DELIVERABLE D.T3.2.2
SUMMARY REPORT

Pilot heat planning at local level | Version n° 07/2020

D.T3.2.2: Summary Report

A.T3.2 Development of pilot heat planning

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1. Introduction

The EU Parliament´s statutory climate target means that the EU´s greenhouse gas emissions must be reduced by 55 % in 2030 compared to 1990 and must be climate neutral by 2050. The energy sector is considered one of the largest greenhouse gas emitters. The heating sector plays a not irrelevant part in this.

In order to achieve the climate targets, the heat transition is an important issue. But since heat, compared to electricity, cannot be transported over long distances without significant losses, it is usually generated locally for each building in a variety of ways. The heat transition can therefore only succeed locally and regionally.

As one example, in the whole state of Baden-Württemberg in Germany urban districts as well as large district towns are required to carry out municipal heat planning. For smaller municipalities, which are exempt from the obligation, financial incentives for municipal heat planning are created through a funding program.

The municipalities are the driving force, as a wide variety of players, such as citizens, companies and energy suppliers, must be involved in the successful implementation of the heat transition. As the municipality represents all interests of the respective actors, they are the perfect strategists to coordinate a municipal heat plan and possibly implement the necessary measures resulting from it.

Municipal heat planning does not only include the creation of one heat plan, it goes far beyond that: This is a long-term process that reacts to changes and guides the changeover to renewable heat supply.

Municipal heat planning essentially consists of 4 steps. First, an inventory analysis is carried out in which the current heat demand/consumption is determined. This is determined, among other things, from the building types and age classes, the supply and heating structure as well as the existing storage tanks and heating centers. In addition, the resulting greenhouse gas emissions of the entire heating sector of the municipality are determined.

In the next step, a potential analysis is carried out. This serves to determine the savings potential of space, hot water and process heat in the household, industry, commercial and public buildings sectors. Furthermore, the available potential of waste heat and renewable energies on the municipal territory is determined.

In the 3rd step, a target scenario is drawn up. Here, a concrete solution is provided as to how a climate-neutral heat supply can look by 2050. This can be achieved, for example, by identifying suitable areas for district heating and self-supply.

The final step is the heat transition strategy: A concrete transformation path is formulated. This contains detailed measures for achieving the energy savings targets and expanding the future energy supply, with additional information on the periods of implementation and a timetable.

Municipal heat planning has a supportive effect on municipalities. This can be used as a guideline for future urban and energy planning and enables a faster and clearer heat transition by proposing solutions!

2. Development of pilot heat planning – Croatia

District heating counts around 10 % of the overall heat supply in the Croatia. There are around 13 district heating companies in 19 cities and towns, including the main district heating company is HEP-Toplinarstvo, subsidiary of national power company HEP, holding 85 % of the market share. Current district heating systems in Croatia mainly belong to so called 2nd generation of district heating, using hot water with supply temperatures well above 100 °C. Natural gas is the main fuel for district heat, while around 80 % of district heat was generated through combined heat and power. Bad condition of existing building stock as well as the distribution grid requires substantial retrofitting. Modernisation and expansion of district heating systems in set as one of the priorities for Croatian energy policy.

As part of the INTERREG Central Europe project ENTRAIN, partner 2, the Regional Energy Agency of Northwest Croatia prepared this study, which contains a spatial analysis of thermal energy needs for space heating and domestic preparation of hot water, potential for renewable energy sources and potential for district heating. The area for this analysis is the Karlovac City. The implementation team for this study consists of several stakeholders, namely: Karlovac City, the Karlovac City Heating Plant, and the company GeotermiKA d.o.o. for energy from Karlovac established by the City for research and exploitation of geothermal water for the needs of the existing heating system and for the production of electricity for the needs of public facilities (hospitals, schools, kindergartens, city administration facilities, public lighting…). For the successful implementation of project, it was necessary to involve local organizations with as much access as possible to potential investors such as: the city, local/national media and local organizations that bring together a large number of people.

Karlovac City is the administrative, political, economic, cultural and sports center of Karlovac County and also the largest city in the county. The city with its 52 settlements covers an area of 396.4 km2 (10.9 % of the county area) and according to the 2011 census has 55,705 inhabitants (41.9 % of the county population). In the area of Karlovac City, there is a plant for the production of thermal energy with an installed thermal capacity of 116 MW, connected capacity of 70 MW and a possible connection of 30 MW with the associated distribution network, which allows further development of the distribution network.

Currently in the Karlovac City there is a relatively developed district heating system (CTS) managed by the city company Gradska toplana d.o.o. Production facilities are located in Toplana Centar at 7 Tina Ujevića Street.

The distribution network is spread over the area of 5 city districts (Banija, Grabrik, Luščić Jamadol, Novi Centar and Rakovac) where the heating service for households and business users is fully or partially provided. The mentioned CTS of the city of Karlovac does not have the possibility of heating domestic hot water (PTV). Karlovac has good geothermal potential according to the available data from a few existing boreholes. The geothermal area around wells, Ka-2 and Ka-3, is around 8-10 km from the city and is favorable for utilization of the geothermal water for district heating system for house heating, hotel and spa systems, green houses, fish farming or other industries. The existing data show that Ka-2 and Ka-3, drilled in 1983 and 1988, have measured temperatures up to 140 °C and a possible flow of 50 kg/s. The temperature and flow indicate a good geothermal resource.

The district heating central is designed to cover about 50 % of the heat demand for the population of 55,700 individuals in Karlovac. The district heating company 2016 has built up 3×13 MW boilers, only one boiler was running and burning 1,217 kg/h of natural gas for the delivery of 12.9 MW to the district heating system.

The boilers are long past normal lifetime and the district heating company can expect a sudden shutdown or a major failure of the boilers main equipment or material.

Gradska toplana Karlovac is in preparing a significant network refurbishment under the Integrated territorial investments scheme. Karlovac has a significant geothermal potential and it was recognized that the DH system could in future be run on geothermal energy.

The Karlovac City heating plant exists for half a century and heats half of the citizens of the urban part of Karlovac, and supplies heat to about 8,000 users. The biggest challenge facing the company is, among other things, the worn-out hot water system, which causes cracks during the heating season. Renovation of hot water pipelines is a basic precondition for the introduction of renewable, geothermal energy sources.

The study includes the following elements:

1. GIS map of spatial demand for thermal energy for space heating and preparation of domestic hot water with a resolution of 1 ha;

2. GIS map of potential zones for the application of district heating systems with regard to their potential cost-effectiveness;

3. Analysis of the potential of renewable energy sources in the existing and potential district heating system (solar energy, geothermal energy and energy storage system);

The required data for the implementation of this study and the expected results were:

1. GIS analysis

The spatial analysis proposed in this study was primarily based on publicly available data and the obtained maps can be used to identify priority zones for in-depth analysis, not as a direct tool for designing energy supply systems. If data will be available, the analyses performed can be calibrated based on the actually measured values.

2. Potential for the application of renewable energy sources and analysis of potential costs

The analysis of the technical and economic profitability of the application of renewable sources is based on publicly available data and data obtained from the City Heating Plant and the company Geothermika. Required data included:

- Available energy sources - locations, yield and estimated costs;
- Locations of the existing district heating network;
- Estimated costs of expanding the district heating network in EUR/m.

