on investment loan (6% p.a.) - without subsidy	6 822 395,80	15	454 826,39		
Interest on investment loan (6% p.a.) - subsidy for TC	6 481 746,60	15		432 116,44	
Interest on investment loan (6% p.a.) - subsidy for heating and distribution	3 529 887,60	15			235 325,84

The total investment costs for the implementation of the northern interconnection variant are **EUR 13 146 734,56 excluding VAT**. If the investment was financed through a loan, the total reimbursement on interest would amount to **EUR 6 822 395,80 excluding VAT.** The increase in annual depreciation would then be **EUR 1 225 875,48 excluding VAT.**

In the case of the northern interconnection variant, the possibility of financing investments with a subsidy can also be assumed, as up to 94% of the heat produced is provided by heat pumps using the heat of geothermal boreholes and biomass, which would make the CHP system meet the condition of an efficient CHP system. If the subsidy amounting to 50% of the investment for heat pumps using low-potential heat of geothermal boreholes is used, the total investment costs would slightly decrease to **EUR 12 490 302,29 excluding VAT.** The total interest reimbursement would also be slightly lower at **EUR 6 481 746,60 excluding VAT.** The increase in annual depreciation would then be **EUR 1,121,111.50 excluding VAT.**

The highest investment burden is the construction of the interconnection of the supplied areas and the reconstruction of the distribution lines and the connection of the objects in the boiler house circuits. With a subsidy of 50 % of the investment for heat pumps and heat distribution systems, the total investment costs would fall to **EUR 6 802 080,16 excluding VAT.** The total interest reimbursement would also be lower, at **EUR 3 529 887,60 excluding VAT.** The increase in annual depreciation would then be **EUR 639 909,79 excluding VAT.** The impact of the subsidy can be seen at two levels, namely **the reduction in the investment intensity of the project and the significant reduction in the total interest reimbursement.**

3.4.4 Comparison of the impact on the price of heat

When comparing the impact on the heat price of the different options, it is necessary to take into account not only the investment costs for implementation, but also the impact of the change in fuel mix as well as the maintenance intensity of the technology to operate.

Emission allowances per tonne of $_{CO2eq.}$ produced have been taken into account in all options, but this impact is most pronounced for Option 0, as the fuel base is based on fossil natural gas. The estimated annual costs for the purchase of emission allowances and pollution charges for Option 0 amounted to approximately EUR 376 thousand.

In the case of the implementation of the northern and southern variants, the increased maintenance requirements for geothermal boreholes and heat pumps have been taken into account.
Within these items, maintenance of filters and borehole, costs for replacement of the submersible pump (approximately every 5 years) have been considered

and maintenance of heat pumps. Increased operating costs are estimated at EUR 54 thousand per year (EUR 16 thousand for the HGTP-1 well and EUR 38 thousand for the FGTZ-2 well). The estimated annual costs for the purchase of emission allowances and pollution charges were approximately EUR 32 thousand for both the northern and southern variants.

Table 19: Impact on the heat price - comparison with the current heat price

Impact on the price of heat - comparison with the current heat price	Parameter	0.variant	without subsidy		with subsidy for CH		with subsidy for heating and distribution	
			southern variant	northern variant	southern variant	northern variant	southern variant	northern variant
Variable component of the maximum heat price	EUR/kWh	0,014	-0,005	-0,005	-0,005	-0,005	-0,005	-0,005
Fixed component of the maximum heat price	EUR/kW	118,69	216,41	170,86	201,85	156,18	110,64	88,79
Unit price	EUR/MWh	**36,39**	**35,83**	**27,34**	**33,09**	**24,57**	**15,88**	**11,85**

When comparing the impact on the heat price of the different options relative to the current heat price, it can be seen that in all cases the unit price of heat would increase. However, it should be stressed that for this analysis the current status of depreciation was not known, which may no longer be reflected in the heat price in the future. Therefore, these values can only be taken as indicative and it is more appropriate to compare the different options with each other.

For the mutual comparison of the impact on the heat price between the individual options, **Option 0 was chosen** as the **reference option**, where it would be the maintenance of the current form of the CHP system with the necessary reconstruction of boiler houses and distribution systems (chap. 3.2.1). Under the northern and southern options, a redesign of the supplied areas is envisaged in order to make greater use of renewable energy sources (3.2.2).

Table 20: Impact on the price of heat - comparison of the options with each other

Impact on the price of heat - comparison of variants with each other	Parameter	0.variant	without subsidy		with subsidy for CH		with subsidy for heating and distribution	
			southern variant	northern variant	southern variant	northern variant	southern variant	northern variant
Variable component of the maximum heat price	EUR/kWh	ref.	-0,019	-0,019	-0,019	-0,019	-0,019	-0,019

Fixed component of the maximum heat price	EUR/kW	ref.	97,72	52,17	83,17	37,50	-8,05	-29,90
Unit price	EUR/MWh	ref.	**-0,562**	**-9,056**	**-3,308**	**-11,825**	**-20,518**	**-24,542**

Comparing with the reference option 0, it can be seen that the unit price of heat would be cheaper if both the southern and northern interconnection options were implemented. The higher investment intensity of both the southern and northern interconnection variants is reflected in an increased fixed component of the maximum heat price, but these variants are operationally cheaper. In addition, the implementation of both the southern and northern interconnection variants opens up the possibility of drawing subsidies to address the creation of an efficient CHP system and to increase the share of the use of renewable sources in the CHP system. If the subsidy for the reconstruction and construction of heat distribution systems and heat pumps is used at the rate of 50% of the total investment, the price of heat could be cheaper by EUR 20.518/MWh in the case of the southern interconnection variant and by up to EUR 24.542/MWh in the case of the northern interconnection variant.

3.5 Evaluation and recommendations

Main advantages and disadvantages of maintaining the status quo of heat management in Partizánske and the considered interconnected CHP systems are summarized in the table below.

Table 21: Comparison of the advantages and disadvantages of the different options

Design variants	Benefits	Disadvantages
Maintaining the status quo	Low investment intensity Low project and the administrative complexity of implementation. No need for external expertise.	Increase in operating costs due to fuel prices and emission permits. High dependence on development energy market prices. Lower predictability of the heat price. Heat price increase.
Variants of southern or northern Links	Reduction of operating costs CZT system. Lower dependence on energy market price developments. Significant use of renewable energy sources. Reducing dependence on fossil fuels fuels. Higher predictability of the heat price. The possibility of using subsidies for investment projects.	High investment intensity. High total reimbursement on interest in case of loan financing and no NFA. High project and the administrative complexity of implementation. Need for external expertise.

Comparison of advantages and disadvantages between the considered options for interconnecting the supplied areas shown in the table below.

Table 22: Inter-comparison of interconnection options

Variants of interconnection	Benefits	Disadvantages
Southern variant Links	Direct connection to boiler house B (second largest supplied area in Luhy)	Higher investment intensity Higher heat price (by approx. 4 EUR/MWh)

	Route running alongside the planned River Star residential area (connection potential) Potential to connect the areas around the K7 and K6 boiler house (by completing the footbridge over the Nitra River)	Higher heat loss of the heat feeder (longer length) The necessity to build its own footbridge over the river Nitra Most of the boiler houses are in the north of the city
Northern variant Links	Lower investment intensity Lower heat price (by approx. 4 EUR/MWh) Direct connection to boiler house D (the largest supplied area in Luhy) Most of the boiler rooms are on the north side cities (south of the route) Shorter heat feeder (lower thermal losses)	Routing in the protection zone of the railway line (necessary negotiation with the railway owner) Connecting the areas around boiler houses K6 and K7 would require excavation work through the city centre

3.6 Staging

The following table proposes an indicative action plan for the hydraulic interconnection of heat supply areas in order to maximise the use of existing and future RES, improve the utilisation of existing heat fuel sources (natural g a s , wood chips) and ensure a more economically efficient and secure heat supply.

Table 23: Indicative action plan for the hydraulic connection of the areas supplied with heat in the city of Partizánske[31]

Step under consideration	Estimated date
Reconstruction of boiler room D	Until the beginning of the heating season 2024/2025
Completion of HDS preparation for FGTZ-2 and HGTP-1 well	2024
Mapping of the condition of the former steam heat distribution routes in the wider city centre (e.g. for the purpose of connecting objects to the boiler house 11 circuit)	2025
HDS implementation for FGTZ-2 and HGTP-1 well	
Elaboration of project documentation for the installation of CHP using geothermal water from the FGTZ-2 borehole[32] and the connection of the heat distribution system from the FGTZ-2 borehole to boiler room D	
Elaboration of project documentation for the installation of CHP using geothermal water from borehole HGTP-1[32] and the connection of the heat distribution system from borehole HGTP-1 to boiler room E	
Preparation of project documentation for the reconstruction of the heat distribution circuit boiler rooms D	
Reconstruction of the heat distribution circuit of boiler house D	2026
Connection of the heat distribution system from the FGTZ-2 borehole to the boiler room D and installation of a CHP plant using geothermal water from the borehole	
Connection of heat distribution from borehole HGTP-1 to boiler room E and installation of CHP using geothermal water from a borehole	
The decision of the city management to merge the objects of the house and smaller block boiler houses into the circuits of the larger block boiler houses in the eastern part of the city Luhov and the wider part of the city centre (reducing the number of connection points)[33]	
The decision of the city management to build one of the interconnection variants the areas of Šípok and Luhov (southern or northern variant)	
Preparation of project documentation for connection of boiler houses K12, K13, K14, K18, K20,K21, K ALFA to boiler room circuit E	2027
Preparation of project documentation[34] interconnection of the supplied areas according to the selected variant and initiation of negotiations with the interested parties pages[35]	2027 - 2029
Preparation of project documentation for connection of boiler houses K19, K16, K15, K22 to boiler house circuit 11	2028
Connection of boiler houses K12, K13, K14, K18, K20,K21, K ALFA to the circuit boiler rooms E	

[31] The action plan does not include activities related to the reconstruction of distribution and boilers, which are not considered in the hydraulic connection, but are part of the thermal management of TSM Partizánske. These activities are included in the calculations of the heat price of the boiler houses PK9, PK7, PK6, PK24.

[32] We consider that HDSwill show positiveresults of thecreationalcapability toproduce long-validated yieldsof the source.

[33] We consider that the decision to extend the circuits of boiler houses K11 and KKE as proposed in this study may be reached.

[34] Including the preparation of the plan for permitting procedures

[35] E.g. for the northern variant it is necessary to start negotiations with theSR Railways.

Connection of boiler house K19, K16, K15, K22 to the boiler house 11 circuit	2029
Construction of the interconnection of the supplied areas according to the selected variant (southern or northern variant)	2030 - 2034
Commissioning	2034

The above stages are only indicatively determined and their timing is up to the city management and other stakeholders.

4 Connection of other objects to the circuit boiler rooms E

Based on the simple analysis of Chapter 2.1, it is clear that boiler house E has a significantly oversized heat output in relation to the consumption capacities of the connected buildings. In the vicinity of the distribution network of boiler house E there are other buildings belonging to the City Property Administration[36] (hereinafter also SMM), or buildings of other private owners, whose heat sources are owned by TSM Partizánske and which are already in advanced age. In the subchapters below it is examined what are the possibilities of their connection to the circuit of boiler house E.

4.1 Analysis of boiler capacity, heat distribution systems and power consumption of buildings in the boiler room E circuit

For the purpose of a more detailed verification of the free capacity of the heat sources installed in boiler room E, the following balance of the consumption of the individual objects was created. The average values of heat consumption for central heating and for TV preparation were calculated from the last five calendar years (2019-2023).

The highest central heating consumption in almost all buildings was recorded in the heating season in 2021, when the coldest winter was recorded. The only exceptions were the apartment building with the enumeration number 145 (maximum reached in 2019) and the apartment building with the enumeration number 61 (maximum in 2020). Max. withdrawals shown in Table 25 were based on the highest measured values of consumption for the central heating system, and were further increased by calculating for the standard day rates (3656 K.day). From the maximum heat demand for DHW determined in this way, the maximum heat input (highest value from the morning, evening or heating peak) was calculated.

