D2.5

Demo-followers' District Round Table

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Technical References

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Project Coordinator	ACCIONA
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[1] PU = Public
PP = Restricted to other programme participants (including the Commission Services)
RE = Restricted to a group specified by the consortium (including the Commission Services)
CO = Confidential, only for members of the consortium (including the Commission Services)

Document history

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Executive Summary

In WEDISTRICT project, industry innovators from 9 European countries will integrate multiple sources of renewable energy and excess heat to showcase solutions for 100% fossil free district heating and cooling systems being aligned with the foremost goal of the European Green Deal which is reaching climate-neutrality in 2050.

The WEDISTRICT solutions will be implemented in four real-scale projects in Spain, Romania, Poland and Sweden. These demosites will showcase technological montages that can be replicated across different climate zones and building types. The demosites will be used to establish best practices that will transform the heating and cooling sector.

As part of the project, other virtual demosites have been set-up. These virtual demosites are based on new or existing DHC system wishing to test improvements based on WEDISTRICT concepts (e.g: RES, waste heat recovery option). The virtual demosites are counted as WEDISTRICT demo-followers. Each virtual demosite has one referent WEDISTRICT partner in charge of its evaluation.

Discussions have started to gather information regarding virtual demosites expectations, needs and action plan. Key DHC system characteristics as central station size, equipment features, thermal and cooling profiles, current operation strategies, economic information and other useful inputs have been collected in order to agree on the main challenges in terms of energy efficiency and costs reduction.

The main objective of the activity is to support the current system, in retrofit cases, or propose the new generation plan, in greenfield cases, of the demo-followers, demonstrating the WEDISTRICT replicability potential by multiplying examples of DHC based on renewable energies. Each virtual demosite will integrate the most suitable technologies and operation strategies for improving the energy efficiency and lowering the emissions, considering the best cost-effective solutions.

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There are two categories of demo-followers: the first corresponds to new proposals of DH/C systems and the second to the retrofitting of existing DH/C system:

NEW DH/C SYSTEMS		
Demo-follower	**Location**	**Description**
SeiMilano	Milan (Italy)	New modern urban and landscape re-development project that transforms the area by generating a new landscape.
Montegancedo Campus	Madrid (Spain)	School of software engineering and research pole with multiple research institutions currently supplied by individual gas boilers and compression chillers.
Playa del Inglés	Gran Canaria (Spain)	New DHC network in potential Canary Islands area.
Tecnoalcalá	Alcalá de Henares (Spain)	Scientific and Technological Park with individual heating and cooling supply in more than 40 companies located in the Park.
Independencia	Santiago de Chile (Chile)	10 clients (4 health clients, 2 residential apartments, 1 university, 1 mall and 2 offices and public clients), with 18 buildings for a new DHC proposal.
RETROFITTING OF EXISTING DH/C SYSTEMS		
Demo-follower	**Location**	**Description**
Parc de l'Alba	Barcelona (Spain)	New urban development with a high efficiency energy system and DHC partially implemented. 2 new production plants are planned.
Cyprus University	Nicosia (Cyprus)	DHC initially developed in 1999, expanded twice (in 2007 and 2010) and new expansion planned for year 2022. Currently operating with oil boilers and air-cooled chillers.
Żyrardów	Żyrardów (Poland)	Existing DH with around 500 heat centres coal-fired based (35-year old)
Valladolid	Valladolid (Spain)	6 buildings covered by a recent (2018) DH installation biomass-based with extension perspective.
Focsani	Focsani (Romania)	Old DH network retrofitted in 2018 with new CHP and gas boiler facilities.
Mrągowo	Mrągowo (Poland)	Old DH network (247 buildings connected) which has started a retrofitting action replacing coal by biomass.

To summarize, the WEDISTRICT demo-followers' community focuses on the large-scale replication potential of the technologies. Key outcomes of the project will be established guidelines based on the real and virtual demos aiming at advising for DHC systems improvement and optimisation, adapting the solution to the country and climate in which the DH/C is installed. The use of local resources, renewable energies, and waste heat recovery technologies will be encouraged.