3. Use of thermal energy outside the heating season

In order to enable a quality transition for the use of renewable sources in the district heating system of the Karlovac City, it is crucial to gradually introduce the supply of domestic hot water or energy for its preparation through the district heating system. Such a modification would allow a much more cost-effective integration of technologies such as solar collectors and geothermal energy. The energy required for space heating and preparation of domestic hot water will be considered separately. In addition+ to the preparation of domestic hot water, the potential of cascading use of thermal energy will also be considered. As part of the study, a preliminary proposal of potential solutions will be given and their analysis will be carried out if the necessary data should be available for it.

Analysis of the spatial distribution of energy demand for heating and preparation of domestic hot water

In order to define zones suitable for the development of district heating systems, it is necessary to analyze the spatial distribution of current and potential future energy demand for heating and preparation of domestic hot water. This analysis is based on a large amount of georeferenced data that is often not available. In this case, the cadaster of the Karlovac City and the publicly available global distribution of population density were used for the analysis. Because Karlovac City Heating Plant currently supplies users with energy for space heating, energy for heating domestic hot water was considered separately except in the case of definitions of priority zones for the development of central heating systems. The method of analysis of the spatial distribution of heat demand is based on the scientific paper "Heat demand mapping and district heating assessment in data-poor areas" published in the journal "Renewable and Sustainable Energy Reviews

Mapping of heat demand

Mapping of the demand for thermal energy for space heating and preparation of domestic hot water is based on two scenarios:

1. Current state;
2. Alternative state - development of additional settlements in the Karlovac City in accordance with the general urban plan.

Figure 1 shows the assumed distribution of facilities at the locations of the new planned settlements in the urban center of the Karlovac City.

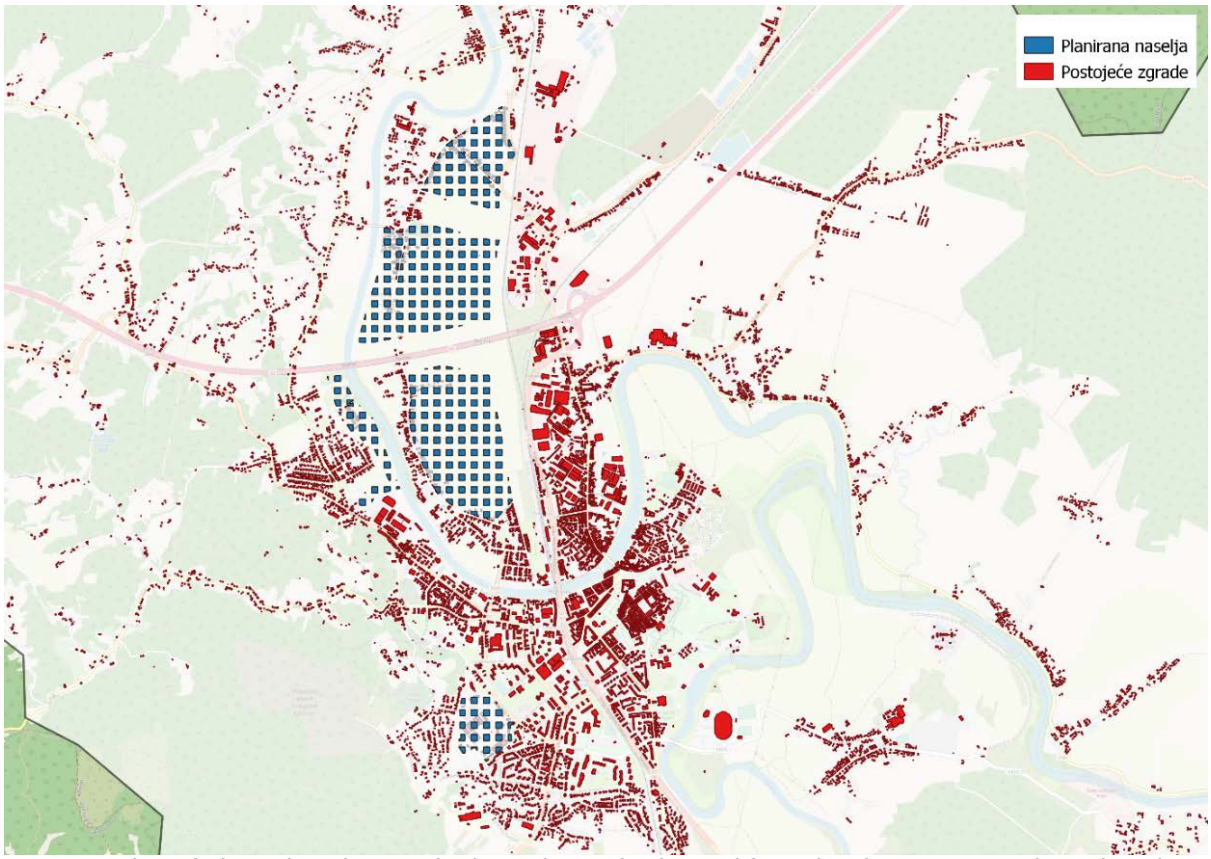


Figure 1: Overview of planned settlements in the Karlovac City (Legend from the picture: BLUE - planned settlements; RED - existing buildings)