The heat consumption for TV preparation was analysed in such a way as to avoid potential bottlenecks on the existing TV distribution lines when determining the dimensions of the new heat distribution lines. All the connected points of use had higher TV consumption than the usual maximum values given by the standard (45 l/person at an occupancy of 40 m2/person for residential buildings). The analysis was therefore based on the maximum values of TV consumption in the observed years, with the addition of a suitable

[36] Správamajetkumesta, n.o., Partizánske-non-profit organizationproviding services of general interestfounded by the City of Partizánske

Fig. 22: Annual CHP consumption of connected buildings

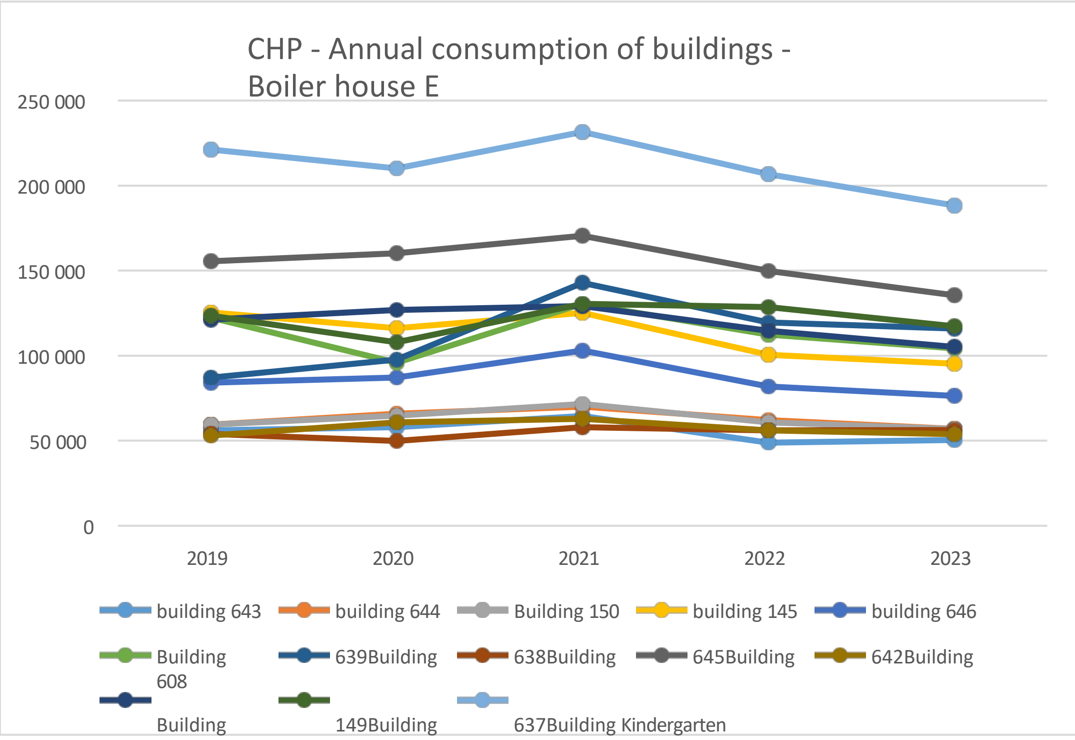


Fig. 23: Annual TV consumption of connected buildings

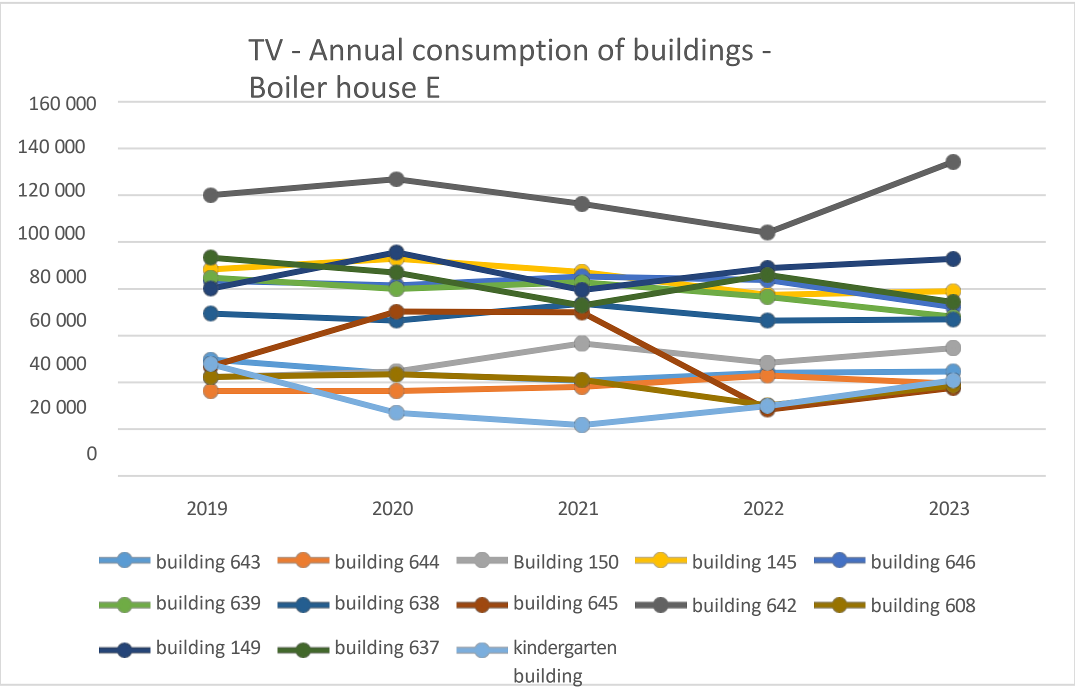


Fig. 24: Evolution of the diurnal range in recent years[37]

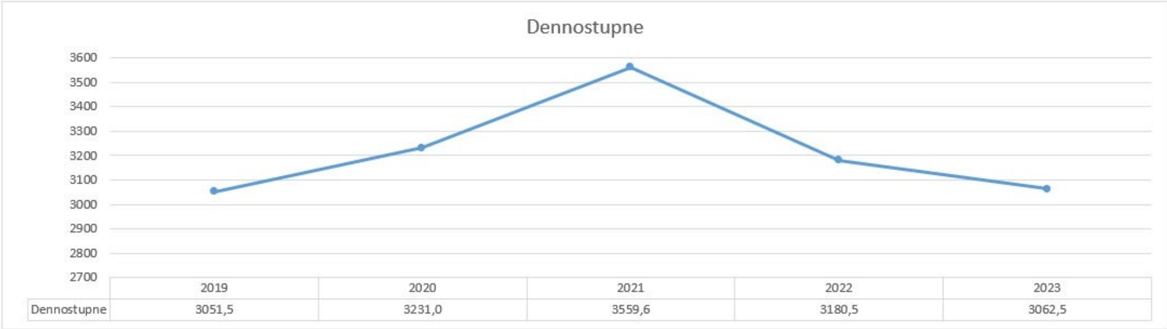


Table 24: Analysis of the objects connected in the boiler house E circuit - deviation from the average value of DHW and TV consumption

blok	2019		2020		2021		2022		2023	
	úk	tuv	úk	tuv	úk	tuv	úk	tuv	úk	tuv
budova 643	1,1%	11,6%	4,2%	-2,0%	16,1%	-8,8%	-12,1%	-1,0%	-9,3%	0,1%
budova 644	-5,4%	-5,9%	4,7%	-5,9%	11,3%	-1,5%	-1,2%	11,2%	-9,5%	2,2%
budova 150	-5,1%	-14,3%	3,2%	-9,4%	14,1%	15,0%	-3,0%	-1,9%	-9,3%	10,7%
budova 145	11,5%	4,0%	3,2%	9,3%	11,3%	2,6%	-10,7%	-8,9%	-15,3%	-7,0%
budova 646	-2,8%	2,7%	0,8%	0,2%	19,1%	5,0%	-5,3%	3,2%	-11,8%	-11,1%
budova 639	8,3%	8,1%	-15,2%	1,9%	15,4%	5,6%	-0,6%	-2,4%	-7,9%	-13,2%
budova 638	-22,6%	1,2%	-13,3%	-3,1%	26,8%	7,4%	6,1%	-3,1%	2,9%	-2,3%
budova 645	-1,4%	-7,5%	-9,1%	38,9%	5,6%	38,2%	2,3%	-44,1%	2,5%	-25,5%
budova 642	0,7%	-0,3%	3,9%	5,5%	10,5%	-3,3%	-2,9%	-13,6%	-12,2%	11,6%
budova 608	-7,5%	8,2%	6,2%	11,0%	9,6%	5,0%	-2,1%	-23,0%	-6,2%	-1,2%
budova 641	-4,2%	-4,3%	11,2%	14,5%	9,0%	6,0%	-4,4%	-20,8%	-11,6%	4,6%
budova 149	1,5%	-8,3%	6,3%	9,4%	8,2%	-9,0%	-4,0%	1,7%	-12,0%	6,2%
budova 637	1,6%	12,8%	-11,2%	5,2%	7,3%	-11,9%	5,7%	4,0%	-3,5%	-10,1%
budova MŠ	4,6%	42,9%	-0,7%	-19,4%	9,4%	-35,0%	-2,3%	-10,7%	-11,0%	22,1%

Table 25: Analysis of objects connected in the boiler house E circuit - average and max. consumption of central heating and TV

Objects	**Average**		**Max. subscriptions**	
	CHP [MWh/year]	**TV [MWh/year]**	**CHP [MWh/year]**	**TV [MWh/year]**
building 643	55,58	44,58	66,30	49,76
building 644	62,93	38,61	71,96	42,93
Building 150	62,74	49,29	73,55	56,66
building 145	112,50	84,97	128,85	92,89
building 646	86,54	81,22	105,82	85,25
building 639	113,11	78,43	134,06	84,79
building 638	112,59	68,57	146,68	73,61
building 645	54,85	50,61	59,52	70,29
building 642	154,33	120,31	175,12	134,29
building 608	57,36	39,15	64,59	43,46

[37] Due to the absence of daily rates for Partizánske, the trend of daily rates was plotted according to the data for the city of Prievidza. The plotting of the trend in the number of daily days in the last five years is for the most part good, moreover, the values of daily days for Prievidza are generally higher (conservative approach).

building 641	62,42	38,80	71,32	44,44
building 149	119,42	87,39	132,68	95,60
building 637	121,55	82,72	134,00	93,32
kindergarten building	211,57	33,42	237,82	47,76
TOTAL	**1 387**	**898**	**1602**	**1015**

Boiler house E has three boilers installed, each with a rated thermal output of 0.95 MW. The boilers are in good condition based on the declaration of TSM Partizánske and can serve for several more years, which was also confirmed by the analysis in Chapter 2.1. The level of oversizing based on its own methodology (Chapter 2.1) showed a power oversizing of 102 %, but the methodology was based on a simple principle and is more suitable for a more global initial assessment of the condition of several heat sources. For a more accurate determination it is better

Table 26: Assessment of the consumption peaks of the objects connected to the circuit of boiler house E in the current state

Connected buildings	Morning subscription peak (kW)	Evening subscription peak (kW)	Heat Engineering peak (kW)	Max. peak (kW)
building 643	56,39	57,51	58,23	58,23
building 644	57,55	55,85	57,36	57,55
Building 150	63,03	64,66	65,37	65,37
building 145	108,32	109,50	111,15	111,15
building 646	91,92	95,25	96,01	96,01
building 639	108,80	106,90	109,40	109,40
building 638	112,72	105,59	109,59	112,72
building 645	59,06	66,83	65,78	66,83
building 642	149,88	153,60	155,31	155,31
building 608	53,28	53,05	54,08	54,08
building 641	57,66	56,47	57,85	57,85
building 149	111,53	112,73	114,43	114,43
building 637	111,58	111,94	113,87	113,87
kindergarten building	159,17	128,74	139,93	159,17
Peak take-up	-	-	-	**1,332 MW**

When estimating heat losses in heat distribution systems and considering the operating efficiency of boilers[38] the boiler plant's heat output is used at the level of about 1.63 MW in the absolute peak demand. Taking into account other factors that may affect heat demand in the future, such as possible changes in the age structure of the customers, the increasing share of home working, etc., the required boiler output may still increase slightly, but **still remains at least 1,2 MW**.

The heat distribution circuit of boiler room E was reconstructed in approximately 2010. The diameters of the heat distribution lines were sized for the consumption of the buildings at that time. Although it is logical to consider that a number of buildings have improved the thermal protection of their envelope and therefore the dimensions of the distribution systems have become slightly oversized (especially the CHP distribution systems), it is still advisable to

[38] Considered efficiency of 90 %of natural gas.

to check the geometry of the pipelines in a balanced way, so that when other objects are connected
bottlenecks in sections of existing pipelines (bottlenecks) do not arise.

Thermos was used for this purpose[39], into whose interface were inserted the counted consumption and consumption power of the objects and plotted the existing distribution network of central heating and TV distribution network from the provided project documentation TSM Partizánske. The program then determined the minimum diameters (DN) of the individual distribution sections. As a rule, if the simulated DN is smaller than the real DN (from the project drawing), the distribution system is oversized in terms of diameter and it is possible to consider connecting additional object(s) to the network.