For more information you can visit our webpage www.wedistrict.eu

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Acronyms

Acronym	Description
A/A	Air to Air
A/W	Air to Water
ANRE	Autoritatea Naţională de Reglementare în domeniul Energiei (Romania)
APTE	Association of Science and Technology Parks of Spain
BAU	Business As Usual
CAPEX	CApital EXpenditure
CCHP	Combined Cooling, Heating and Power Generation
CHP	Cogeneration Heat and Power
COP	Coefficient Of Performance
DC	District Cooling
DH	District Heating
DHC	District Heating and Cooling
DH/C	District Heating and/or Cooling
DHW	Domestic Hot Water
EU	European Union
ESCO	Energy Service Company
ESEER	European Seasonal Energy Efficiency Ratio
FC-WHR	Fuel Cell – Waste Heat Recovery
GDPR	General Data Protection Regulation
HP	Heat Pump
ITC	Canarian Technological Institute
OPEX	OPeration EXpenditure
PTC	Parabolic Trough Collector
PV	Photovoltaic
PVT	Photovoltaic and Thermal
RACU	Renewable Air Cooling Unit
RES	Renewable Energy Sources
TF-FTC	Tracking Concentrator for Fixed Tilt Collector
UCY	University of Cyprus
WHR	Waste Heat Recovery

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1 Introduction

The heating and cooling of buildings accounts for 50% of the total EU energy consumption[1]. A large part of this energy (70%) is currently generated from fossil fuels – coal, natural gas and oil[2]. By switching to fossil fuel free energy, this sector could bring Europe one step closer to climate neutrality decreasing greenhouse gases emissions. This switch would also improve the air quality and the global quality of life in European cities. One of the goals from the EU, which is at the heart of the European Green Deal, is to become climate-neutral by 2050[3]. WEDISTRICT project is completely aligned and aims to do just that - demonstrate innovative 100% fossil free heating and cooling solutions for new and existing district heating and cooling systems.

WEDISTRICT project aims to demonstrate that District Heating and Cooling systems can be built on a combination of renewable energy sources and waste heat recovery solutions. To fulfill this ambition, WEDISTRICT will set up four demonstration sites across Europe to showcase our success stories. Four real-scale projects (see Figure 1-1) will be carried out in different climate zones across Europe, where there are distinctive district heating and cooling systems and construction traditions. Each demonstration case will be based on the integration of two or more renewable energy-based technologies, building upon local resources and innovative technologies.