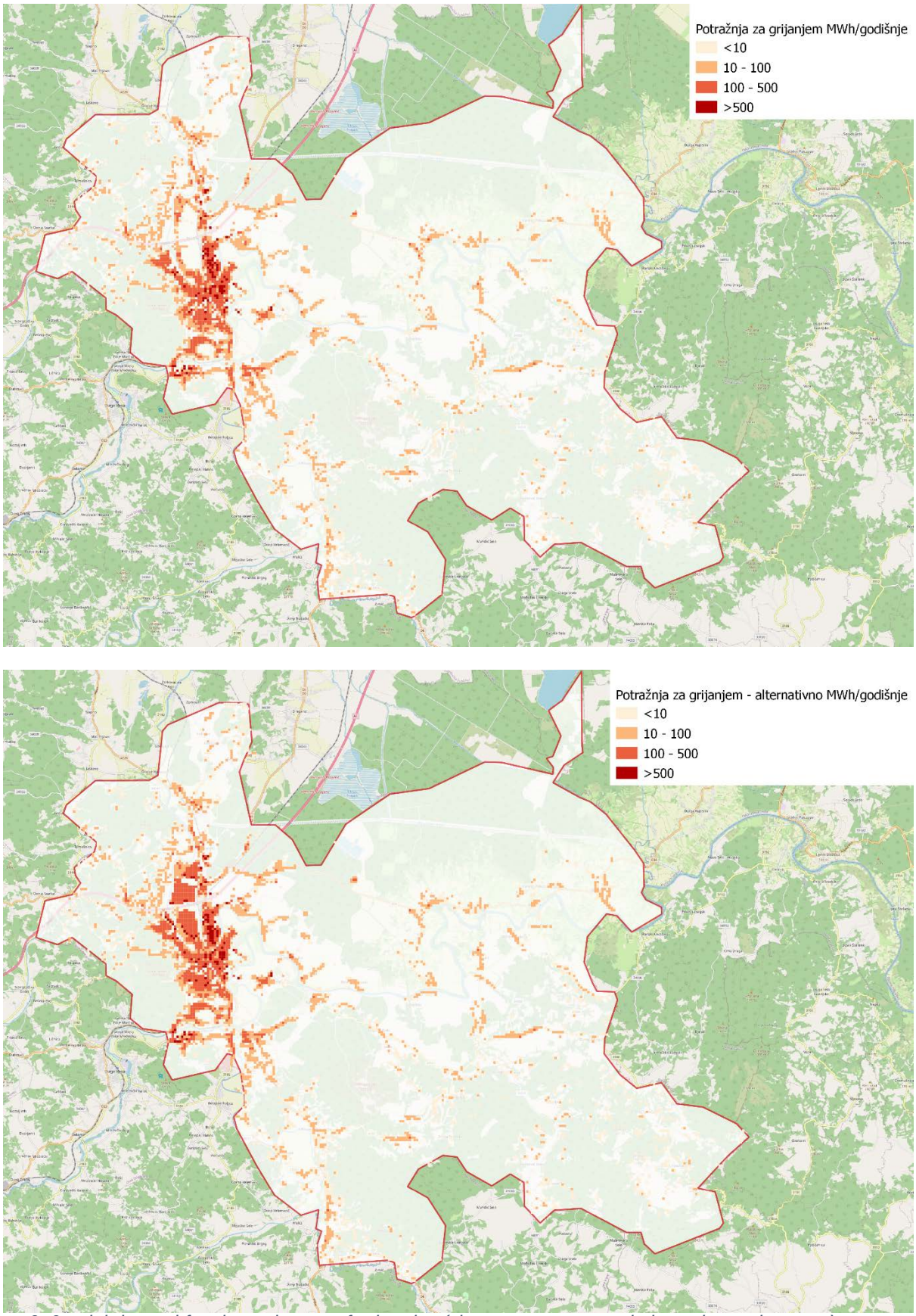


Figure 2: Spatial demand for thermal energy for heating (above: current state, below: alternative state)

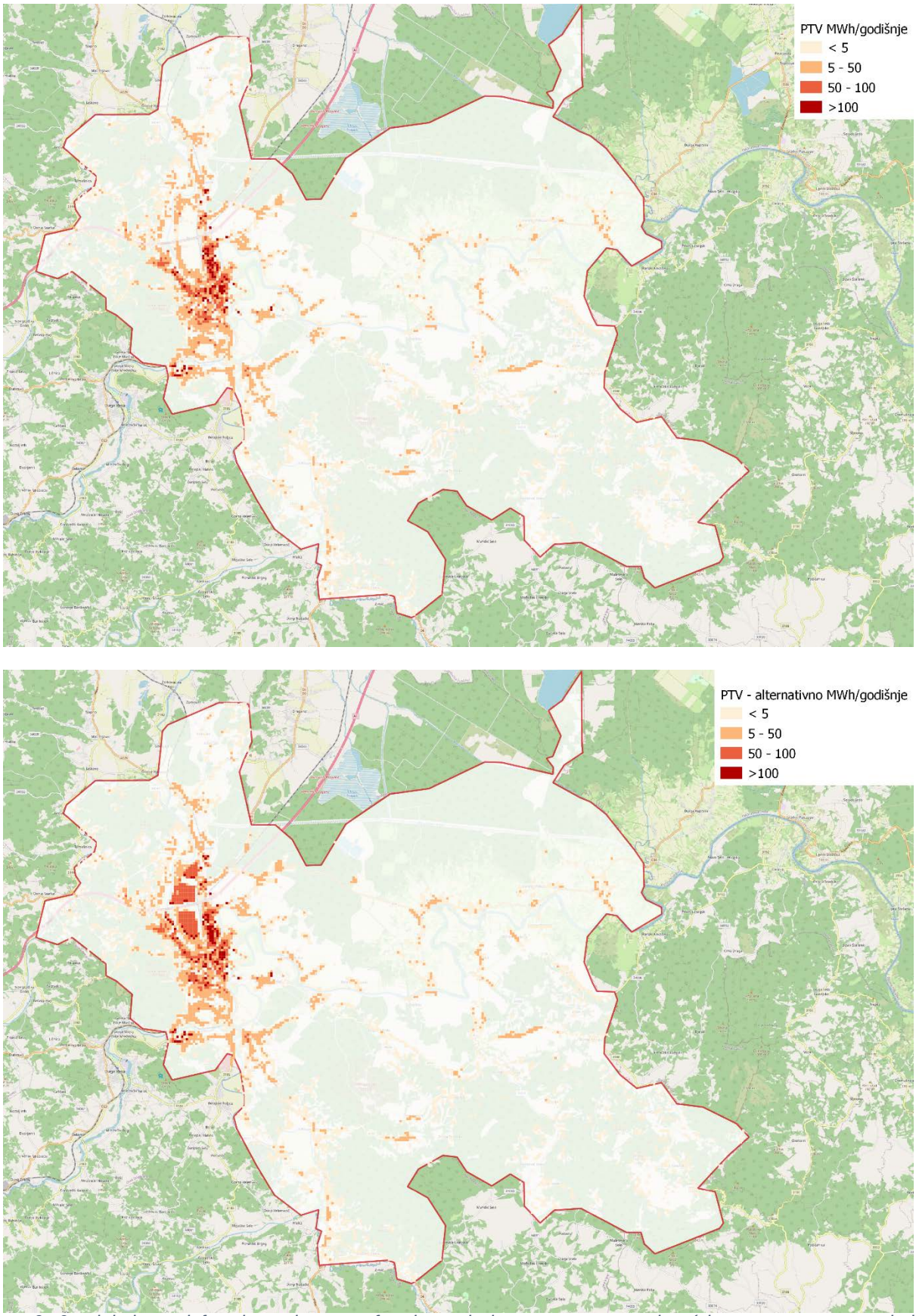


Figure 3: Spatial demand for thermal energy for domestic hot water preparation (above: current state, below: alternative state)

Figure 2 shows the spatial distribution of heat demand for heating of space and Figure 3 for the preparation of domestic hot water for the current (up) and alternative (down) situation with a resolution of 1 ha. The total demand for thermal energy in the area of the Karlovac City is assumed to be 300,000 MWh per year in communication with the City Heating Plant Karlovac. The total energy demand of the building sector in the Karlovac City is approximately 479,000 MWh according to the data available in the Action Plan for Energy Sustainable Development and Climate Change Adaptation of the Karlovac City.

Zoning of the Karlovac City according to priorities for the development of centralized heating systems

In order to take into account, the broader picture of energy demand when defining priority zones for the development of district heating systems in the Karlovac City, the demand was considered for thermal energy for heating and preparation of domestic hot water within a radius of 1 km. This gave a high-resolution image, 1 ha, which nevertheless considers the area of adequate surface area in the analysis. Figure 4 shows the result of this analysis, that is it shows the 4 priority zones for the development of district heating systems in the case of the current (above) and alternative (below) state. These zones are:

1. Not a priority;
2. Low priority;
3. Medium priority;
4. High priority;

It can be seen from the presentation that the wider center of the Karlovac City is extremely suitable for the development of central heating systems as well as settlements whose development is planned in the near future.