Table 27: Analysis of the boiler house E circuit heat distribution diameters in the current state

Description of the distribution section[40]	**DN - ÚK real**	**DN - ÚK simulated**	**DN - TV supply real**	**DN - TV inlet simulated**	**DN - TV circulation real**
Branch to the kindergarten building	50	40	25	25	20
The section from the boiler house to branch to 643 and 644 and to the new shaft	200	80	100	65	80
Section to 643 and 644 (after branch to 644)	65	32	40	32	32
Branch to 644	50	32	25	25	20
Branch to 643	50	25	25	25	20
The section from the turn-off to 644 and 643 after the new shaft	150	65	80	65	65
Branch to 645	50	25	32	32	25
The section from the new shaft to 642, 145 and 150 after branch to 642	100	50	50	40	40
Branch to 642	65	40	40	40	32
Section from the turn-off to 642 to the turn-off to 145	65	40	40	32	32
Branch to 145	65	32	32	32	25
Branch to 150	50	32	25	25	20
Section from the new shaft to the branch line to 646	150	65	65	50	50
Branch to 646	150	32	32	32	25
Branch to 641 and 149	80	40	40	32	32
Branch to 641	50	32	25	25	20
Branch to 149	65	32	32	32	25
Detour to 608	50	25	25	25	20
Section to 638, 637 and 639	100	50	50	40	40
Branch to 638	100	40	32	32	25

Branch to 639	65	32	32	32	25
Branch to 637	65	32	32	32	25

[39] https://www.thermos-project.eu/thermos-tool/what-is-thermos/

[40] Heat distribution sections are named descriptively according to the starting point and the end point of the section. The numbers in the descriptions shall be the descriptive number of the pipelines.

As can be seen from the table above, the actual CC distribution averages are in most cases significantly oversized compared to the simulated averages. This evokes that since 2010, the last time the ductwork was refurbished, several properties have undergone building thermal protection refurbishment, or the ductwork was sized for non-actual, higher DH demand during the refurbishment. In the case of the TV distribution systems, there is no longer such a large oversizing, but all distribution sections have the same or smaller simulated diameters compared to the actual diameters in the current state.

From the above it follows that the distribution network of boiler house E has room for connection of other objects, but it depends from which connection point the new connection branch will be led and what parameters (consumption and consumption power) the connected objects will have. These facts are analysed in the next chapter and in the relevant subchapters.

4.2 Analysis of objects with domestic boiler rooms in the vicinity of boiler room E

At a reasonable distance from boiler house E, or from its distribution network, there are several buildings that have their own boiler house installed in the administration of TSM Partizánske (see Fig. 25 and Table 28). Most of the objects are owned by SMM.

Fig. 25: Domestic boiler houses in the vicinity of boiler house E

Source: own processing in Thermos and image editor

Table 28: Domestic boiler houses in the vicinity of the E boiler house distribution network

Mark. boiler rooms	Description of condition	Ownership of the object
PK 18	Domestic boiler house supplies heat to the Partizánske Municipal Office and the Tax Office[41]. The boiler house is in good condition based on the analysis in chapter 2.1, but in reality the boilers are borderline lifetime (declaration of the Partizánske City Council) and the source si currently requires renovation.	City of Partizánske
PK ALFA	Domestic boiler room supplies heat to the building of the same name - Alfa House of Services. Based on the analysis in chapter 2.1, the boilers are outdated and in a state of low reliability of heat supply.	City of Partizánske
PK 13	The house boiler room supplies heat to the multifunctional building (day centre and other services). Based on the analysis in Chapter 2.1, this is a critically low reliability boiler house and all boilers are beyond their useful life.	City of Partizánske
PK 14	The house boiler room supplies heat to the multifunctional building (day centre and other services). Based on the analysis in Chapter 2.1, this is a critically low reliability boiler house and all boilers are beyond their useful life.	Private company - Rent Partizánske, s. r. o.
PK 12	The house boiler room supplies heat to the bachelor house. At Based on the analysis in Chapter 2.1, this is a critically low reliability boiler plant and all boilers are beyond their useful life.	City of Partizánske
PK 21	The domestic boiler room supplies heat to the apartment building. On the basis of the analysis in Chapter 2.1, this is a boiler house with boilers aged between 15 and 25 years and its condition in terms of operational reliability can still be considered good.	City of Partizánske
PK 20	The domestic boiler room supplies heat to the apartment building. On the basis of the analysis in Chapter 2.1, this is a boiler house with boilers aged between 15 and 25 years and its condition in terms of operational reliability can still be considered good.	City of Partizánske

From the point of view of the necessity to avoid a possible emergency condition of one of the analysed boiler houses, it is advisable to verify the possibility of connecting individual boiler house objects to the boiler house E circuit and to prioritise those objects whose house boiler houses are already at the limit of their service life.

The following subsections analyse the possibilities of connecting these objects as well as their impact on the price of heat.

4.2.1 Connection of boiler house PK 18 and PK Alfa

In the variant we consider the connection of the boiler house PK 18 and PK Alfa.

[41] The tax office building is connected to the PK 18 boiler room by an internal distribution pipe for the central heating system.

Table 29: Calculation parameters for the boiler house PK 18 and PK Alfa objects considered for connection to the boiler house E circuit

Objects	Contemporary. boiler room	Subscription of the central heating system [MWh/year]	TV subscription [MWh/year]	Power consumption CHP [kW]	Power consumption TV [kW]
Municipal Office building - Nám. SNP 212	PK 18	370	30	223	20
Building of the State Office - Makarenkova 213	PK 18	139	-	84	-
Building ALFA - Februárová 1478/2	PK ALFA	189	-	114	-

The connection of the objects was considered in two sub-options, based on the connection point of the new distribution branch:

- Connection of the branch line to building 149 (see Fig. 26)
- New branch from the shaft at building 645 (see Fig. 28)

Variant of the extension of the branch leading to building 149

In the case of the variant of the extension of the branch leading to building 149, we consider the connection of new distribution sections from the branch to the apartment building (Fig. 26). The branch extension has been investigated in terms of the impact on the diameters of the existing DHW and HVAC duct sections (Table 30).

Fig. 26: Extension of the distribution branch leading to building 149 (blue - connected section and connected objects)[42]

Source: own processing in Thermos and image editor

[42] The building of the DÚ is only connected to the branch of the central heating system from the project of the Municipal Office, therefore the distribution lines of the central

heating system to the building of the DÚ are not drawn. The tap to the Alfa building is only in the form of a hot water distribution system, since the Alfa building is not supplied with TV.

Table 30: Impact of the connection of boiler house PK 18 and PK Alfa on the DN of the existing pipelines to the boiler house E circuit (variant of the extension of the branch leading to building 149)

Description of the distribution section[43]	**DN - ÚK real**	**DN - ÚK simulated**	**DN - TV supply real**	**DN - TV inlet simulated**	**DN - TV circulation real**
Branch to the kindergarten building	50	40	25	25	20
The section from the boiler house to branch to 643 and 644 and to the new shaft	200	80	100	65	80
Section to 643 and 644 (after branch to 644)	65	32	40	32	32
Branch to 644	50	32	25	25	20
Branch to 643	50	25	25	25	20
The section from the turn-off to 644 and 643 to the new shaft	150	80	80	65	65
Branch to 645	50	25	32	32	25
The section from the new shaft to 642, 145 and 150 after branch to 642	100	50	50	40	40
Branch to 642	65	40	40	40	32
Section from the turn-off to 642 to the turn-off to 145	65	40	40	32	32
Branch to 145	65	32	32	32	25
Branch to 150	50	32	25	25	20
Section from the new shaft to the branch line to 646	150	65	65	50	50
Branch to 646	150	32	32	32	25
Branch to 641 and 149	80	40	40	32	32
Branch to 641	50	32	25	25	20
Branch to 149	65	32	32	32	25
Detour to 608	50	25	25	25	20
Section to 638, 637 and 639	100	50	50	40	40
Branch to 638	100	40	32	32	25
Branch to 639	65	32	32	32	25
Branch to 637	65	32	32	32	25

The addition of the Local Government Building, the DUC, and the Alpha Building by extending the branch line leading to Building 149 increased some simulated diameters of the existing mains compared to Table 27, but no section showed sections with simulated diameters greater than the actual diameters. However, the addition caused that for the TV distribution lines, most of the simulated sections already required the same DN as the actual diameters, even though only the MU takes the TV from the connected buildings (the MU and the Alfa building only take the heat for the CHP). In the next branching of the section,

[43] Divorce sections shall be named descriptively according to the starting point and the ending point of the section. The numbers in the descriptions shall be the descriptive number of the buildings.

possibly with an increase in TV consumption in the objects connected to this branch, could the risk of bottlenecks.

The parameters of the connected section and the parcels through which the section passes are in the tables below. The proposed DNs are the minimum calculated values at which peak demand bottlenecks should not yet occur. The specific DN design is up to the designer. All new sections cross land belonging to the City of Partizánske. Various underground utilities are located on the land[44]which need to be taken into account in the implementation project (parallel lines and crossing). Most of the length of the sections requires excavation only on the green, none of the public roads should be underdrilled. A portion of the driveways and parking lots (asphalt, concrete panels) at the rear entrances to the MUD and Alpha Building will be impacted by excavation. The specific lengths of excavation will depend on the connection points to each building and will be determined in the final design documents.

Table 31: Parameters of the connected heat distribution lines to the boiler room E circuit (variant of the extension of the branch leading to building 149)

Description of the connected distribution section[45]	**Plots of land**	**Engineer. networks/ other obstacles**	**DN - ÚK simulation.**	**DN - TV supply simul.**	**Length of section - greenery [m]**	**Length of section - hard surface [m]**
Section from 149 to the turn-off to ALFA	3710/1 3711/3	external LV underground power lines underground communication lines Slovak Telekom, a.s. underground sewer pipe underground water pipes	65	20	155	16
The section from branches to ALFA after MÚ	3710/1	-	50	20	15	30
Branch to ALFA	3710/1	-	40	-	0 (ÚK only)	36 (ÚK only)

The estimated budget for the implementation amounted to EUR 152 747.04 excluding VAT and the impact on the heat price is summarised in the table below.

[44] On the basis of provideddocumentation of engineeringnetworksfrom the city of Partizánske.

[45] Heat distribution sections are named descriptively according to the starting point and the end point of the section. The numbers in the descriptions shall be the serial numbers of the buildings.

Table 32: Impact on the heat price - connection of boiler house PK 18 and PK Alfa (variant of extension of the branch leading to building 149)

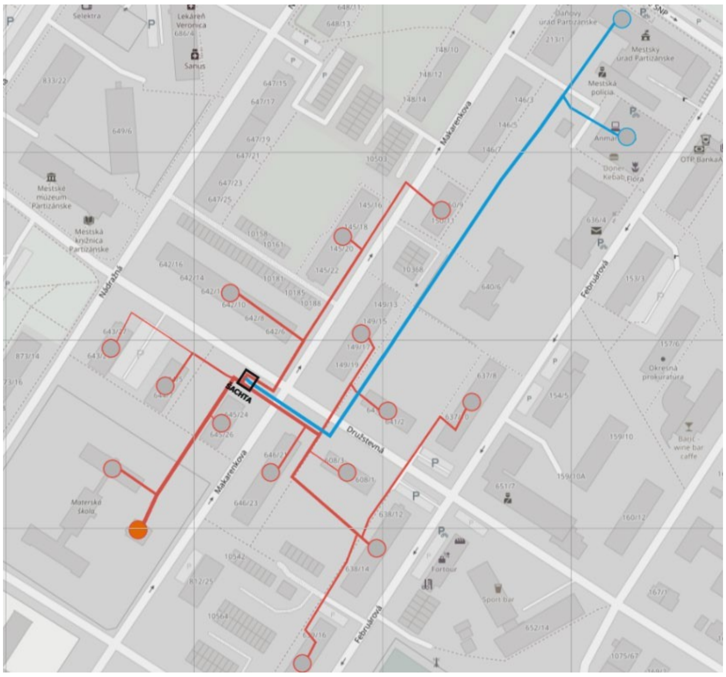
Component of the heat price	Value
Impact on the variable component of the heat price	0,08 Eur without VAT/MWh
Impact on the fixed component of the heat price	1,07 Eur without VAT/kW
Impact on the unit price of heat	0,30 Eur without VAT/MWh

Variant of construction of a new branch from the shaft at building 645

The option of building a new branch from the manhole at building 645 reduced the risk of bottlenecks on the TV branch in the direction of apartment building 149 (see the impact on the DN of the existing heat distribution system in Table 33). However, the connection requires a higher investment cost.

Fig. 27: Location of the shaft in question

Fig. 28: New distribution branch from the shaft at building 645 (blue - connected section and connected objects) [46]



Source: own processing in Thermos and image editor

[46] The building is supplied by the internal branch of the central heating system from the building of the local authority, therefore the distribution of the central heating system to the building of the local authority is not plotted. The branch line to the Alfa building is only in the form of a duct hot water system, since the Alfa object does not receive TV.