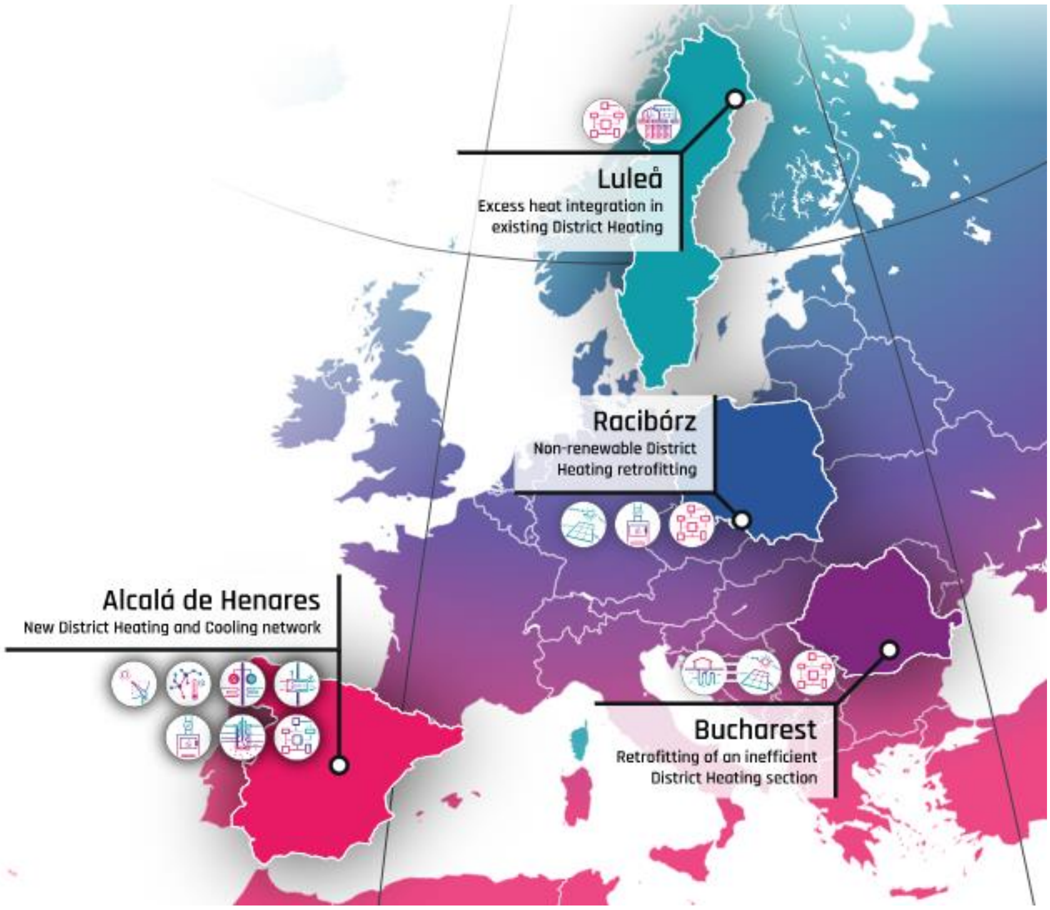

Figure 1-1. WEDISTRICT project demosites

[1] European Commission. 10 things you didn't know about heating and cooling. https://ec.europa.eu/energy/sites/ener/files/DG_Energy_Infographic_heatingandcolling2016.jpg
[2] European Commission. Towards a smart, efficient and sustainable heating and cooling sector. February 2016
[3] https://ec.europa.eu/clima/policies/strategies/2050_en

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Besides the real demosites, WEDISTRICT project will extend its replicability by collaborating with other virtual demosites. These virtual demosites (called demo-followers) are real locations which will be studied from a theoretical point of view, which will be assessed in the frame of WEDISTRICT project for the next months in order to study the WEDISTRICT technologies and solutions replicability in different scenarios (namely weather conditions, current systems, consumers, etc.). The study will be simulation-based (using Trnsys software) and will serve to gather more outputs which will be useful for acquire a better understanding of the project conclusions.

The WEDISTRICT demo-followers' community focus on the large-scale replication potential of the technologies. Key outcomes of the project will be guidelines established based on the real and virtual demos aiming at advising for DHC systems improvement and optimisation, adapting the solution to the country and climate in which the DHC is installed. The use of local resources, renewable energies, and waste heat recovery technologies will be encouraged.

1.1 Methodology

This activity corresponds to Task 2.5 (Demo followers' District Round Table) and it has been focused on the demo-followers identification and their description as virtual demosite. Different existing and new DHCs systems have been identified to be part of Demo followers' community which will be studied for improving the current status by integrating WEDISTRICT concept (RES and waste heat recovery integration based).

A first contact was established in order to gather needed inputs and perform a first preliminary ideas and measures description. Partners involved in virtual demos evaluation have had a first picture of each of their selected demo-follower. Central station size, equipment features, thermal and cooling profiles, current operation strategies, economic information and other useful inputs have been collected in order to make a first agreement about challenges for energy efficiency and reduction costs possibilities.

This activity will continue further in the project (Task 5.4) in order to perform a detailed analysis using simulation models developed in the frame of WEDISTRICT project in order to evaluate the most promising and cost-effective solutions for each particular demo-follower (which will be considered virtual demosite, able to extend the conclusions obtained from the WEDISTRICT demosites).

Within the project, the Simulation Working Group has been created in order to perform the different activities related to simulations, cooperating since the very beginning in the definition and structure of the simulation work as a whole.

Next table shows the activities breakdown summary performed along the task:

Table 1-1 Task 2.5 Activities breakdown

Activity	Description of Activity
Activity 1	**First round with DHC already contacted at proposal phase**. Output: First demo followers' district confirmed.
Activity 2	**Contact with potential demo followers** (1st common round). Output: List of demo followers' district creation.
Activity 3	**Contact with potential demo followers for virtual demo definition**. Output: List of demo followers' district confirmation.

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Activity 4	**Development of a template** with a questionnaire for demo followers' district in order to gather suitable information about DHCs. Output: Inputs template definition.
Activity 5	**Contact with potential demo followers** (2nd common round). Output: Final list of demo followers' district.
Activity 6	**Definition of final demo followers' district confirmed and virtual demos which will be studied within WEDISTRICT project**. Output: Final definition of demo followers' district and virtual demos.
Activity 7	**Inputs gathering from demo followers' district selected for simulation and preliminary potential measures**. Output: Preliminary assessment of virtual demos and possible solutions to be simulated in T5.4.
Activity 8	**Redaction of deliverable D2.5 with all the contents related to task 2.5**. Output: Deliverable D2.5.