Table 1 shows the demand for thermal energy for heating, domestic hot water preparation and a total of four identified zones for the development of district heating systems for the Karlovac City. As can be seen from the overview, most of the demand is located in the high priority zone, that is in the area of the wider center of the Karlovac City.

Table 1: Demand for thermal energy in individual zones

Zone	Heating energy demand [MWh]	Energy demand for preparation of domestic hot water [MWh]	Total demand [MWh]
Not a priority (nije prioritet)	464.47	92.89	557.36
Low priority (nizak prioritet)	16,281.67	3,256.33	19,538.00
Medium priority (srednji prioritet)	48,677.03	97,35.41	58,412.44
High priority (visok prioritet)	234,576.83	46,915.37	281,492.20

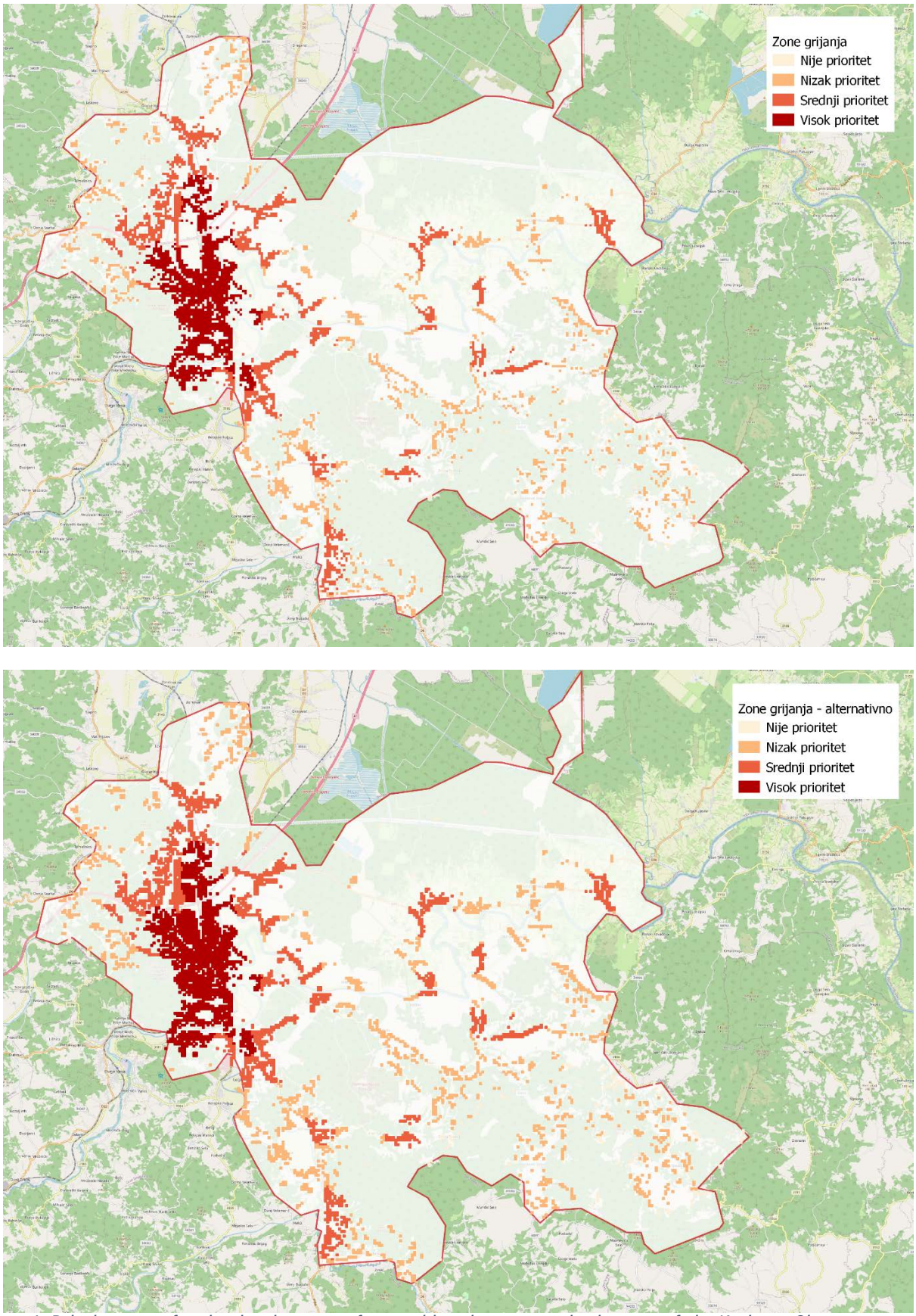


Figure 4: Priority zones for the development of central heating systems in the area of the Karlovac City

Potential for the application of renewable energy sources and analysis of potential costs

The second step was to analyse different technologies which could supply existing district network in the City of Karlovac. The chosen combination of technologies included solar thermal collectors, vacuum solar collectors, heat pump, biomass boiler and geothermal energy. The methodology for calculating LCOH (Levelized cost of heat) or levelled cost of energy production for heating is given below.

The input data for the calculation were as follows:

- Unit investment cost
- Unit maintenance cost
- Annual increase in maintenance costs
- Annual fuel consumption
- Fuel price
- Annual increase in fuel prices
- Annual energy production
- Discount rate

All data were prepared and used for one production unit (1 kW or 1 m^2 for solar panels). For all the equipment LCOH calculating the life expectancy of 25 years. In addition, a load factor of 90 % was taken, assuming that 10 % of the time the annual plant is not working. The formula for calculating the LCOH is:

- The initial cost of investment expenditures (I)
- Maintenance and operations expenditures (M)
- Fuel expenditures (if applicable) (F)

The total output of the power-generating asset will include:

- The sum of all electricity generated (E)

The last two important factors to be considered in the equation are:

- The discount rate of the project (r)
- The life of the system (n)

$$LCOE = \frac{\text{NPV of Total Costs Over Lifetime}}{\text{NPV of Electrical Energy Produced Over Lifetime}}$$

$$LCOE = \frac{\sum \frac{(I_t + M_t + F_t)}{(1 + r)^t}}{\sum \frac{E_t}{(1 + r)^t}}$$

The formula works by putting the net present value of all costs (investment, fuel maintenance) in the numerator and the net present value of the produced energy (not earnings but energy) in the denominator. Everything is netted because the energy produced in 5 years is worth less than the energy produced today (the price of energy, if it does not change, falls in value again as time passes).