Table 33: Impact of the connection of the boiler house PK 18 and PK Alfa on the DN of the existing piping to the boiler house E circuit (variant new distribution branch from the shaft at building 645)

Description of the distribution section[47]	**DN - ÚK real**	**DN - ÚK simulated**	**DN - TV supply real**	**DN - TV inlet simulated**	**DN - TV circulation real**
Branch to the kindergarten building	50	40	25	25	20
The section from the boiler house to branch to 643 and 644 and to the new shaft	200	80	100	65	80
Section to 643 and 644 (after branch to 644)	65	32	40	32	32
Branch to 644	50	32	25	25	20
Branch to 643	50	25	25	25	20
The section from the turn-off to 644 and 643 after the new shaft	150	80	80	65	65
Branch to 645	50	25	32	32	25
The section from the new shaft to 642, 145 and 150 after branch to 642	100	50	50	40	40
Branch to 642	65	40	40	40	32
The section from the turn-off to 642 to the turnoff to 145	65	40	40	32	32
Branch to 145	65	32	32	32	25
Branch to 150	50	32	25	25	20
Section from the new shaft to the branch line to 646	150	65	65	50	50
Branch to 646	150	32	32	32	25
Branch to 641 and 149	80	40	40	32	32
Branch to 641	50	32	25	25	20
Branch to 149	65	32	32	32	25
Detour to 608	50	25	25	25	20
Section to 638, 637 and 639	100	50	50	40	40
Branch to 638	100	40	32	32	25
Branch to 639	65	32	32	32	25
Branch to 637	65	32	32	32	25

The parameters of the connected section and the parcels through which the section from the manhole passes are in the tables below. The proposed DNs are the minimum calculated values at which bottlenecks should not yet occur at peak diversions. The specific DN design is up to the designer. All the new heat distribution lines under consideration pass through land belonging to the City of Partizánske. Various underground utilities are located on the land[48]which need to be taken into account in the implementation project (parallel lines and crossing). The newly built pipelines from the shaft will have to be pushed through two roads (Makarenkova and Družstevná streets). Within the model, we are considering a new distribution line from

[47] Divorce sections shall be named descriptively according to the starting point and the end point of the section. The numbers in the descriptions shall be the descriptive number of the buildings.

[48] On the basis of provideddocumentation of engineeringnetworksfrom the city of Partizánske.

shafts through Makarenkova Street, then through Družstevná Street between buildings 641 and 149. The layout of the section is only indicative, the final decision on the location of the new heat distribution lines is up to the investor and should be justified by the project documentation. Part of the driveways and parking areas (asphalt, concrete panels) at the rear entrances of the Municipal Office and Alfa building will be affected by the excavation. However, most of the sections of the new heat pipes will be routed through green areas (similar to the branch extension option). The specific lengths of the trenches will depend on the connection points to the individual buildings and will be determined in the final design documents.

Table 34: Parameters of the connected heat distribution lines to the boiler house E circuit (variant new distribution branch from the shaft at building 645)

Description of the connected distribution section[49]	Plots of land	Engineer. networks/ other obstacles	DN - ÚK simulation.	DN - TV supply simul.	Length of section - greenery [m]	Length of section - hard surface [m]
Section from the shaft to the branch to ALFA	3615/1 3611/2 3608 3617 3710/1	external LV underground power lines underground communication lines Slovak Telekom, a.s. underground sewer pipe underground water pipes	65	20	250	27
The section from branches to ALFA after MÚ	3710/1	-	50	20	15	33
Branch to ALPHA	3710/1	-	40	-	6 (ÚK only)	31 (ÚK only)

The estimated budget for implementation was EUR 212 158,90 excluding VAT and the impact on the heat price is summarised in the table below.

Table 35: Impact on the heat price - connection of boiler house PK 18 and PK Alfa (new section from the shaft at building 645)

Component of the heat price	Value
Impact on the variable component of the heat price	0,08 Eur without VAT/MWh
Impact on the fixed component of the heat price	1,49 Eur without VAT/kW
Impact on the unit price of heat	0,38 Eur without VAT/MWh

[49] Divorce sections shall be named descriptively according to the starting point and the ending point of the section. The numbers in the descriptions shall be the descriptive number of the buildings.

4.2.2 Connection of boiler house objects PK 18, PK Alfa and PK 13

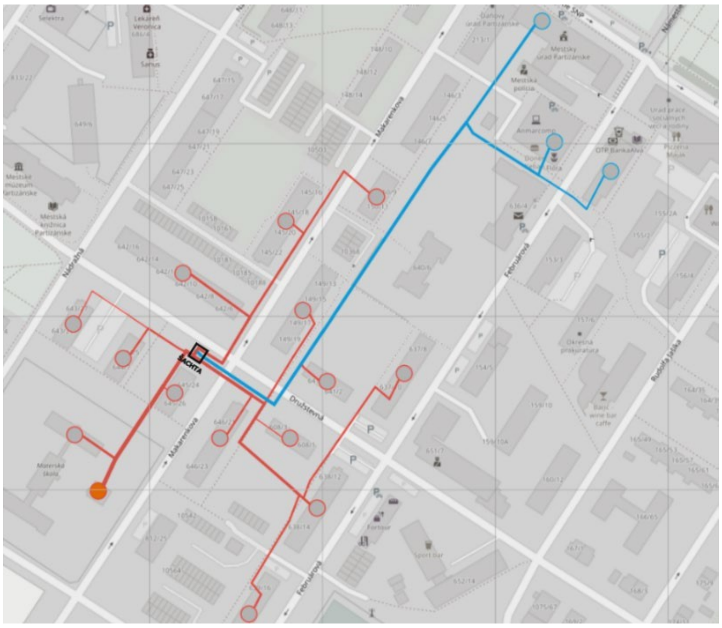
In the variant, in addition to the connection of the boiler house PK 18 and PK Alfa, we also consider the connection of the boiler house PK 13.

Table 36: Calculation parameters for the boiler house PK 18, PK Alfa and PK 13 considered for connection to the boiler house E circuit

Objects	Contemporary. boiler room	Subscription of the central heating system [MWh/year]	TV subscription [MWh/year]	Power consumption CHP [kW]	Power consumption TV [kW]
Municipal Office Building - Square. SNP 212	PK 18	370	30	223	20
Building of the State Office - Makarenkova 213	PK 18	139	-	84	-
Building ALFA - Februárová 1478/2	PK ALFA	189	-	114	-
Building - Februárová 152/1 (PK13)	PK 13	132	21	80	14

Due to the limiting simulated diameters of the TV distribution lines in the sub-option of extending the branch from the apartment house 149, we do not consider this option anymore and we only consider the construction of a new HVAC branch from the shaft at the building 645.

Fig. 29: New distribution branch from the shaft at building 645 (blue - connected section and connected objects PK 18, PK Alfa and PK 13)[50]



Source: own processing in Thermos and image editor

[50] The building is supplied by the internal branch of the central heating system from the building of the local authority, therefore the distribution of the central heating system to the

building of the local authority is not plotted. The branch line to the Alfa building is only in the form of the DHW distribution, as the Alfa building does not receive TV.

The simulated and actual DN of the individual sections on the UK and TV branches can be seen in the table below. None of the sections showed bottlenecks.

Table 37: Impact of the connection of boiler house PK 18, PK Alfa and PK 13 on the DN of the existing pipelines to the boiler house circuit E

Description of the distribution section[51]	**DN - ÚK real**	**DN - ÚK simulated**	**DN - TV supply real**	**DN - TV inlet simulated**	**DN - TV circulation real**
Branch to the kindergarten building	50	40	25	25	20
The section from the boiler house to branch to 643 and 644 and to the new shaft	200	80	100	65	80
Section to 643 and 644 (after branch to 644)	65	32	40	32	32
Branch to 644	50	32	25	25	20
Branch to 643	50	25	25	25	20
The section from the turn-off to 644 and 643 after the new shaft	150	80	80	65	65
Branch to 645	50	25	32	32	25
The section from the new shaft to 642, 145 and 150 after branch to 642	100	50	50	40	40
Branch to 642	65	40	40	40	32
The section from the turn-off to 642 to the turnoff to 145	65	40	40	32	32
Branch to 145	65	32	32	32	25
Branch to 150	50	32	25	25	20
Section from the new shaft to the branch line to 646	150	65	65	50	50
Branch to 646	150	32	32	32	25
Branch to 641 and 149	80	32	25	25	20
Branch to 641	50	32	25	25	20
Branch to 149	65	32	32	32	25
Detour to 608	50	25	25	25	20
Section to 638, 637 and 639	100	50	50	40	40
Branch to 638	100	40	32	32	25
Branch to 639	65	32	32	32	25
Branch to 637	65	32	32	32	25

The parameters of the connected section and the parcels through which the section from the manhole passes are in the tables below. The proposed DNs are the minimum calculated values at which bottlenecks should not yet occur at peak diversions. The specific DN design is up to the designer. All the new heat distribution lines under consideration pass through land belonging to the City of Partizánske. Various underground utilities are located on the land[52]which need to be

[51] Divorce sections shall be named descriptively according to the starting point and the ending point of the section. The numbers in the descriptions shall be the descriptive number of the buildings.

[52] On the basis of the provided documentation of the engineering networks of the city of Partizánske.

to be taken into account in the implementation project (parallel lines and crossing). The newly constructed distribution lines from the shaft will have to be pushed through three roads - through Makarenkova and Družstevná streets for the lines pulled from the shaft similarly as in the previous variant and through Februárová street between the buildings of the Alfa boiler house and the PK13 boiler house. The layout of the distribution branch is only indicative and the final position is up to the agreement of the investor and the designer.

Table 38: Parameters of the connected heat distribution lines to the boiler house E circuit (connected objects PK18, PK Alfa and PK13)

Description of the connected distribution section[53]	**Plots of land**	**Engineer. networks/other obstacles**	**DN - ÚK simulation.**	**DN - TV inlet simulation.**	**Length of section - green [m]**	**Length of section - hard surface [m]**
Section from the shaft to the branch line to ALFA and 152	3615/1 3611/2 3608 3617 3710/1	external LV underground power lines underground communication lines Slovak Telekom, a.s. underground sewer pipe	65	25	198	57
Section from the turn-off to ALFA and 152 to the branch line ALPHA	3710/1 3724	?[54]	50	25	53	0
Branch to ALPHA	3710/1	? [54]	40	-	8 (ÚK only)	9 (ÚK only)
Branch k 152	3710/1 3551 3294/5 3294/6	? [54]	32	20	17	40
The section from Branches ALFA after MÚ	3710/1	-	50	20	35	35

The estimated budget for implementation was EUR 275 645.86 excluding VAT and the impact on the heat price is summarised in the table below.

[53] Divorce sections shall be named descriptively according to the starting point and the ending point of the section. The numbers in the descriptions shall be the descriptive number

of the buildings.

[54] The utility design documentation provided did not include detailed drawings of the land in question and therefore it is not possible to determine what underground utilities run through the land.

Table 39: Impact on the heat price - connection of boiler house PK 18, PK Alfa and PK 13

Component of the heat price	Value
Impact on the variable component of the heat price	0,09 Eur without VAT/MWh
Impact on the fixed component of the heat price	1,94 Eur without VAT/kW
Impact on the unit price of heat	0,47 Eur without VAT/MWh

4.2.3 Connection of boiler house objects PK 18, PK Alfa, PK 13 and PK 14

To the previous variant of connection of the boiler house PK18, PK Alfa and PK13, the boiler house PK14 was also connected.

Table 40: Calculation parameters for boiler house PK 18, PK Alfa, PK 13 and PK 14 considered for connection to the boiler house circuit E

Objects	Contemporary. boiler room	Subscription of the central heating system [MWh/year]	TV subscription [MWh/year]	Power consumption CHP [kW]	Power consumption TV [kW]
Municipal Office Building - Square. SNP 212	PK 18	370	30	223	20
Building of the State Office - Makarenkova 213	PK 18	139	-	84	-
Building ALFA - Februárová 1478/2	PK ALFA	189	-	114	-
Building - Februárová 152/1 (PK13)	PK 13	132	21	80	14
Building - Rudolfa Jasika 156 (PK14)	PK 14	143	41	87	27

Due to the limiting simulated diameters of the TV distribution lines in the case of the extended branch to the Municipal Office building from the apartment building 149, we no longer consider this sub-option and only consider the construction of a new branch of the central heating and TV from the shaft at the building 645.