As said previously, the main objective of the activity is to improve the current system of demo followers by integrating renewable energy systems and demonstrate WEDISTRICT replicability. Each particular virtual demosite will integrate the most suitable technologies and operation strategies for improving the energy efficiency and lowering the emissions.

Representative people from demo-followers have been asked for sharing some information (fulfilling always GDPR issues). The Simulation Working Group developed a template to be filled and it was up to each demo-follower to provide as much detail as they considered.
Exceptional contacts could be needed from the simulation working group in order to clarify unclear points, having in mind that each demo-follower is free to manage the contact procedures with the simulation working group.

In this document, each of the demo-follower description is structured following the next contents:

GENERAL DESCRIPTION: Short description as introduction, with main features of the location, RES potential and current DHC development in the site.

PRELIMINARY ASSESSMENT: Energy baseline description, identification of possible suitable solutions and main impacts expected according to this very preliminary assessment.

CONCLUSION: Short conclusion about the demo-follower at this stage.

During the full activity (Task 2.5 + Task 5.4) two workshops will take place with representative people from each demo-follower in order to show them the performed work and obtained results, generating debate and receiving their feedback in order to provide the expected study. It is foreseen the first workshop in Madrid (Nov-Dec 2021) and the second workshop in Bucharest (Sept-Oct 2022). Physical participation is not mandatory although recommended for an optimal interaction and discussion.

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2 WEDISTRICT Demo-followers

2.1New DH/C demo-followers

The first type of selected demo-followers corresponds to locations where there is no existing DH/C system currently. The demo-followers which will be studied are listed as follows:

- **SeiMilano (Milan - Italy)**
- **Montegancedo Campus (Madrid - Spain)**
- **Playa del Inglés (Gran Canaria - Spain)**
- **Tecnoalcalá (Alcalá de Henares - Spain)**
- **Independencia (Santiago de Chile - Chile)**

Next, the description of the different new demo-followers is shown:

2.1.1 SeiMilano (Milan – Italy)

GENERAL DESCRIPTION

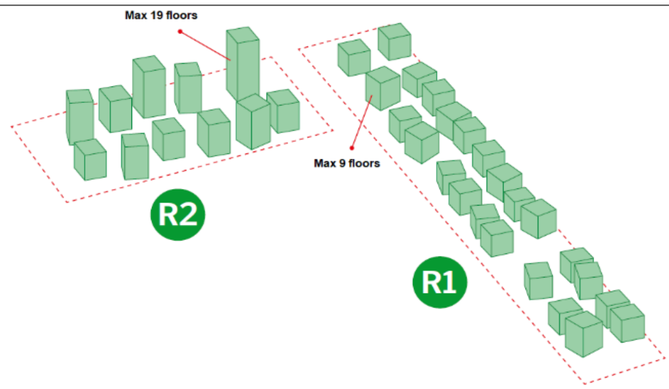
SeiMilano is a new DHC demo-follower and concerns the establishment of a new city district in Milan. Heating and cooling will be provided via DHC networks by the local utility A2A, one of Italy's largest multiutilities.

The project was started during 2nd semester of 2019, and the delivery of the first real estate units is planned for 1st semester of 2022. By the 2nd semester of 2022, the work on several sectors (named "R1", "Tertiary" (T), "Commercial" (C) and "Park" is planned to be completed. Preliminary illustrations of the sectors (called lots) are shown in Figure 2-1 through Figure 2-4 below.

The area of investigation is located south-west of Milan, between *Via Calchi Taeggi* and *Via Bisceglie*, adjacent to the metro terminus (M1). The area is part of an impressive urban regeneration project, which will lead to the creation ofan innovative multifunctional district integrated in a park.

The area consists of approx. 115,000 m^2, where the following lots will be built:

- Lot "R1": planned to consist of 6 blocks of residences for a total of 550 flats.
- Lot "R2": planned to consist of 470 flats, currently being designed.
- Tertiary Lot, "T".



(a) The lots "R1" and "R2" showing the blocks of residences currently being designed.

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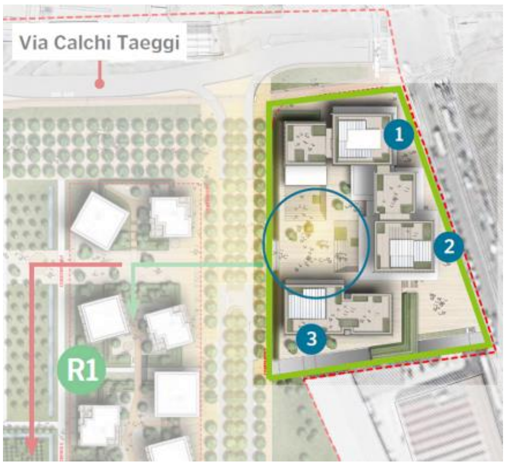


(b) The Tertiary Lot, "T", is shown encircled in light green, to the upper right of Lot "R1".