The scenarios analyzed are as follows:

1. Solar thermal collectors

Load factor	90 %
Unit investment cost	200 EUR
Unit maintenance cost	0,04 %/year
Annual increase in maintenance costs	1 %
Annual fuel consumption	0 kWh/year
Fuel price	0 EUR/kWh
Annual increase in fuel prices	0 %
Annual energy production	533 kWh/year
Equipment life	25 years
Discount rate	5 %
LCOH (Levelized cost of heat)	25,44 EUR/MWh

*Input data is collected from the page:
https://ens.dk/sites/ens.dk/files/Statistik/technology_data_catalogue_for_el_and_dh_-_0009.pdf

2. Vacuum solar collectors

Load factor	90 %
Unit investment cost	620 EUR
Unit maintenance cost	2 EUR/year
Annual increase in maintenance costs	1 %
Annual fuel consumption	0 kWh/year
Fuel price	0 EUR/kWh
Annual increase in fuel prices	0%
Annual energy production	673 kWh/year
Equipment life	25 years
Discount rate	5 %
LCOH (Levelized cost of heat)	65,53 EUR/MWh

3. Heat pump

Load factor	90 %
Unit investment cost	950 EUR
Unit maintenance cost	2 EUR/year
Annual increase in maintenance costs	1 %
Annual fuel consumption	2464 kWh/year
Fuel price	0,15 EUR/kWh
Annual increase in fuel prices	1%
Annual energy production	7884 kWh/year
Equipment life	25 years
Discount rate	5 %
LCOH (Levelized cost of heat)	60,08 EUR/MWh

4. Biomass boiler

Load factor	90 %
Unit investment cost	510 EUR
Unit maintenance cost	40 EUR/year
Annual increase in maintenance costs	1 %
Annual fuel consumption	7096 kWh/year
Fuel price	0,04 EUR/kWh
Annual increase in fuel prices	1 %
Annual energy production	7884 kWh/year
Equipment life	25 years
Discount rate	5 %
LCOH (Levelized cost of heat)	49,64 EUR/MWh

5. Geothermal energy

Load factor	90 %
Unit investment cost	2710 EUR (without borehole)

Unit maintenance cost	22,6 EUR/year
Annual increase in maintenance costs	1 %
Annual fuel consumption	0 kWh/year
Fuel price	0,04 EUR/kWh
Annual increase in fuel prices	0
Annual energy production	7884 kWh/year
Equipment life	25 years
Discount rate	5 %
LCOH (Levelized cost of heat)	26,39 EUR/MWh

As evident from the presented results, the City of Karlovac has a significant potential for the further development of its district heating infrastructure. Most of the cities urban centre has a high population and therefore a high heat demand density which is necessary for the exploitation of district heating. This combined with the long tradition and the existing grid all represent driving factors for the networks continued modernisation and expansion. The primary barriers for the exploitation of district heating as well as renewable and sustainable heating in general are the age and efficiency of both the existing network and the buildings (consumers) resulting in low efficiencies as well as the relatively cheep retail price of natural gas. Another barrier, especially for the utilization of geothermal and solar energy for heating, is the fact that the existing district heating system only supplies energy for space heating and not for domestic hot water. Due to this, the system has no summer load.

When the four most viable renewable energy sources (solar, biomass, geothermal and heat pumps) are compared, it is evident that they can all supply energy at relatively affordable prices. This is especially true in the case of conventional solar thermal collectors which can supply energy at a levelized cost of heat of as low as 25,44 EUR/MWh. In cases when the conventional plate collectors can't supply the necessary temperatures, vacuum collectors can be utilized although their costs is significantly higher. Both biomass and heat pumps are viable options as well, depending on the input (electricity and biomass) prices. Finally, geothermal energy is perhaps the cities strongest option and can be viable long term if adequate sources of energy and funding are discovered at favourable locations.

North-West Croatia Regional Energy Agency (REGEA) with city of Karlovac is exploring the possibilities to utilize a geothermal energy in Karlovac, in addition to the high potential for the utilization of renewable sources in their supply, their connection and integration as well as a large-scale expansion of the network could have a tremendous impact. Such an action could help in the long-term decarbonization of the entire area and support a gradual shift toward the utilization of district solutions and away from individual gas.

The City of Karlovac has recently completed its Sustainable Energy and Climate Action Plan and is now in the process of modifying its spatial and zoning plans. The City has recognized the potential synergy between the two actions and is, with the support from the North-West Croatia Regional Energy Agency, integrating them into the first Green spatial and zoning plan in Croatia. The overall concept is to empower and enable local and regional governments to explicitly set and bindingly enforce their development pathways with a focus on sustainable development and environmental protection, using tools already at their disposal.

Within the project, a set of guidelines for the integration of energy and climate measures into the cities spatial and zoning plans will be developed, backed by a set of assessments and analysis, and subsequently implemented. The final result of the action will be a Green spatial and zoning plan which will define and mandate the implementation of climate change mitigation and adaptation measures within the City limits. This will include measures which will go beyond the state of the art. These measures will include the definition of low carbon or carbon free zones, limitation on the expansion of the use of fossil fuels for heating, mandate the implementation of building scale renewable energy production or use of green infrastructure and so on.

As this is a pilot project in Croatia, it consisted of several new concepts in the field of spatial and urban planning and was, as such, a learning experience both for the City of Karlovac and REGEA. It was a challenge to adapt some of the proposed measures to the language of spatial planning for them to be properly adapted to the plans they were being integrated in.

The stakeholders directly targeted by ENTRAIN include public authorities and DH operator/supplier in the City of Karlovac. Other key stakeholders relevant to achieve the project proposal are citizens interested in connecting on renewable energy, financial institutions, investors, contractors, replicators.

REGEA will keep supporting the City of Karlovac in the development and implementation of renewables projects and will utilize the findings of the ENTRAIN project to advocate for supportive funding mechanisms as well as positive policy changes.

3. Development of pilot heat planning – Germany

The target region of the ENTRAIN project in Germany, the Neckar-Alb region, is located in the southern German state of Baden-Württemberg. The region includes the three districts of Tübingen, Reutlingen and Zollernalbkreis with a total of 66 municipalities and about 705,000 inhabitants on an area of 2,531 km².

The region can be taken as an example of rural areas, with the exception of some urban centres. In this combination, overarching spatial and heat planning is an important criterion for a sustainable and climate-neutral heat supply for an entire region.

The state of Baden-Württemberg is breaking new ground in the strategic approach of municipal heat planning for cities: since 2021, all urban districts and large district cities have been obliged to carry out municipal heat planning. For smaller municipalities, there are financial incentives for the implementation of municipal heat planning.

Against this background, the planned procedure in ENTRAIN was varied, deviating from the creation of holistic spatial and heat plans and adapting the activities to the conditions in the region.

Instead of one or two holistic space and heat plans, a variety of overarching activities and measures were developed and implemented. The measures aimed at informing, motivating and activating the municipalities to tackle the issue of spatial and heat planning (especially smaller municipalities) in a timely manner:

- Updating the Neckar-Alb regional plan
- Municipal land development
- Municipal consultations
- GIS-based development of scenarios and visualization
- Consultations and further approaches

Update of the Neckar-Alb Regional Plan

The objective of the 4th regional plan amendment in 2021 was to provide cities and municipalities with sufficient space for the construction of ground-mounted solar plants within the framework of municipal urban land use planning. In addition to opening up for ground-mounted photovoltaic systems, the Neckar-Alb Regional Association also took the step of including ground-mounted solar thermal systems. Against the backdrop of agricultural and landscape concerns, a guiding framework was given for controlling the siting of the plants.