Fig. 30: New distribution branch from the shaft at building 645 (blue - connected section and connected objects PK 18, PK Alfa, PK 13 and PK 14) [55]

Source: own processing in Thermos and image editor

Table 41: Impact of the connection of boiler house PK 18, PK Alfa, PK 13 and PK 14 on the DN of the existing pipelines to the boiler house circuit E

Description of the distribution section[56]	**DN - ÚK real**	**DN - ÚK simulated**	**DN - TV supply real**	**DN - TV inlet simulated**	**DN - TV circulation real**
Branch to the kindergarten building	50	40	25	25	20
The section from the boiler house to branch to 643 and 644 and to the new shaft	200	100	100	65	80
Section to 643 and 644 (after branch to 644)	65	32	40	32	32
Branch to 644	50	32	25	25	20
Branch to 643	50	25	25	25	20
The section from the turn-off to 644 and 643 after the new shaft	150	80	80	65	65
Branch to 645	50	25	32	32	25
The section from the new shaft to 642, 145 and 150 after branch to 642	100	50	50	40	40
Branch to 642	65	40	40	40	32

[55] The building of the DÚ is only connected to the branch of the central heating system from the project of the Municipal Office, therefore the distribution lines of the central heating system to the building of the DÚ are not drawn. The tap to the Alfa building is only in the form of a DHW distribution line, as the Alfa building does not receive a TV.

[56] Divorce sections shall be named descriptively according to the starting point and the end point of the section. The numbers in the descriptions shall be the descriptive number of the buildings.

The section from the turn-off to 642 to the turnoff to 145	65	40	40	32	32
Branch to 145	65	32	32	32	25
Branch to 150	50	32	25	25	20
Section from the new shaft to the branch line to 646	150	65	65	50	50
Branch to 646	150	32	32	32	25
Branch to 641 and 149	80	65	40	32	32
Branch to 641	50	32	25	25	20
Branch to 149	65	32	32	32	25
Detour to 608	50	50	25	25	20
Section to 638, 637 and 639	100	50	50	50	40
Branch to 638	100	40	32	32	25
Branch to 639	65	32	32	32	25
Branch to 637	65	32	32	32	25

The parameters of the connected section and the parcels through which the section from the manhole passes are in the tables below. The proposed DNs are the minimum calculated values at which bottlenecks should not yet occur at peak diversions. The specific DN design is up to the designer. All the new heat distribution lines under consideration pass through land belonging to the City of Partizánske. There are various underground utilities on the land[57]which need to be taken into account in the implementation project (parallel lines and crossing). The newly constructed pipelines from the shaft will have to be pushed through three roads (Makarenkova and Družstevná Streets for the pipelines immediately from the shaft and Februárová Street between the buildings of boiler house Alfa and boiler house PK13). The section from boiler houses PK13 and PK14 will require the dismantling of paved areas (pavements, parking lots, pavement, etc.). The laying of the distribution branch is only indicative and the final position is up to the agreement of the investor and the designer.

Table 42: Parameters of the connected heat distribution lines to the boiler house E circuit (connected objects PK 18, PK Alfa, PK13 and PK14)

Description of the connected distribution section[58]	**Plots of land**	**Engineer. networks/other obstacles**	**DN - ÚK simulation.**	**DN - TV inlet simulation.**	**Length of section - green [m]**	**Length of section - hard surface [m]**
Section from the shaft to the branch line to ALFA, 152 and 156	3615/1 3611/2 3608 3617 3710/1	external LV underground power lines underground communication lines Slovak Telekom, a.s.	65	32	198	57

[57] On the basis of provideddocumentation of engineeringnetworksfrom the city of Partizánske.

[58] Divorce sections shall be named descriptively according to the starting point and the ending point of the section. The numbers in the descriptions shall be the descriptive number of the buildings.

		underground sewer pipe				
Section from the turn-off to ALFA and 152 to the branch line ALFA	3710/1 3724	?	50	25	45	0
Branch to ALFA	3710/1	?[59]	40	-	9 (ÚK only)	12 (ÚK only)
Section from the turn-off to ALFA to the taps 152	3710/1 3551 3294/5	?[59]	40	25	43	0
Branch k 152	3294/5 3294/6	?[59]	32	20	0	22
The section from Branches ALFA after MÚ	3710/1	-	50	20	35	35
Branch to 156	3294/5 3287/3 3297/5	external LV underground power lines external power lines HV underground underground communication lines Slovak Telekom, a.s. undergroun d gas pipeline STL	40	25	12	98

The estimated budget for implementation was EUR 354 945.23 excluding VAT and the impact on the heat price is summarised in the table below.

Table 43: Impact on the heat price - connection of boiler house PK 18, PK Alfa, PK 13 and PK 14 (new section from the shaft at building 645)

Component of the heat price	**Value**
Impact on the variable component of the heat price	0,09 Eur without VAT/MWh
Impact on the fixed component of the heat price	2,49 Eur without VAT/kW
Impact on the unit price of heat	0,57 Eur without VAT/MWh

[59] The utility design documentation provided did not include detailed drawings of the land in question and therefore it is not possible to determine what underground utilities run through the land.

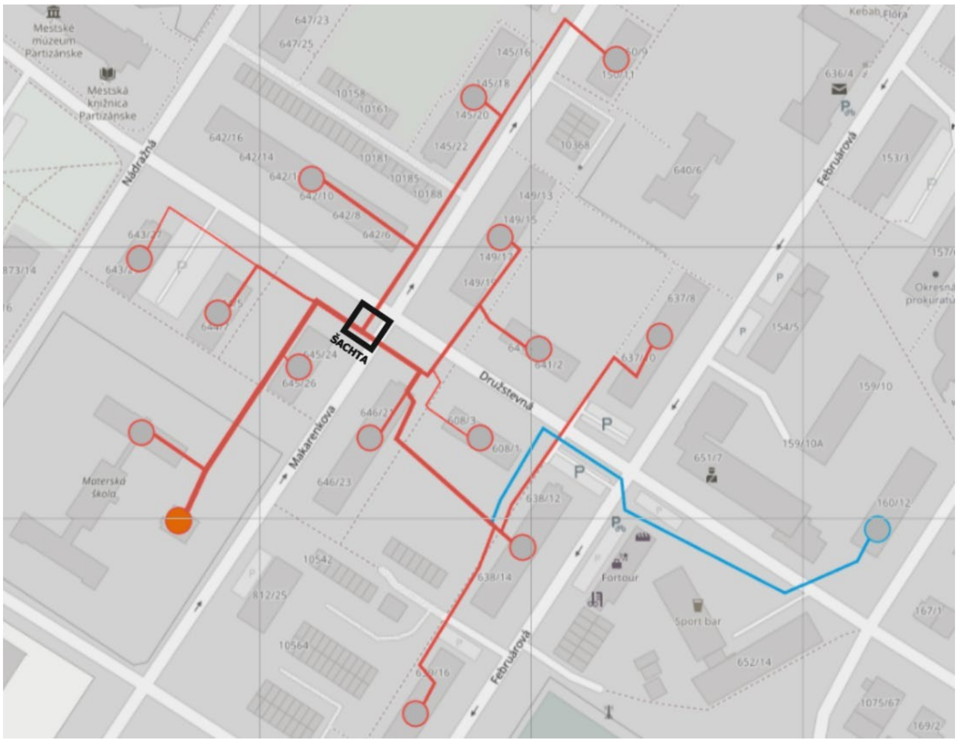
4.2.4 Connection of objects of boiler house PK12

In the variant we consider the connection of the boiler house PK12. Due to the location of the building, we consider connecting the building to the existing section between the apartment house 646 and 638 (DHW distribution with DN100, TV supply with DN50, TV circulation with DN40). Potentially, the building could be connected to a shorter distance, namely to the section between 638 and 637, but the diameter of this section for TV would probably not be sufficient in peak demand and would risk creating a bottleneck.

Table 44: Calculation parameters for the boiler house PK 12 considered for connection to the boiler house E circuit

Objects	Contemporary. boiler room	CHP consumption [MWh/year]	TV consumption [MWh/year]	Power consumption CHP [kW]	Power consumption TV [kW]
Building - Rudolfa Jasika 160 (PK12)	PK 12	128	40	77	27

Fig. 31: Connection of the boiler house PK12 (blue - connected section and connected objects)



Source: own processing in Thermos and image editor

Table 45: Impact of the connection of the boiler house PK 12 on the DN of the existing piping to the boiler house E circuit

Description of the distribution section[60]	DN - ÚK real	DN - ÚK simulated	DN - TV supply real	DN - TV inlet simulated	DN - TV circulation real
Branch to the kindergarten building	50	40	25	25	20
The section from the boiler house to branch to 643 and 644 and to the new shaft	200	80	100	65	80
Section to 643 and 644 (after branch to 644)	65	32	40	32	32
Branch to 644	50	32	25	25	20
Branch to 643	50	25	25	25	20
The section from the turn-off to 644 and 643 after the new shaft	150	80	80	65	65
Branch to 645	50	25	32	32	25
The section from the new shaft to 642, 145 and 150 after branch to 642	100	50	50	40	40
Branch to 642	65	40	40	40	32
The section from the turn-off to 642 to the turnoff to 145	65	40	40	32	32
Branch to 145	65	32	32	32	25
Branch to 150	50	32	25	25	20
Section from the new shaft to the branch to 646	150	65	65	50	50
Branch to 646	150	32	32	32	25
Branch to 641 and 149	80	40	40	40	32
Branch to 641	50	32	25	25	20
Branch to 149	65	32	32	32	25
Detour to 608	50	25	25	25	20
Section to 638, 637 and 639	100	50	50	40	40
Branch to 638	100	40	32	32	25
Branch to 639	65	32	32	32	25
Branch to 637	65	32	32	32	25

The parameters of the connected section and the parcels through which the considered section passes are in the tables below. The proposed DNs are the minimum calculated values at which peak demand bottlenecks should not yet occur. The specific DN design is up to the designer. All the new heat distribution lines under consideration passed through land belonging to the City of Partizánske. Various underground utilities are located on the land[61] which need to be taken into account in the implementation project (parallel lines and crossing). The newly constructed lines will have to be pushed through at least two roads (Februárová and Družstevná streets) and two access roads (the car park at building 638 and the access to building 652). Connecting the building will probably require digging up the adjacent

[60] Divorce sections shall be named descriptively according to the starting point and the end point of the section. The numbers in the descriptions shall be the descriptive number of the buildings.

[61] On the basis of provideddocumentation of engineeringnetworksfrom the city of Partizánske.

parking by the boiler house (building 160). The location of the distribution branch is only indicative and the final opinion is up to the agreement of the investor and the designer.

Table 46: Parameters of the connected heat distribution lines to the boiler house E circuit (connected building PK 12)

Description of the connected distribution section[62]	**Plots of land**	**Engineer. networks/other obstacles**	**DN - ÚK simulation.**	**DN - TV inlet simulation.**	**Length of section - green [m]**	**Length of section - hard surface [m]**
Connection from section to 638, 637 and 639 to 160	3608 3551 3307/2 3305/3 3307/1 3304 3303	external LV underground power lines underground communication lines Slovak Telekom, a.s. underground water pipes existing route OK Orange a.s. underground gas pipeline STL route of the trench for the optical network with overpressure (or overdigging) underground sewer pipe	32	25	124	69

The estimated budget for implementation was EUR 101 855.32 excluding VAT and the impact on the heat price is summarised in the table below.

Table 47: Impact on the heat price - connection of boiler house PK12

Component of the heat price	**Value**
Impact on the variable component of the heat price	0,01 Eur without VAT/MWh
Impact on the fixed component of the heat price	0,72 Eur without VAT/kW
Impact on the unit price of heat	0,13 Eur without VAT/MWh

[62] Divorce sections shall be named descriptively according to the starting point and the ending point of the section. The numbers in the descriptions shall be the descriptive number of the buildings.

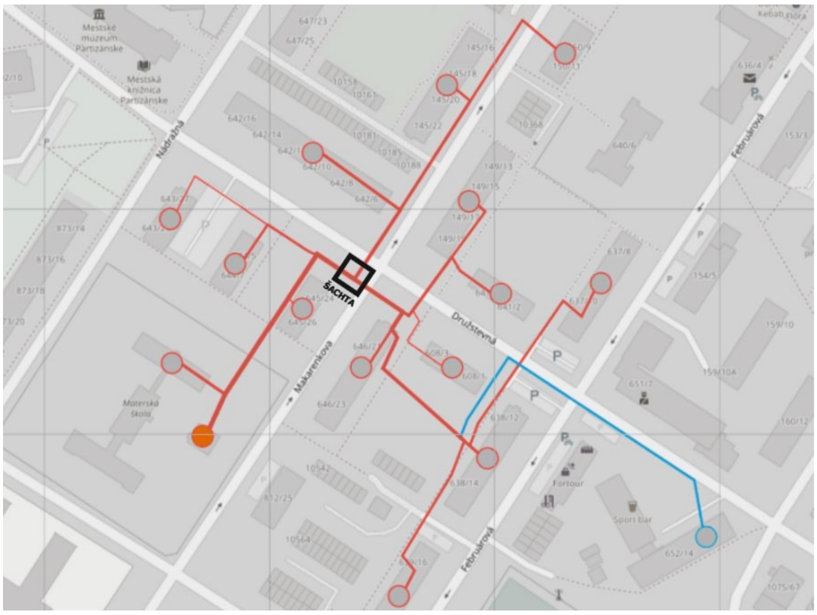
4.2.5 Connection of objects of boiler house PK21

In the variant we consider the connection of the boiler house PK21. Due to the location of the building, we consider the connection of the building to the section between the apartment house 646 and 638 (similarly to the connection of the boiler house PK21). Potentially, the building could be connected to a shorter distance, namely to the section between 638 and 637, but the diameter of this section for TV would probably not be sufficient in peak demand and would risk creating a bottleneck.