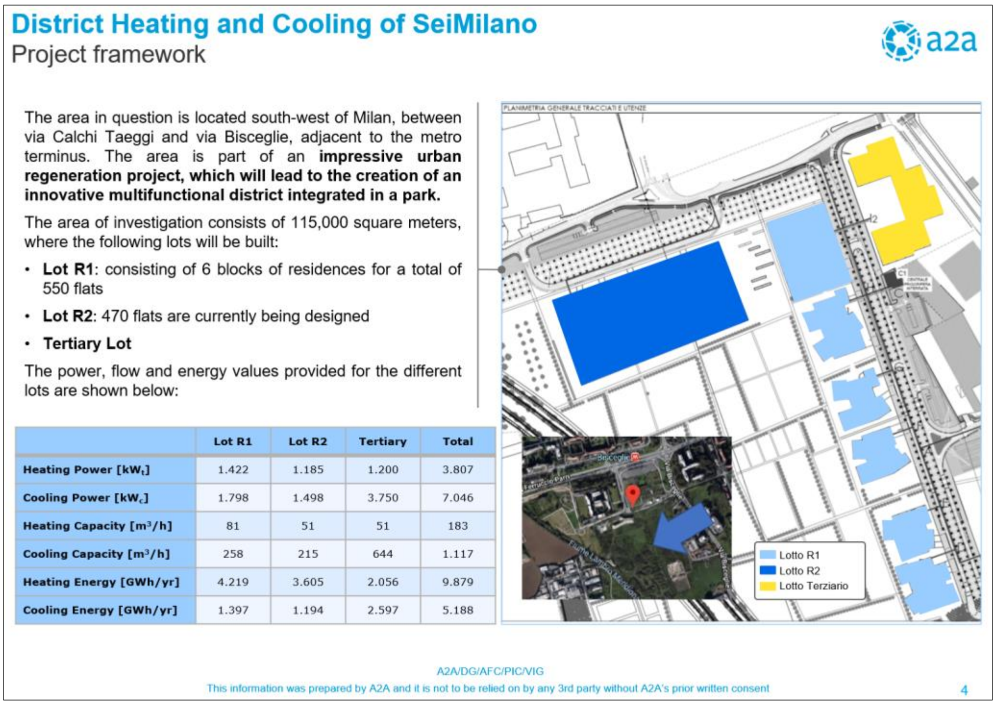
(c) The Tertiary Lot, "T", visualised from the road Via Bisceglie (rightmost in (b).)

Figure 2-1. Lots of the area in question, located south-west of Milan[4]

These lots are further described and illustrated in the following sections. It is informed that SeiMilano is in the need of two types of energy demands:

- District heating to a no. of buildings; not yet finally clarified, approx. 1,020 apartments.
- District cooling to a no. of buildings; not yet finally clarified, approx. 1,020 apartments.

Provided data and buildings information schematics are presented in Figure 2-2 and Figure 2-3. Figure 2-2 highlights the lots of investigation and lists their expected energy demands, while Figure 2-3 shows the western Milan DHC network (leftmost) and the approx. areas of the lots (rightmost).



	Lot R1	Lot R2	Tertiary	Total
Heating Power [kW_t]	1.422	1.185	1.200	3.807
Cooling Power [kW_c]	1.798	1.498	3.750	7.046
Heating Capacity [m^3/h]	81	51	51	183
Cooling Capacity [m^3/h]	258	215	644	1.117
Heating Energy [GWh/yr]	4.219	3.605	2.056	9.879
Cooling Energy [GWh/yr]	1.397	1.194	2.597	5.188

Figure 2-2. The SeiMilano lots of investigation and their expected energy demands.

[4] Ref: SeiMilano-IT02.pdf (internal document)

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Figure 2-3. SeiMilano and the western Milan DHC network and approx. areas of lots.

A table with the basic data summarized is included in Annex 1: Basic info tables (Table 4-1).

The areas of investigation in SeiMilano are further illustrated in Figure 2-4, in greater detail, along with the commercial sector, "C".