An important criterion for the siting is the evaluation of the landscape with a multitude of influencing factors. From this, criteria were formulated for areas in which open-space solar installations are not permitted, taking into account the existing guidelines. These are formulated in such a way that substantial space remains for the planning and construction of such systems. The regional green corridors, areas for nature conservation and landscape management and areas for agriculture as well as areas for the extraction of near-surface raw materials have been moderately opened up for ground-mounted solar plants. The amendment of the regional plan gives municipal urban land use planning greater scope for the implementation of ground-mounted solar

energy systems. Furthermore, advice was given on how to implement the plan in a way that is compatible with the landscape.

Municipal land development

In a subsequent step, existing map material was adapted on the basis of the 4th regional plan amendment in order to be able to use it directly as a regional planning orientation tool for the planning of ground-mounted solar plants. The maps show where there are no restrictions from a regional planning perspective, in which areas there are regional planning specifications (which can be overcome in individual cases), and in which areas regional planning restrictions stand in the way of the development of ground-mounted solar plants.

The overview provides initial orientation in the search for areas for ground-mounted solar plants. The map material was offered to all 66 municipalities in the Neckar-Alb region, 23 of which accepted the offer. In addition, the ENTRAIN pilot project municipalities were given concrete support in their search for sites for ground-mounted solar thermal systems.

Municipal consulting

In two specific cases, the process of municipal heating planning was initiated and support was provided for a concrete measure in the city of Mössingen and in the city of Hechingen through initial consultations.

In Mössingen, a holistic workshop with representatives of the city and the public utility company was conducted based on the initial discussion. For this purpose, existing information on heat demand, potentials, etc. was collected and processed in advance. The results were presented and discussed at the workshop. Different approaches were considered and the municipality was shown ways to achieve a climate-neutral heat supply. The next step is for the municipality to prepare a municipal heating plan.

In the city of Hechingen, a new housing district is to be implemented with an emission-free heat supply. For this purpose, a share of 70 % is to be provided by an open-space solar thermal system (in combination with a seasonal heat storage system) and geothermal probes with a heat pump. The heat generation plants are to be built on an existing earth dump. Through the involvement of the regional association, the necessary adjustments and changes in the development plan could be implemented in a targeted manner and thus the project could proceed quickly.

GIS-based development of scenarios and visualization

In close cooperation with the ENTRAIN project partner Energy Agency Styria and the energy agencies of the Neckar-Alb region, two municipalities (Ammerbuch-Entringen and Engstingen) were supported in the concrete search for locations for the heating plant and the ground-mounted solar thermal plant, as well as in the basic assessment of the establishment of a heating network.

In a first step, a so-called spatial multi-criteria analysis was used to analyse and evaluate potential areas in Ammerbuch-Entringen, taking into account the restrictions from the 4th regional plan amendment and a large number of applied criteria.

In Entringen, an estimate of the potential for the construction of a heating network was made on the basis of existing data. In further work steps, which will take place in autumn 2021, these approaches will be concretised and further developed.

The report on D.T3.2.1: Pilot heat planning at local level shows all the activities in this area that were carried out in the Neckar-Alb target region as part of the ENTRAIN project by the project partners Regionalverband Neckar-Alb, Holzenergie-Fachverband BW and the Steinbeis Research Institute Solites. The activities demonstrated led to an impulse in the region, through which several municipalities were further made aware of the topic and demonstrated the necessity for a climate-neutral heat supply.

In the coming years, new renewable heating networks will be created and existing heating networks will be decarbonised as a result of the mandatory municipal heating planning in Baden-Württemberg and especially in the Neckar-Alb region.

4. Development of pilot heat planning – Italy

Within the ENTRAIN project, APE FVG adopted a different strategy than the suggested one for identifying pilot plant opportunities. In fact, with the current Italian regulation for funding of DH projects, it is much simpler and efficient to engage directly with public administrations.

In order to create general acceptance and demonstrate the benefits that an efficient RES-DH plant could bring locally, APE FVG focuses on connecting the allocation of public funds with the adoption of the QM Holzheizwerke planning process and certification. To this aim, the most effective way to implement a pilot plant is to work directly with municipalities and establish small-scale RES-DH plants to supply public buildings like townhalls, schools, gyms and hospitals.

Under this assumption, it was decided not to perform a detailed local heat planning, with high geographical resolution, of the entire heat demand of towns. It was instead very fruitful to contact directly municipalities and offer a free consultancy on the possibility to establish a small biomass DH network at the service of public buildings. With several meetings and thorough data collection, APE FVG developed 12 pre-feasibility studies for new DH plants and assessed them following the QM principles. Moreover, 4 pre-feasibility studies for requalification and repowering of existing plants have been carried out as well and evaluated in the same way. All this material was then shared with the administrators and events (both online and in person) have been organized in order to support the creation of a working group and a common knowledge of quality management in DH plants.

Nevertheless, a more canonical approach to heat planning was adopted for one of the four mountain areas of FVG region, namely Carnia. This work has been carried out in parallel with ENTRAIN activities and its results represent an ideal preparatory activity for an in-depth heat planning over a vast area of the region. The Mountain Community of Carnia is a public entity bundling 28 municipalities located in the north-west mountains of Friuli. Within the development of the Carnia Energy Plan, a proper analysis of the heating consumption has been carried out, with a municipal resolution and by energy vector involved. This work is of great interest for the ENTRAIN project since the Carnia area is one of the most promising for the establishment of new DH plants. In fact, the large availability of local biomass, the lack of a natural gas infrastructure and the current wide utilization of old and inefficient boilers and heating systems make it the perfect environment for developing further feasibility studies.

Data collection from local administrations, the local DH operator (ESCo Montagna), gas and oil product suppliers, as well as from the regional environmental agency (ARPA) was performed and data were unified and cross-checked. With all this data a reliable and detailed status of the heating demand has been portrayed for the entire area. This is a very important step for future development plans and further implementation of measures.

Future steps foresee to keep this picture up to date and, where possible, to improve the level of detail. This is a great starting point to decide on which settlements to focus on for further heat planning, and to decide which solution could fit better for the development of the area.

5. Development of pilot heat planning – Slovenia

TARGET AREA PTUJ

The Lower Podravje region comprises 16 municipalities: Cirkulane, Destrnik, Dornava, Gorišnica, Hajdina, Jursinci, Kidricevo, Majšperk, Markovci, Podlehnik, Ptuj Municipality, Sveti Andraž in Slovenske gorice, Trnovska vas, Videm, Zavrč and Žetale.

The area of the Lower Podravje region, covering 647 km2, is relatively hosted by the population in agriculture, a targeted area that haloze to parts of the Slovenian hills and plains along the Drava river.

In the north, the Lower Podravje region also covers the central-western part of Slovenske gorice and extends from Krčevina near Vurberk across the River Pesnica to the municipality of Sveti Andraž in Slovenske gorice.

The DHS Ptuj has five gas boilers installed in two boiler rooms. The first – main boiler room EO 1 operate with three gas boilers with the power of 7,0 MW each. Gas burners can use also reserve heating oil as an energy source. In the boiler room is also installed CHP unit with a heating power of 2,2 MW. The second boiler room EO 2 has installed two natural gas boilers with the power of 1,3 MW and 1,7 MW. The together boiler output is 26,0 MW. All boilers are already quite old. They were installed in the years 1984 and 1989. The total annual heat production was approx. 12.500 MWh.