Table 48: Calculation parameters for the boiler house PK 21 considered for connection to the boiler house circuit E

Objects	Contemporary. boiler room	Subscription of the central heating system [MWh/year]	TV subscription [MWh/year]	Power consumption CHP [kW]	Power consumption TV [kW]
Building - Rudolfa Jasik 652 (PK21)	PK 21	134	54	81	36

Fig. 32: Connection of the boiler house PK21 (blue - connected section and connected objects)



Source: own processing in Thermos and image editor

Table 49: Impact of the connection of the boiler house PK 21 on the DN of the existing piping to the boiler house circuit E

Description of the distribution section[63]	DN - ÚK real	DN - ÚK simulated	DN - TV inlet real	DN - TV inlet simulated	DN - TV Circulation real
Branch to the kindergarten building	50	40	25	25	20
The section from the boiler house to branch to 643 and 644 and to the new shaft	200	80	100	65	80

[63] Divorce sections shall be named descriptively according to the starting point and the ending point of the section. The numbers in the descriptions shall be the descriptive number of the buildings.

Section to 643 and 644 (after branch to 644)	65	32	40	32	32
Branch to 644	50	32	25	25	20
Branch to 643	50	25	25	25	20
The section from the turn-off to 644 and 643 after the new shaft	150	80	80	65	65
Branch to 645	50	25	32	32	25
The section from the new shaft to 642, 145 and 150 after branch to 642	100	50	50	40	40
Branch to 642	65	40	40	40	32
Section from the turn-off to 642 to the turn-off to 145	65	40	40	32	32
Branch to 145	65	32	32	32	25
Branch to 150	50	32	25	25	20
Section from the new shaft to the branch line to 646	150	65	65	50	50
Branch to 646	150	32	32	32	25
Branch to 641 and 149	80	40	40	40	32
Branch to 641	50	32	25	25	20
Branch to 149	65	32	32	32	25
Detour to 608	50	25	25	25	20
Section to 638, 637 and 639	100	50	50	40	40
Branch to 638	100	40	32	32	25
Branch to 639	65	32	32	32	25
Branch to 637	65	32	32	32	25

The parameters of the connected section and the parcels through which the considered section passes are in the tables below. The proposed DNs are the minimum calculated values at which peak demand bottlenecks should not yet occur. The specific DN design is up to the designer. All the new heat distribution lines under consideration passed through land belonging to the City of Partizánske. Various underground utilities are located on the land[64]which need to be taken into account in the implementation project (parallel lines and crossing). The newly constructed pipelines will have to be pushed through at least one road (Februárová Street) and two access roads (parking lot at building 638 and access to building 652). The location of the distribution branch is only indicative and the final position is up to the agreement of the investor and the designer.

[64] On the basis of provideddocumentation of engineeringnetworksfrom the city of Partizánske.

Tab. 50: Parameters of the connected heat distribution lines to the boiler room E circuit (connected building PK 21)

Description of the connected distribution section[65]	Plots of land	Engineer. networks/other obstacles	DN - ÚK simulation.	DN - TV inlet simulation.	Length of section - green [m]	Length of section - hard surface [m]
Connection from section to 638, 637 and 639 to 652	3608 3551 3307/3 3307/1 3305/3	external LV underground power lines underground communication lines Slovak Telekom, a.s. underground water pipes existing route OK Orange a.s. underground gas pipeline STL route of the trench for the optical network with overpressure (resp. by trenching)	32	25	120	44

The estimated budget for implementation was EUR 81 731.87 excluding VAT and the impact on the heat price is summarised in the table below.

Tab. 51: Impact on the heat price - connection of boiler house PK21

Component of the heat price	Value
Impact on the variable component of the heat price	0,01 Eur without VAT/MWh
Impact on the fixed component of the heat price	0,57 Eur without VAT/kW
Impact on the unit price of heat	0,11 Eur without VAT/MWh

[65] Divorce sections shall be named descriptively according to the starting point and the ending point of the section. The numbers in the descriptions shall be the descriptive number of the buildings.

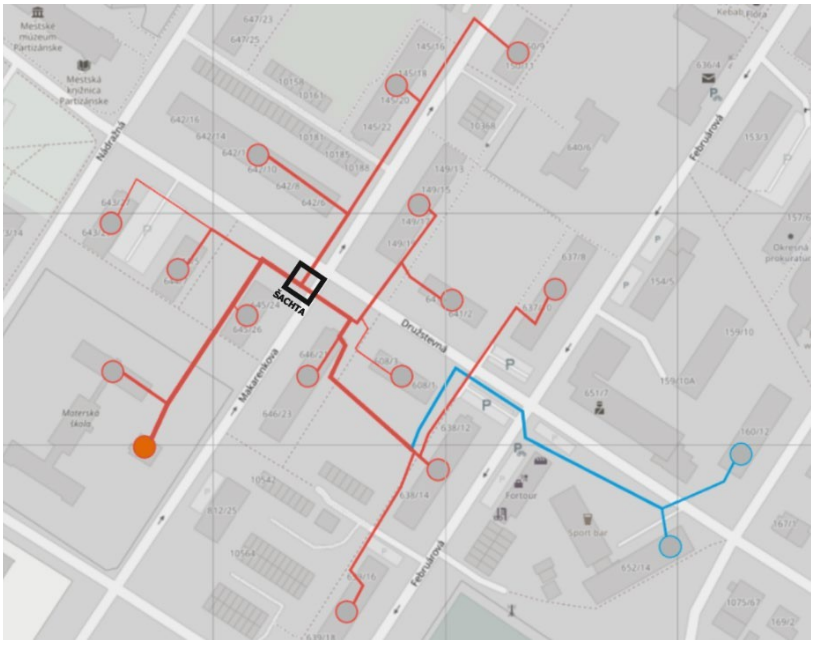
4.2.6 Connection of boiler house objects PK12 and PK21

Due to the fact that the branch line in case of connecting objects PK12 and PK21 can be largely shared, the possibility of connecting both objects at the same time was also analysed.

Tab. 52: Calculation parameters for boiler house PK 12 and PK 21 objects considered for connection to the boiler house circuit E

Objects	**Contemporary. boiler room**	**CHP consumption [MWh/year]**	**TV consumption [MWh/year]**	**Power consumption CHP [kW]**	**Power consumption TV [kW]**
Building - Rudolfa Jasika 160 (PK12)	PK 12	128	40	77	27
Building - Rudolfa Jasik 652 (PK21)	PK21	134	54	81	36

Fig. 33: Connection of the boiler house PK12 and PK21 (blue - connected section and connected objects)



Source: own processing in Thermos and image editor

Tab. 53: Impact of the connection of boiler house PK 12 and PK 21 on the DN of the existing pipelines to the boiler house circuit E

Description of the distribution section[66]	**DN - ÚK real**	**DN - ÚK simulated**	**DN - TV supply real**	**DN - TV inlet simulated**	**DN - TV circulation real**
Branch to the kindergarten building	50	40	25	25	20
The section from the boiler house to branch to 643 and 644 and to the new shaft	200	80	100	65	80

[66] The conduit sections shall be named descriptively according to the starting point and the end point of the section. The numbers in the descriptions shall be the serial numbers of the buildings.

Section to 643 and 644 (after branch to 644)	65	32	40	32	32
Branch to 644	50	32	25	25	20
Branch to 643	50	25	25	25	20
The section from the turn-off to 644 and 643 after the new shaft	150	80	80	65	65
Branch to 645	50	25	32	32	25
The section from the new shaft to 642, 145 and 150 after branch to 642	100	50	50	40	40
Branch to 642	65	40	40	40	32
Section from the turn-off to 642 to the turn-off to 145	65	40	40	32	32
Branch to 145	65	32	32	32	25
Branch to 150	50	32	25	25	20
Section from the new shaft to the branch line to 646	150	65	65	50	50
Branch to 646	150	32	32	32	25
Branch to 641 and 149	80	40	40	40	32
Branch to 641	50	32	25	25	20
Branch to 149	65	32	32	32	25
Detour to 608	50	25	25	25	20
Section to 638, 637 and 639	100	50	50	50	40
Branch to 638	100	40	32	32	25
Branch to 639	65	32	32	32	25
Branch to 637	65	32	32	32	25

The parameters of the connected section and the parcels through which the considered section passes are in the tables below. The proposed DNs are the minimum calculated values at which peak demand bottlenecks should not yet occur. The specific DN design is up to the designer. All the new heat distribution lines under consideration passed through land belonging to the City of Partizánske. The layout of the distribution branch is only indicative and the final position is up to the agreement of the investor and the designer.

Tab. 54: Parameters of the connected heat distribution lines to the boiler house E circuit (connection variant of buildings PK 12 and PK 21)

Description of the connected distribution section[67]	Plots of land	Engineer. networks/other obstacles	DN - ÚK simulation.	DN - TV inlet simulation.	Length of section - green [m]	Length of section - hard surface [m]
Connection from section to 638, 637 a 639	3608 3551 3307/2 3305/3	external LV underground power lines	40	32	120	34

[67] Divorce sections shall be named descriptively according to the starting point and the ending point of the section. The numbers in the descriptions shall be the descriptive number of the buildings.

to the taps 160 a 652		underground communication lines Slovak Telekom, a.s. underground water pipes existing route OK Orange a.s. undergroun d gas pipeline STL route of the trench for the optical network with overpressure (resp. overdigging				
Branch k 160	3305/3 3307/1 3304 3303	undergroun d gas pipeline STL existing route OK Orange a.s. underground sewer pipe	32	25	0	39
Branch to 652	3305/3 3307/1	-	32	25	0	13

The estimated budget for implementation was EUR 120 591,07 excluding VAT and the impact on the heat price is summarised in the table below.

Tab. 55: Impact on the heat price - connection of boiler house PK12 and PK21

Component of the heat price	**Value**
Impact on the variable component of the heat price	0,02 Eur without VAT/MWh
Impact on the fixed component of the heat price	0,85 Eur without VAT/kW
Impact on the unit price of heat	0,16 Eur without VAT/MWh

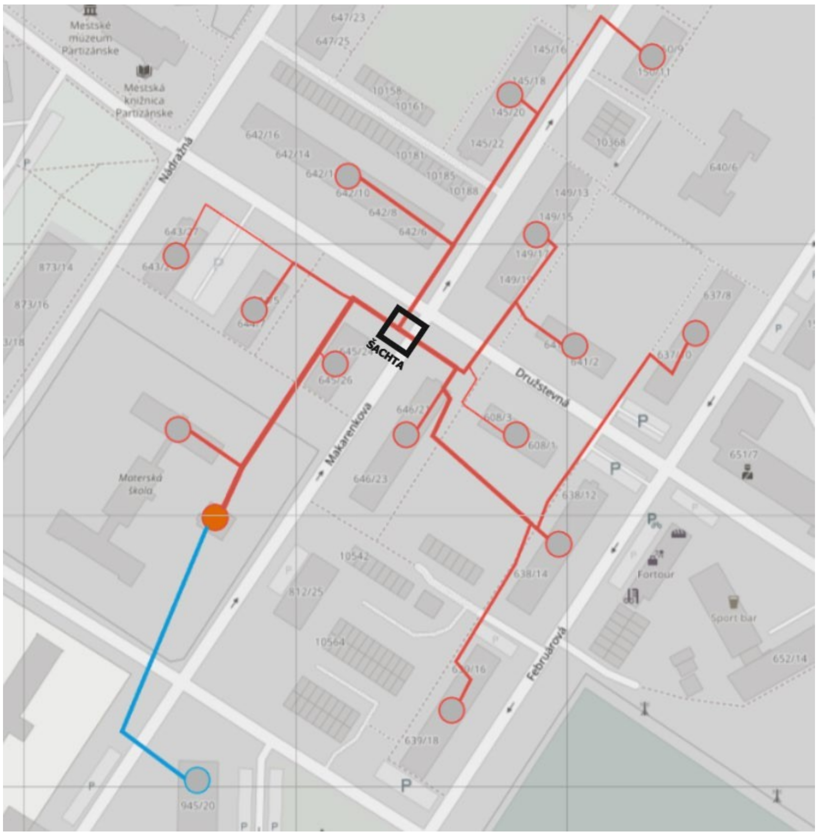
4.2.7 Connection of objects of boiler house PK20

The connection of the boiler house PK20 is considered directly from boiler house E, since PK20 on the opposite
side compared to the other objects under consideration.