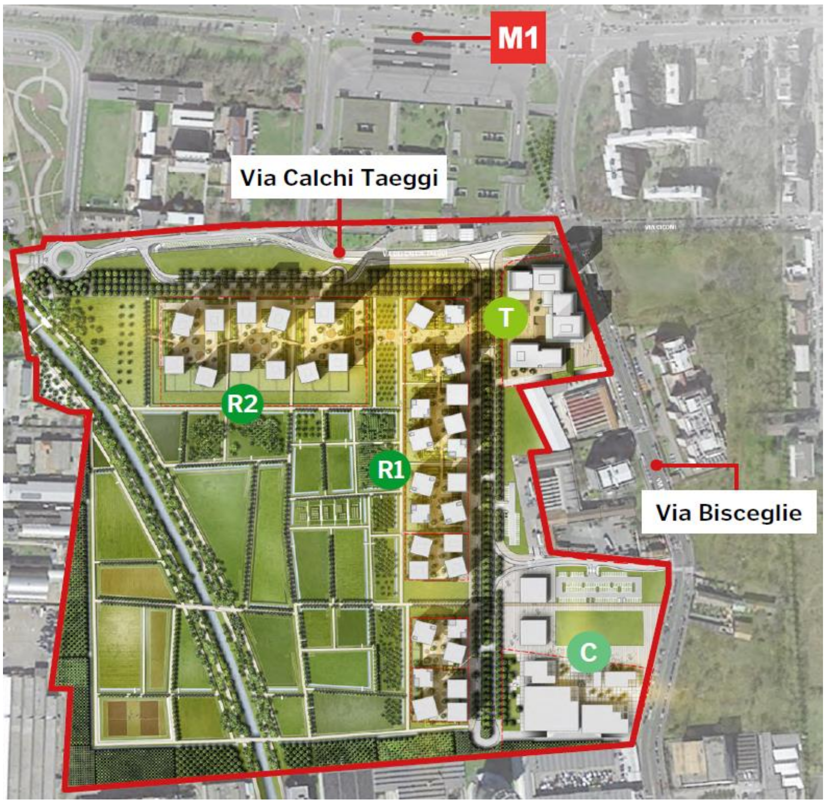

Figure 2-4. Map of SeiMilano showing sections "R1", "R2", "T", "C" and the park area.

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In 2017 only 3% of Italy's heating demand came from district heating, while 56% came from natural gas, 8% came from oil (or petroleum products), and 6% came from electricity[5]. In Figure 2-5 below "Renewables" include wood pellets, wood chips, biomass, firewood, geothermal and solar thermal.

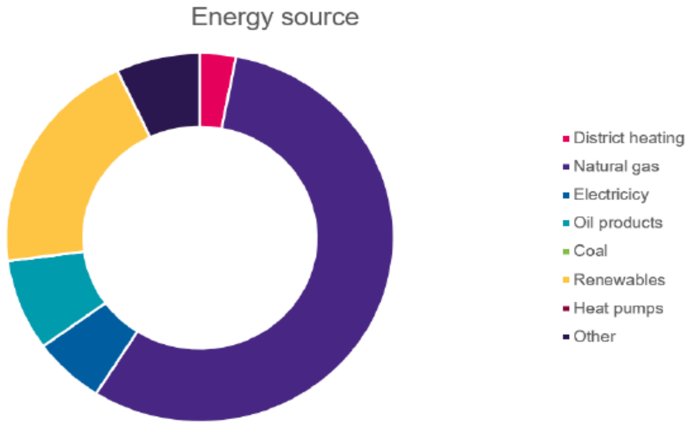

Figure 2-5. Distribution of energy sources used to satisfy heat demand in the Italian residential sector in 2017.

This means that there is a significant potential for reducing Italy's carbon footprint by converting private gas- and oil-fired central heating systems to parts of city-wide district heating and cooling systems using one or more WEDISTRICT technologies for DHC production.

PRELIMINARY ASSESSMENT

For the preliminary assessment, it is noted that the power- and energy-related values in Table 2-1 are only estimated so far. Based on the final design document, awaiting, R2M informs to calculate and provide these values with a dynamic simulation software.

Table 2-1 Heating and cooling power, capacity, and energy for the SeiMilano lots R1, R2 and T.