The grid with a total length of 5.990 m is owned by the DHS. Therefore the Javne službe Ptuj, d. o. o. is also responsible for the distribution of the heat.

To meet EU and national requirements, DHS Ptuj decided to explore the possibilities of the use of renewable energy sources. And here was the start of the project named "DOLB Ptuj".

With the help of the Entrain project, we prove which renewable energy source is appropriate for DHS Ptuj. Based on the action plan made, we confirmed that invest in biomass boilers is the optimal solution. The result is: appropriate solution for DHS of Ptuj.

One of the most important aims of the Action plan is also promoting RES DH. Promoting RES DHS means:

- What are the benefits of DHS?
- Use of biomass in district heating systems
- Use of another renewable energy source in DHS (solar energy, geothermal, heat pumps,…)

The RSAG Group agrees that DHS are good and they are the future if we want to become a low-carbon society. Practically, the RSAG group agrees and supports the construction of RES DH and connect to the system all possible facilities in a region, city,… It's important to make people aware that this is one of the solutions for society to switch to RES. Of course, It's necessary to present good practices from abroad to local society. In that case, we provided good practice cases from foreign countries through local training: The result is: change in people's mindsets.

The next steps were the technology for such systems – Wood biomass boiler and necessary equipment. During the Train to trainers sessions, we got a lot of knowledge about such systems. Over the past local training, we provided knowledge to relevant participants and other

stakeholders. The result is: Get more trust in such systems and designers was more confident during the project planning.

The current status of the pilot project is almost ready for project implementation. Designers are coordinate some minor adjustments to the project.

And also this information: For the investment in biomass boilers, national and EU funds are available. DHS Ptuj applied to MZI (Ministry of infrastructure) call where can receive up to 35 % of subsidy. Own sources and loans from commercial banks will cover the remaining part of the investment. Negotiations with the bank are still ongoing.

MAJOR OBSTACLES:

At the moment, we can't define any major obstacles that may hinder the investment, but the operator shall put the effort into communication with relevant stakeholders and residents.

MINOR OBSTACLES:

Residents' doubts about flue gases and wood biomass logistics. This was solved with a good advertising campaign and knowledge transfer through the Entrain project. The most relevant stakeholders are our RSAG members, who got knowledge in this field through the Entrain.

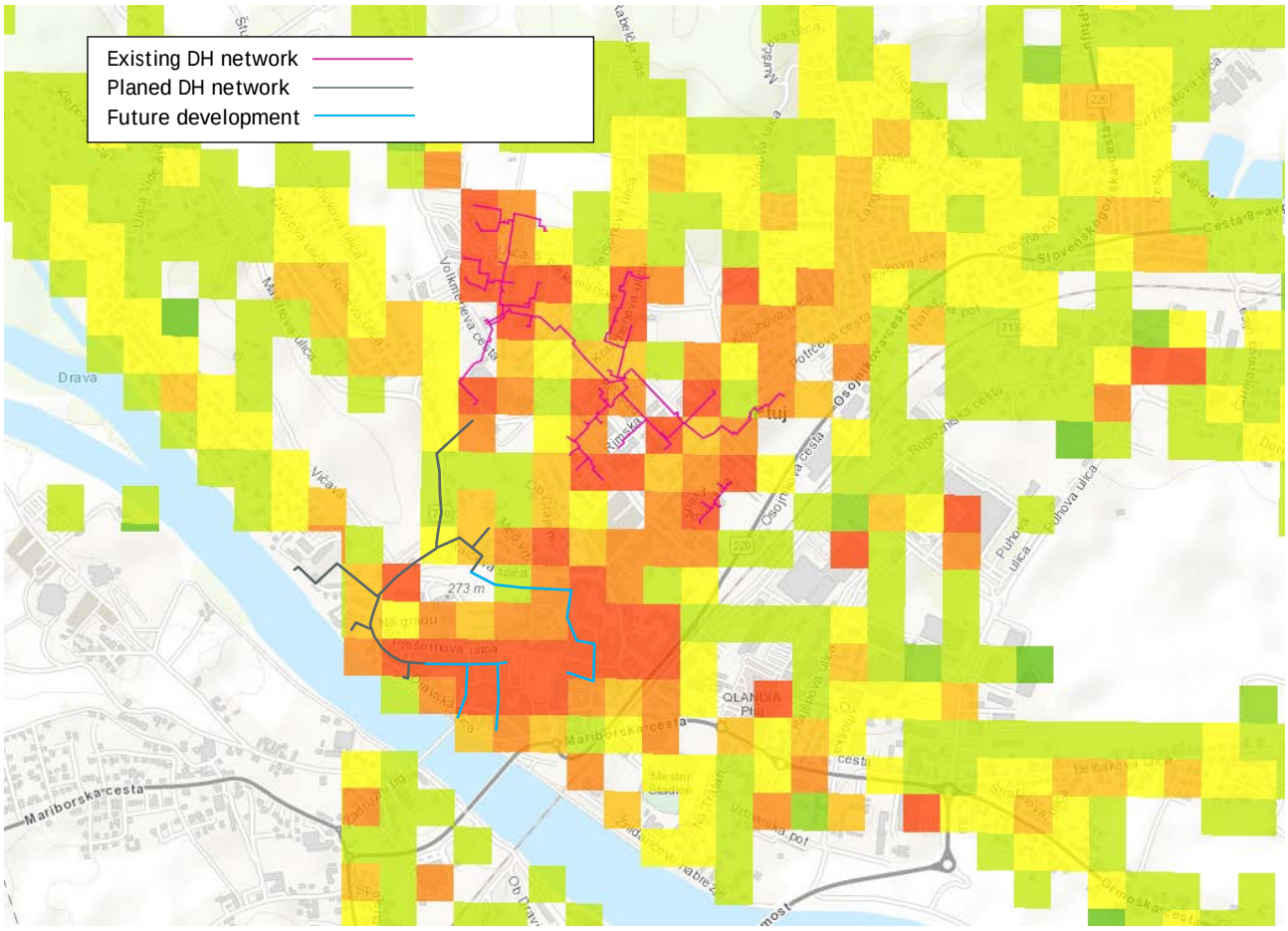
RISKS:

We identify some risks that may interrupt the timeline of the investment. First, is related to the project team and lack of time to focus on the project and second, are residents that may object to the biomass boilers in the city. These risks are manageable with close cooperation among project team members and external support services. The communication campaign with a detailed presentation of technical solutions and air quality monitoring should calm the local population.

FUTURE DEVELOPMENT:

Definitely the project is set up for future development.

- Source side: The boiler room can be upgraded with additional hot water storage tanks
- Distribution site: Here is the greatest opportunity for expansion. DH network can be expanded into the direction to the old part of the city centre where it's a huge potential of heat demand. Potential is also DH network to the industrial part of the city. There is huge potential also for the construction of a brand new boiler room – heat source. There could be a bigger boiler room with more space for biomass storage and logistic.



[Source: https://www.arcgis.com]

KEY POINT:

The planning is still an ongoing activity right now. Entrain have a big impact on all activities during the planing.