Tab. 56: Calculation parameters for the boiler house PK 21 considered for connection to the boiler house circuit E

Objects	**Contemporary. boiler room**	**Subscription of the central heating system [MWh/year]**	**TV subscription [MWh/year]**	**Power consumption CHP [kW]**	**Power consumption TV [kW]**
Building - Februárová 945 (PK20)	PK 20	302	153	183	101

Fig. 34: Connection of the boiler house PK20 (blue - connected section and connected objects)



Source: own processing in Thermos and image editor

Tab. 57: Effect of the connection of the boiler house PK20 on the DN of the existing pipelines to the boiler house circuit E

Description of the distribution section[68]	**DN - ÚK real**	**DN - ÚK simulated**	**DN - TV supply real**	**DN - TV inlet simulated**	**DN - TV circulation real**
Branch to the kindergarten building	50	40	25	25	20

[68] Divorce sections shall be named descriptively according to the starting point and the ending point of the section. The numbers in the descriptions shall be the descriptive number

of the buildings.

The section from the boiler house to branch to 643 and 644 and to the new shaft	200	80	100	65	80
Section to 643 and 644 (after branch to 644)	65	32	40	32	32
Branch to 644	50	32	25	25	20
Branch to 643	50	25	25	25	20
The section from the turn-off to 644 and 643 after the new shaft	150	80	80	65	65
Branch to 645	50	25	32	32	25
The section from the new shaft to 642, 145 and 150 after branch to 642	100	50	50	40	40
Branch to 642	65	40	40	40	32
The section from the turn-off to 642 to the turnoff to 145	65	40	40	32	32
Branch to 145	65	32	32	32	25
Branch to 150	50	32	25	25	20
Section from the new shaft to the branch line to 646	150	65	65	50	50
Branch to 646	150	32	32	32	25
Branch to 641 and 149	80	40	40	40	32
Branch to 641	50	32	25	25	20
Branch to 149	65	32	32	32	25
Detour to 608	50	25	25	25	20
Section to 638, 637 and 639	100	50	50	40	40
Branch to 638	100	40	32	32	25
Branch to 639	65	32	32	32	25
Branch to 637	65	32	32	32	25

As the new branch would run directly from the boiler house, its construction would have no impact on the DN of the existing heat distribution pipes. The parameters of the new section and the parcels through which the proposed section passes are given in the tables below. The proposed DNs of the section are the minimum calculated values at which bottlenecks should not yet occur at peak demand. The specific DN design is up to the designer. All new heat distribution lines under consideration passed through land belonging to the City of Partizánske. The layout of the distribution branch is only indicative and the final position is up to the agreement of the investor and the designer.

Tab. 58: Parameters of the connected heat distribution lines to the boiler room E circuit (connected building PK 20)

Description of the connected distribution section[69]	**Plots of land**	**Engineer. networks/other obstacles**	**DN - ÚK simulation.**	**DN - TV inlet simulation.**	**Length of section - green [m]**	**Length of section - hard surface [m]**

[69] Divorce sections shall be named descriptively according to the starting point and the ending point of the section. The numbers in the descriptions shall be the descriptive number of the buildings.

Connection from boiler room to 945	3612/3 4782 4781/10 4785/1	underground sewer pipe underground water pipes undergroun d gas pipeline STL external LV underground power lines route of the trench for the optical network with overpressure (or overdigging) underground communication lines Slovak Telekom, a.s.	50	40	82	30

The estimated budget for implementation was EUR 65 276.31 excluding VAT and the impact on the heat price is summarised in the table below.

Tab. 59: Impact on heat price - connection of boiler house PK20

Component of the heat price	**Value**
Impact on the variable component of the heat price	0,04 Eur without VAT/MWh
Impact on the fixed component of the heat price	0,46 Eur without VAT/kW
Impact on the unit price of heat	0,09 Eur without VAT/MWh

4.2.8 Connection of all objects under consideration

The connection of all the objects considered in chapters 4.2.1 to 4.2.7 would mean the maximum possible use of the boiler capacity of boiler plant E. However, to connect all the objects considered, it is necessary to check whether the boiler plant is able to provide heat of sufficient quality for all the objects considered during peak periods.

Table 60: Peak demand assessment of all connected and considered objects to the boiler house circuit E

Connected buildings	Morning subscription peak (kW)	Evening subscription peak (kW)	Heat Engineering peak (kW)	Max. peak (kW)
building 643	56,39	57,51	58,23	58,23
building 644	57,55	55,85	57,36	57,55
Building 150	63,03	64,66	65,37	65,37
building 145	108,32	109,50	111,15	111,15
building 646	91,92	95,25	96,01	96,01
building 639	108,80	106,90	109,40	109,40
building 638	112,72	105,59	109,59	112,72
building 645	59,06	66,83	65,78	66,83
building 642	149,88	153,60	155,31	155,31
building 608	53,28	53,05	54,08	54,08
building 641	57,66	56,47	57,85	57,85
building 149	111,53	112,73	114,43	114,43
building 637	111,58	111,94	113,87	113,87
kindergarten building	159,17	128,74	139,93	159,17
Municipal Office building - N. SNP 212	231,97	173,03	193,32	231,97
building of the State Office - Makarenkova 213	83,40	58,38	66,72	83,40
building - Februárová 1478/2 (ALFA)	113,72	79,60	90,98	113,72
building - Februárová 152/1 (PK13)	86,40	68,09	74,65	86,40
building - Rudolf Jasika 156 (PK14)	99,37	84,23	90,16	99,37
building - Rudolf Jasika 160 (PK12)	89,85	77,38	82,41	89,85
building - Rudolf Jasik 652 (PK21)	97,89	87,90	92,41	97,89
building - Februárová 945 (PK20)	232,25	217,75	225,93	232,25
Peak take-up	-	-	-	**2,367 MW**

When estimating heat losses in heat distribution systems and considering the operating efficiency of boilers[70] the boiler plant's utilised thermal output would be about 2.86 MWt at absolute peak demand, which is practically the exact output of the boiler plant at present. Considering other factors that may affect heat demand in the future, such as possible changes in the age structure of customers, increasing proportion of home working, etc., the required boiler plant capacity may increase slightly further, therefore, in case of connecting all the objects under consideration, it would be more optimal to either increase the capacity of the sources in boiler plant E or to look for interconnection possibilities.

[70] The considered efficiency of 90 % of the natural gasheating capacity.

boiler rooms with other other CZT systems, or connection of another heat source to the circuit boiler houses (e.g. near the existing geothermal borehole HGTP-1).

Due to the analysis of the overall interconnection of the block and house boiler house circuits and the Šípok CTZ system, we will consider that the heat sources in boiler house E have sufficient capacity to ensure the necessary quality in the supply of heat for central heating and TV.

Fig. 35: Connection of all objects in the vicinity of the boiler house E circuit (blue - connected section and connected objects)

Source: own processing in Thermos and image editor

The addition of the sections did not cause bottlenecks in the sections of the current heat distribution lines (simulated diameters were increased, but did not exceed the actual diameters at any point).

Table 61: Effect of connecting all objects to the DN of the existing pipelines to the boiler house circuit E

Description of the distribution section[71]	DN - ÚK real	DN - ÚK simulated	DN - TV inlet real	DN - TV inlet simulated	DN - TV Circulation real
Branch to the kindergarten building	50	40	25	25	20

[71] Divorce sections shall be named descriptively according to the starting point and the ending point of the section. The numbers in the descriptions shall be the descriptive number of the buildings.

The section from the boiler house to branch to 643 and 644 and to the new shaft	200	100	100	80	80
Section to 643 and 644 (after branch to 644)	65	32	40	32	32
Branch to 644	50	32	25	25	20
Branch to 643	50	25	25	25	20
The section from the turn-off to 644 and 643 after the new shaft	150	100	80	65	65
Branch to 645	50	25	32	32	25
The section from the new shaft to 642, 145 and 150 after branch to 642	100	50	50	40	40
Branch to 642	65	40	40	40	32
The section from the turn-off to 642 to the turnoff to 145	65	40	40	32	32
Branch to 145	65	32	32	32	25
Branch to 150	50	32	25	25	20
Section from the new shaft to the branch line to 646	150	65	65	65	50
Branch to 646	150	32	32	32	25
Branch to 641 and 149	80	40	40	32	32
Branch to 641	50	32	25	25	20
Branch to 149	65	32	32	32	25
Detour to 608	50	25	25	25	20
Section to 638, 637 and 639	100	65	50	50	40
Branch to 638	100	40	32	32	25
Branch to 639	65	32	32	32	25
Branch to 637	65	32	32	32	25

Connecting all objects would require virtually all of the actions described in the subsections above. The parameters of the sections to be connected and the parcels through which the sections under consideration pass are given in the tables below. The proposed DNs are the minimum calculated values at which peak demand bottlenecks should not yet occur. The specific DN design is up to the designer. All the new heat distribution lines under consideration passed through land belonging to the City of Partizánske. Various underground utilities are located on the land[72]which need to be taken into account in the implementation project (parallel lines and crossing). Several sections also require under-drilling or excavation on hard surfaces (asphalt, concrete).

Table 62: Parameters of the connected heat distribution lines to the boiler house E circuit (variant of connection of objects PK 18, PK Alfa, PK 13, PK 14, PK 12, PK 21 and PK20)

[72] On the basis of the provided documentation of the engineering networks of the city of Partizánske.

Description of the connected distribution section[73]	Plots of land	Engineer. networks/other obstacles	DN - ÚK simulation.	DN - TV inlet simulation.	Length of section - green [m]	Length of section - hard surface [m]
Section from the new shaft to the ALFA turnoff, 152 and 156	3615/1 3611/2 3608 3617 3710/1	external LV underground power lines underground communication lines Slovak Telekom, a.s. underground sewer pipe	65	32	198	57
Section from ALFA, 152 and 156 k digressions 152	3710/1 3724 3551 3294/5	?[74]	50	25	88	20
Branch to ALPHA	3710/1	?[74]	40	-	9 (ÚK only)	12 (ÚK only)
Branch to 152	3294/5 3294/6	?[74]	32	20	0	22
Branch to 156	3294/5 3287/3 3297/5	external LV underground power lines external power lines HV underground underground communication lines Slovak Telekom, a.s. Underground Pipeline STL pipeline	40	25	12	98
The section from ALFA branches to MU	3710/1	-	50	20	35	35

[73] Divorce sections shall be named descriptively according to the starting point and the ending point of the section. The numbers in the descriptions shall be the descriptive number

of the buildings.

[74] The utility design documentation provided did not include detailed drawings of the land in question and therefore it is not possible to determine what underground utilities run through the land.

Connection from the section to 638, 637 and 639 k taps to 160 a 652	3608 3551 3307/3 3307/1 3305/3	3608 3551 3307/3 3307/1 3305/3	40	32	118	34
Branch to 160	3305/3 3307/1 3304 3303	undergroun d gas pipeline STL existing route OK Orange a.s. underground sewer pipe	32	25	0	38
Branch to 652	3305/3 3307/1	-	32	25	0	14
Connection from boiler room to 945	3612/3 4782 4781/10 4785/1	underground sewer pipe Water Supply underground pipeline undergroun d gas pipeline STL external LV underground power lines route of the trench for the optical network with overpressure (or overdigging) underground communication lines Slovak Telekom, a.s.	50	40	81	30

The estimated budget for implementation was EUR 556 125,92 excluding VAT and the impact on the heat price is summarised in the table below.

Table 63: Impact on the heat price - connection of all objects considered

Component of the heat price	Value
Impact on the variable component of the heat price	0,15 Eur without VAT/MWh
Impact on the fixed component of the heat price	3,91 Eur without VAT/kW
Impact on the unit price of heat	0,84 Eur without VAT/MWh

4.3 Evaluation and recommendation

The table below assesses the impacts on the heat price for each option. As can be seen from the table, all activities considered will increase the current heat price. This is mainly due to the relatively high efficiency of the heat source and heat distribution systems in the price proposal.

Table 64: Comparison of the impact on the heat price of the different options for connecting the surrounding buildings to the boiler house circuit E

Variant	Impact on the price of heat		
	Variable price component EUR without VAT/MWh	Fixed price component EUR without VAT/kW	Indicative total heat price EUR without VAT/MWh
Connection of boiler house PK 18 and PK Alfa (extension of the branch to building 149)	+0,08	+1,07	+0,30
Connection of boiler house PK 18 and PK Alfa (new branch from the shaft at building 645)	+0,08	+1,49	+0,38
Connection of boiler house objects PK 18, PK Alfa and PK13	+0,09	+1,94	+0,47
Connection of boiler house objects PK 18, PK Alfa, PK13 and PK14	+0,09	+2,49	+0,57
Connection of objects of boiler house PK12	+0,01	+0,72	+0,13
Connection of objects of boiler house PK21	+0,01	+0,57	+0,11
Connection of boiler house objects PK12 and PK21	+0,02	+0,85	+0,16
Connection of objects of boiler house PK20	+0,04	+0,46	+0,09
Connection of all objects	+0,15	+3,91	+0,84

In addition to the price of heat, investment factors can also be important factors in an investor's decision
costs and the advantages and disadvantages of the options (see table below).