		R1	R2	T	TOTAL
HEATING POWER	$[kW_t]$	1,422	1,185	1,200	3,807
COOLING POWER	$[kW_c]$	1,798	1,498	3,750	7,046
HEATING CAPACITY	$[m^3/h]$	81	51	51	183
COOLING CAPACITY	$[m^3/h]$	258	215	644	1,117
HEATING ENERGY	[GWh/yr]	4,219	3,605	2,056	9,879
COOLING ENERGY	[GWh/yr]	1,397	1,194	2,597	5,188

After a preliminary assessment of SeiMilano, the main information found is summarized below:

- SeiMilano is a project where a new neighbourhood is being built in the western part of Milan; several new homes, offices and shops are to be built.
- A number of absorption heat pumps will be installed; the pumps must provide heat in the wintertime and cooling during summertime.
- A compression heat pump (conventional heat pump) will also be installed; the compression heat pump must help the absorption heat pump if the absorption heat pump cannot quite deliver the required cooling.

[5] WEDISTRICT Project - Deliverable D2.3 "District Heating and Cooling Stock at EU level"

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- It is planned that groundwater is to be pumped up and used to ensure the condensation of the refrigerant in the heat pumps; the heated groundwater is pumped out into a stream that runs through the nearby green area (the park).
- Several PV panels will be installed on the roofs of houses and buildings. It is a legal requirement that PV panels will be installed on new or heavily renovated buildings. The PV panels are intended to supply the buildings' electricity consumption (as well as being on the electricity grid as an electrical storage solution)
- It is suggested to investigate the use of PV-T instead of PV panels as an optimization.
- The neighbouring green area is unfortunately not accessible as it is laid out as a recreational area; in addition, the price of the land is quite high, which would make it very costly to place a solar heating system in the area.
- It is noted that there is not much CO_2 to shift in this project as most, if not all, is renewable energy; therefore, it is agreed, since SeiMilano is a new project and nothing has been completed yet (they have only just begun), it would make more sense for WEDISTRICT to simulate how the district heating system is expected to work.

Considering the previous information, the technologies and solutions proposed to be studied for SeiMilano as a demo-follower are presented in Table 2-2 in the following:

Table 2-2 Summary of technologies proposed for SeiMilano demo-follower.

Technologies proposed	By means of
Advanced Absorption Chiller	Investigation of the performance and operation of the WEDISTRICT advanced absorption chiller compared to a conventional absorption chiller.
Renewable Air-Cooling Unit (RACU)	Investigation of the option of applying a RACU to deliver cooling instead of the absorption chiller solution(s).
Photovoltaics/PV (+ Thermal)	Comparison of possible PV and PVT solutions (possibly with tracking mirrors) to investigate the possibility of increasing the electrical and thermal outputs. The WEDISTRICT PV-geothermal hybrid will also be considered. Several PV panels will be installed on the roofs of the buildings, since it is a legal requirement that PV panels will be installed on new or heavily renovated buildings. PVT is proposed as an optimization to this.
Geothermal System	Investigation of the option of a geothermal system layout as well as the WEDISTRICT PV-geothermal hybrid solution.
Heat Pump (A/W)	Investigation of the performance and operation of an absorption heat pump compared to a (conventional) compression heat pump. A number of absorption heat pumps is planned to be installed in order to provide heat in the wintertime and cooling in the summertime. In addition, a compression heat pump will be installed to assist the absorption heat pump if the absorption cannot deliver the required cooling.
Fuel Cell	Investigation of the application of a fuel cell to deliver power and heat to homes, offices, and businesses in combination with an air-to-water heat pump to deliver cooling, and possibly hot water.

The combination of the different technologies generates three main solutions which will be studied in the next steps (other solutions might arise during the activity):

Table 2-3 Summary of preliminary solutions proposed for SeiMilano demo-follower.

Solutions proposed after preliminary assessment			
Technology	S1	S2	S3
Advanced Absorption Chiller	x		
PV / PVT	x	x	
Geothermal System	x	x	
Heat Pump (A-W)	x	x	x
RACU		x	
Fuel Cell			x

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Table 2-4 Preliminary solutions proposed for SeiMilano demo-follower.