TARGET AREA VELENJE

District heating system in Velenje run on coal – lignite. A nearby thermal power plant called Termo elektrana Šoštanj (hereinafter TEŠ) provide heat to KP Velenje, which operate the DH network. Two legal entities TEŠ and KPV have contractual agreement on heat (hot water-steam) supply, with energy in MWh as key unit.

For the district heating in Šalek valley, the Šoštanj Thermal Power Plants have built three production sources of heat energy. The TP-1 production source is located on block 3., the TP-2 production source is located on block 5, and the TP-3 production source is located on block 6. The heat produced for district heating purposes of the Šalek valley is in its entirety produced by co-generation (cogeneration) (condensation turbines). During the summer months and for the most of the year, only one of the mentioned thermal stations operates, TP-3, which is located in production unit 6 and provides completely simultaneous cogeneration production of thermal energy.

The grid of DHS of the Velenje Municipality and the Municipality of Šoštanj consist of:

Hot water network with pressurized hot water as the medium is connected to the production source (heating plant) and distributes heat through the hot water network to the main heat exchangers (heat stations). DH Velenje has central heat exchange station (CPS).

- District cooling system with cooling medium cooled water, which takes heat from the cooling unit and distributes it to the exchangers in substations via a connected network. The nominal system pressure is 3 bar and the nominal temperature is 6 °C.

NETWORK (GRID) DATA	
Areas of energy corridors	12.66 km2,
Length of the network	173.162 m
Length of the insulated pipes	403.2 km
Pipes dimensions	od DN 15 do DN 600 mm
Network pressures	od PN 6 do PN 25 bar
Typical flow temperature	od 70 do 140 °C
Annual water usage	20.106 m3
Number of substations (TPP)	476
Number of internal substations (ITP)	195
Number of heat exchangers	3.420
Total heated area	714.724 m2

The district heating network was designed and built on two technological designs. Until 1980, a three-pipe heating system with direct substations (TPPs) was built in the Velenje, until later it was completely reconstructed into a pipe system with indirect TPPs and heat exchangers. A three-pipe heating system means that it has separate heating supply pipes, separate domestic hot water pipes and separate common return water pipes.

DH Velenje is second largest DH in Slovenia with more than 11.000 costumers. In past years, the price of heat rose for about 50%, mainly because of the dispute with heat suppliers, which is Thermal power plant Šoštanj and public utility company Velenje (KPV). This dispute and some other uncertainties in the heat supply, show needs for preparation of feasibility study to check the alternative energy sources

Several experts from KP Velenje are involved in ENTRAIN training program, they gained new knowledge and develop their skills in project management, grid renovations and customer relations. Especially in the field of consumer engagement and awareness-raising, we plan to prepare some actions shortly.

Historically, Velenje and Šoštanj had the lowest price of energy for heating for years. Because of the low price of energy, the return of investments in grid efficiency, or even in building renovations has been negative. In recent year's price of heat increases, it is still the lowest in Slovenia, and renovations become more economically feasible. Thus, KP Velenje prepared a plan for grid renovation, which has to be done step by step, through several years. KP Velenje starts considerations about their own heat production unit, which depends on future operations of Thermal power plant Šoštanj. Presumably, TEŠ will close between 2014 and 2050, and by then Velenje and Šoštanj have to have fully operational alternative energy sources.

From today's point of view, natural gas is the most viable solution, but with future development of alternative RES and seasonal heat storage, other solutions must be taken into consideration. Šalek Valley energy transition is the priority for local authorities and relevant stakeholders, which will, together with KP Velenje, try to find the best solution for development and DH heating system.

6. Development of pilot heat planning – Poland

In Poland the ENTRAIN actions focus on the Płońsk District, which is interested in increasing the share of RES in their energy mix, including the share of RES in district heating. Achieving this target requires actions at two levels:

- Actions at district level, targeting specifically district regulatory frameworks

Regarding district level, the plan foresees two key activities/case studies:

Case study 1: Including provisions concerning further development of RES-based district heating in Płońsk Sustainable Energy and Climate Action Plan.

As a Covenant of Mayors, signatory Płońsk is committed to develop and adopt a Sustainable Energy and Climate Action Plan until 2030, with the aim to reduce its GHG emissions by 40 % by 2030. This, on the one hand, will be achieved by reducing energy consumption in public and private sector, and on the other hand, by decarbonising energy production, among others by further development of district heating systems and by increasing share of RES in these systems. Based on the analyses conducted within the ENTRAIN project and the conclusions drawn, relevant provisions will be included in the SECAP to be submitted by the end of 2021 and adopted by the City Council early 2022.

Case study 2: Including provisions concerning further development of RES-based district heating in Low-Emission Development Programmes of other municipalities located in Płońsk District.

Although not being Covenant signatories, also other municipalities in the Płońsk District develop climate and energy – related programmes. At present most of them are in the process of updating their Low-Emission Development Programmes (originally developed until 2020), as they will be required to apply for funds in the new financial perspective. ENTRAIN analyses and conclusions will be used to prepare recommendations concerning provisions that could be included in the programmes to ensure that RES-based district heat will be considered as one of the key priorities in municipalities further sustainable development. The recommendations will be discussed and fine-tuned during the last RSAG meeting.

- Actions at national level, targeting national regulatory frameworks and authorities overall capacities to conduct pilot heat planning at local level

Case study 3: Including provisions concerning further development of RES-based district heating in Płońsk Sustainable Energy and Climate Action Plan.

Although the ENTRAIN pilot area is the Płońsk District, case study 3 is targered at the entities from throughout the country, since it was found necessary to develop overall competences of wider pool of public authorities concerning planning and implementing new/expanded district heating systems based on RES. Therefore, a series of dedicated online trainings is planned to share the knowledge and experiences gained within the ENTRAIN project and to increase competences of:

- Representatives of local authorities;

- Representatives of energy utilities;
- Representatives of RES sector
- Developers/Implementers of district heating systems

to efficiently plan RES-based heat delivery and thus contribute to the development of district heating systems using locally available, renewable sources.

Case study 4: Preparing recommendations for national and regional authorities aiming to improve legal and regulatory frameworks to facilitate development of RES-based district heating systems

Increasing share of RES in district heating systems requires favourable legal and regulatory frameworks. National and regional strategy and planning documents foresee energy transition towards cleaner energy production, however local authorities, smaller energy utilities, NGOs active in the energy sector, etc. find the existing frameworks in need of improvement in order to facilitate investments in small RES-based district heating systems. In order to support communication between the key stakeholders and regulatory authorities, as well as express the needs for legal/regulatory frameworks changes, following activities are planned:

- Discussing legal/regulatory barriers hindering development of RES-based district heating, as well as coming with the first pool of recommendations during the 3rd RSG meeting;
- Conducting online survey among the representatives of the district heating/RES sector
- Presenting conclusions from the two exercises during the vertical workshop with the participation of national, regional and local authorities, as well as the representatives of the district heating/RES sector. Discussing possible legal/regulatory improvements that would support increasing share of RES in system heat production, and thus reaching targets set in National Energy and Climate Plan until 2030 and the Polish Energy Policy until 2040.