Table 65: Summary of investment costs, advantages and disadvantages of the different options

Variant	Estimated investment costs (EUR without VAT)	Benefits	Disadvantages
Connection of boiler house PK 18 and PK Alfa (extension of the branch to building 149)	152 747,04	Increasing the utilisation of the oversized capacity of boiler house E. The connection does not cross the main road (excavation only on the green and partly on the access road and parking to the rear entrances of the buildings) Need to address the substandard condition of the boiler house of the Municipal Office Building (PK18) and PK Alfa.	Risk of a bottleneck on the connected branch if TV consumption increases significantly. Heat price increase.
Connection of boiler house PK 18 and PK Alfa (new branch from the shaft at building 645)	212 158,90	Increasing the utilisation of the oversized capacity of boiler house E. No risk of bottlenecks places. Need to address the substandard condition of the boiler house of the Municipal Office Building (PK18) and PK Alfa.	Crossing of two roads. Heat price increase.
Connection of boiler house objects PK 18, PK Alfa and PK13	275 645,86	Increasing the utilisation of the oversized capacity of boiler house E. Need to address the unsatisfactory condition of the boiler houses (PK18, PK Alfa, PK13).	Heat price increase.
Connection of boiler house objects PK 18, PK Alfa, PK13 and PK14	354 945,23	Increasing the utilisation of the oversized capacity of boiler house E. Need to address the poor condition of the boiler houses (PK18, PK Alfa, PK13 and PK14).	Heat price increase.
Connection of boiler house objects PK12	101 855,32	Increasing the utilisation of the oversized capacity of boiler house E. The need to address substandard condition of boiler room PK12.	Heat price increase.
Connection of boiler house objects PK21	81 731,87	Increasing the utilisation of the oversized capacity of boiler house E.	Heat price increase.

Connection of boiler house objects PK12 and PK21	120 591,07	Increasing the utilisation of the oversized capacity of boiler house E. The need to address substandard condition of boiler room PK12. A substantial part of the branch length for PK12 and PK21 is common.	Heat price increase. The boiler room PK21 is not yet in a bad condition.
Connection of boiler house objects PK20	65 276,31	Increasing the utilisation of the oversized capacity of boiler house E.	Heat price increase. The PK20 boiler room is not yet in bad condition.
Connection of all objects	556 125,92	The amalgamation of all the properties will improve the potential for the area to connect into a larger SCZT unit in the future. Resolving the unsatisfactory condition of some boiler houses.	Risk of undersizing the boiler house heat output. Increase in the price of heat.

In the near future, we recommend to consider connecting objects whose house boiler rooms are already in poor condition. The connection of these objects will probably not be economically competitive with other decentralised solutions, but it will make significant sense for the future merging of the SCZT network in Partizánske. The extension of boiler house E will ensure easier connection of more objects to the envisaged larger SCZT unit (see Chapter 3).

5 Attachments

5.1 Considered routing of the link - southern variant

Table 66: Considered routing - Southern Link Option

Section	Land			Engineering networks
	Plot reg. C	Plot reg. E	Owner	
Boiler room Šípok - KB	4970/26	-	City of Partizánske	-
	5014	3-1656/101 3-269/102 3-268/2	City of Partizánske	-
	4805/1	-	Slovak Republic	fibre optic cable (Orange a.s.)
	4478/152	-	City of Partizánske	-
	4440/2	-	City of Partizánske	-
	4490/1	-	City of Partizánske	underground communication lines (Slovak Telekom a.s.) underground gas pipeline STL outdoor power lines LV underground underground gas pipeline STL outdoor power lines - lighting underground communication lines (Slovak Telekom a.s.) outdoor power lines - lighting underground sewer pipe
	4485/4	-	City of Partizánske	-
	4485/2	-	City of Partizánske	external LV underground power lines 1 kV electricity power cable underground water pipes external power lines LV underground hot water pipe - city of Partizánske
	4462	-	City of Partizánske	1 kV electricity power cable
	4460/1	-	City of Partizánske	hot water pipe - city of Partizánske
KB - KD	4460/1	-	City of Partizánske	external power lines HV underground external LV underground power lines
	4462	-	City of Partizánske	underground sewer pipe
	4459	-	City of Partizánske	underground gas pipeline STL sewer pipe underground external power lines LV underground optical network underground communication lines Slovak Telekom a.s. outdoor power lines - lighting external power lines HV underground
	4453/1	-	City of Partizánske	external LV power lines underground underground communication lines Slovak Telekom a.s.
	4440/1	-	City of Partizánske	-
	4436/2	-	City of Partizánske	fibre optic cable Orange a.s. underground communication lines Slovak Telekom a.s. underground water pipes external LV underground power lines

				external power lines LV underground water pipes underground
	4569	-	City of Partizánske	underground communication lines Slovak Telekom a.s.
	4570	-	City of Partizánske	-
	4571/1	-	City of Partizánske	-
	4594/1	-	City of Partizánske	-
FGTz2 - KD	in the excavation KB - KD			
KD - K11	4594/1	-	City of Partizánske	-
	4571/6	-	City of Partizánske	underground communication lines Slovak Telekom a.s.
	4707	-	City of Partizánske	sewer pipe underground underground communication lines Slovak Telekom a.s. underground water pipes external LV underground power lines
	4700/2	-	City of Partizánske	-
	4620	-	City of Partizánske	external power lines LV underground underground gas pipeline STL external power lines LV underground optical network underground communication lines Slovak Telekom a.s.
	4616/1	-	City of Partizánske	external LV underground power lines
	4620	-	City of Partizánske	underground gas pipeline STL
	4672/1	-	City of Partizánske	underground communication lines Slovak Telekom a.s. underground communication lines Slovak Telekom a.s. external power lines LV underground external power lines LV underground water pipeline underground underground gas pipeline STL underground communication lines Slovak Telekom a.s.
	4704	-	City of Partizánske	underground gas pipeline STL underground gas pipeline STL sewer pipeline underground external power lines LV underground sewer pipeline underground sewer pipeline underground external LV underground power lines
	4715/1	-	City of Partizánske	-
	4719/1	-	City of Partizánske	outdoor power lines - lighting outdoor power lines HV underground outdoor power lines HV underground sewer pipe underground optical network
K11 - KE	4719/1	-	City of Partizánske	external power lines LV underground external power lines LV underground underground communication lines Slovak Telekom a.s. underground communication lines Slovak Telekom a.s.
	4715/1	-	City of Partizánske	underground sewer pipe
	4726	-	City of Partizánske	underground gas pipeline STL existing route OK Orange a.s.

				underground communication lines Slovak Telekom a.s. underground gas pipeline STL
	3656	-	City of Partizánske	-
	3615/1	-	City of Partizánske	external power lines LV underground underground gas pipeline STL underground gas pipeline STL underground communication lines Slovak Telekom a.s. existing route OK Orange a.s. sewerage pipe underground underground communication lines Slovak Telekom a.s. underground water pipes
	3612/3	-	City of Partizánske	fibre optic cable external power lines LV underground fibre optic cable external LV underground power lines
KE - HGTP1	3612/3	-	City of Partizánske	external power lines LV underground fibre optic cable fibre optic cable external LV underground power lines
	3611/2	-	City of Partizánske	-
	3608	-	City of Partizánske	underground communication lines Slovak Telekom a.s. sewer pipe underground underground gas pipeline STL fiber optic cable external power lines LV underground water pipeline underground underground communication lines Slovak Telekom a.s.
	3555/1	-	City of Partizánske	external LV power lines underground underground communication lines Slovak Telekom a.s. fiber optic cable underground pipeline pipeline STL water pipe underground sewer pipe underground underground communication lines Slovak Telekom a.s.
	3551	-	City of Partizánske	fibre optic cable
	3307/1	-	City of Partizánske	outdoor power lines LV underground outdoor power lines LV underground outdoor power lines NN underground outdoor power lines NN underground outdoor power lines NN underground fibre optic cable

5.2 Considered routing of the link - northern variant

Table 67: Considered routing - northern link option

Section	Land			Engineering networks
	Parcel reg. C	Parcel reg. E	Owner	
Boiler room Šípok - KB	4970/22	-	City of Partizánske	-

	5014	3-1656/101 3-269/102 3-268/2	City of Partizánske	-
	4805/1	-	Slovak Republic	-
	3750/1	-	Slovak Republic	-
	3750/30	-	City of Partizánske	-
	3750/1	-	Slovak Republic	-
	3750/29	-	City of Partizánske	-
	3750/1	-	Slovak Republic	-
	3759/1	-	City of Partizánske	-
	3756/13	-	Slovak Republic	-
	3748/1	-	Slovak Republic	-
	3746/3	-	Slovak Republic	-
	3747	-	Slovak Republic	-
	3746/2	-	Slovak Republic	-
	3750/24	667/101	City of Partizánske	-
	4571/1	-	City of Partizánske	underground sewer pipe OK Orange a.s.
	4594/1	-	City of Partizánske	-
KD - KB	4594/1	-	City of Partizánske	-
	4571/1	-	City of Partizánske	-
	4570	-	City of Partizánske	-
	4569	-	City of Partizánske	underground communication lines Slovak Telekom a.s.
	4436/2	-	City of Partizánske	existing route OK Orange a.s. underground communication line Slovak Telekom a.s. water pipe underground external power lines LV underground external power lines LV underground underground water pipes
	4440/1	-	City of Partizánske	-
	4453/1	-	City of Partizánske	external LV power lines underground underground communication lines Slovak Telekom a.s.
	4459	-	City of Partizánske	underground gas pipeline STL sewer pipe underground external power lines LV underground fiber optic cable underground communication lines Slovak Telekom a.s. outdoor power lines - lighting external power lines HV underground
	4462	-	City of Partizánske	underground sewer pipe
	4460/1	-	City of Partizánske	external power lines HV underground external power lines LV underground
FGTz2 - KD	in the excavation KD - KB			

Branch from the power line drawn northern route to K11	4571/1	-	City of Partizánske	existing route OK Orange a.s. sewer pipe underground fibre optic cable sewer pipe underground underground communication lines Slovak Telekom a.s.
	4571/7	-	City of Partizánske	-
	4707	-	City of Partizánske	external power lines LV underground sewer pipe underground underground gas pipeline STL underground water pipes
	4700/2	-	City of Partizánske	-
	4704	-	City of Partizánske	external power lines LV underground sewer pipe underground underground communication lines Slovak Telekom a.s. external LV underground power lines
	4715/1	-	City of Partizánske	-
	4719/1	-	City of Partizánske	external power lines HV underground external power lines HV underground sewer pipe underground fibre optic cable
K11 - KE	4719/1	-	City of Partizánske	external power lines LV underground external power lines LV underground underground communication lines Slovak Telekom a.s. underground communication lines Slovak Telekom a.s.
	4715/1	-	City of Partizánske	underground sewer pipe
	4726	-	City of Partizánske	underground gas pipeline STL existing route OK Orange a.s. underground communication line Slovak Telekom a.s. underground gas pipeline STL
	3656	-	City of Partizánske	-
	3615/1	-	City of Partizánske	external power lines LV underground underground gas pipeline STL underground gas pipeline STL underground communication lines Slovak Telekom a.s. existing route OK Orange a.s. sewerage pipe underground underground communication lines Slovak Telekom a.s. underground water pipes
	3612/3	-	City of Partizánske	fibre optic cable external power lines LV underground fibre optic cable external LV underground power lines
KE - HGTP1	3612/3	-	City of Partizánske	external power lines LV underground fibre optic cable fibre optic cable external LV underground power lines
	3611/2	-	City of Partizánske	-

	3608	-	City of Partizánske	underground communication lines Slovak Telekom a.s. underground sewer pipe underground gas pipeline STL fibre optic cable external LV power lines underground water supply pipes underground underground communication lines Slovak Telekom a.s.
	3555/1	-	City of Partizánske	external LV power lines underground underground communication lines Slovak Telekom a.s. fibre optic cable underground gas pipeline STL water pipeline underground sewer pipeline underground underground communication lines Slovak Telekom a.s.
	3551	-	City of Partizánske	fibre optic cable
	3307/1	-	City of Partizánske	outdoor power lines NN underground outdoor power lines NN underground outdoor power lines NN underground outdoor power lines NN underground outdoor power lines NN underground fibre optic cable