Solutions proposed overall description	
Combination code	**SEIMILANO – S1**
Justification	The proposed solution S1 reflects the solution already planned for SeiMilano and is intended to be used as a sort of benchmark solution. Thus, solution S1 integrates and combines the technologies of advanced absorption chilling, photovoltaics, a geothermal system as well as the air-to-water heat pump technology. This combination is suitable for SeiMilano, since it includes the solutions already considered to provide district heating (A-W heat pump, geothermal system), district cooling (absorption chilling, possibly advanced), as well as electricity generation (PV), which are in the scope for this new DH/C demo-follower and planned to be applied to a number of 1000+ residences and possibly, offices and businesses.
Expected impact	● Investigation of the installation of the new DHC equipment / plant capacity to cover the expected DHC and electricity demands of the new residential buildings. ● Investigation of the possible improvements of the absorption chiller performance. ● Investigation of the possible improvements regarding PV or PV-T system layouts. ● General advising on planning of energy equipment for the new development of residential buildings and possibly, offices and businesses.
Combination code	**SEIMILANO – S2**
Justification	The proposed solution S2 is a variation of the planned setup using RACU to deliver cooling instead of the absorption chiller. Note that the PV (PVT), geothermal, and heat pump technologies from S1 are considered here as well, in combination with the RACU. However, it is noted that the geothermal heat pump system is reversible and can provide cooling by itself, not needing the RACU. Moreover, it can provide free cooling by direct heat exchange with the ground in the right conditions. This solution would directly compare the options provided with Advanced Absorption Chilling to the options provided with RACU.
Expected impact	● Investigation of possible improvements related to the district cooling needs, also considering limitations such as the space available for installation. ● General advising on planning of the new development of residential buildings, equipped with RACUs instead of absorption chilling units. Here it is noted that the absorption chiller would be centralized in the generation plant, while RACUs would be placed in each building. The advantage in this solution would be in converting the system from four pipes with absorption chiller to two pipes with RACU.
Combination code	**SEIMILANO – S3**
Justification	The proposed solution S3 is a variation of the planned setup using fuel cell technology to deliver power and heat to the residences, and possibly new offices and businesses, combined with an air-to-water heat pump to deliver cooling, and possibly hot water.
Expected impact	● Investigation of possible improvements related to the district heating needs, as well as electricity generation, in the form of the WEDISTRICT fuel cell technology. ● Investigation of possible improvements related to the district cooling needs, in the form of the WEDISTRICT heat pump technology. ● General advising on planning of buildings' energy equipment alternatives.

CONCLUSION

At this stage of the WEDISTRICT project, it is concluded that since SeiMilano is a new project and nothing has been completed yet (they have only just begun), it would make more sense for WEDISTRICT to simulate how the district heating system is expected to work (S1).

In addition, A2A has shown their interest in a few other technology combinations including RACU (S2) as well as Fuel cells and an air-to-water heat pump (S3). Furthermore, simulations including the advanced absorption chiller are of interest. Thus, these technology combinations are planned for simulation in order to support A2A in choosing the best suitable heating and cooling generation technologies.

Concerning the energy demand of SeiMilano, overall needs of heating/cooling power as well as annual thermal/cooling energy needs have been given. Further information about cooling (and heating) loads and profiles as well as further information about the buildings (approx. 1,020 apartments planned in "R1" and "R2", in addition to the other sectors, "T", "C", and the park area.) will be received in the next phase.

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2.1.2 Montegancedo Campus (Madrid – Spain)

GENERAL DESCRIPTION

The Montegancedo Campus is a recent development campus belonging to the Polytechnic University of Madrid (UPM). It is located in Pozuelo de Alarcón (Madrid, Spain) and occupies 480.000 m^2. Currently it is composed by six buildings, among which the school of software engineering (ETSI), a sport facility, and 4 research buildings. Among these, two are of special interest because of their high energy consumption. On one hand there is the super-computation and visualization centre of Madrid (CESVIMA) with its data centre, and on the other hand the centre of biotechnology and genomics of plants (CBGP) with its greenhouses.

Figure 2-6. Montegancedo Campus overview.

Figure 2-7. Montegancedo Campus layout.

Pozuelo de Alarcón has a good potential for solar energy harvesting, with an annual direct nominal irradiation (DNI) of 2,053 kWh/m2/year[6], which would be even suitable for CSP. Regarding the biomass potential, Madrid has a consolidate biomass market, with prices of pellet and wood-chip according to the last 2020 semester report of IDAE[7] were around 0.039 €/kWh and 0.025 €/kWh, respectively. The geothermal potential expected in Montegancedo Campus is about 35-50 W/m^2 [8,9], which will depend on the specific characteristics of the soil,

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[6] Global Solar ATLAS. https://globalsolaratlas.info/

[7] IDAE. Informe precios biomasa para usos térmicos 2t 2020. www.idae.es/sites/default/files/estudios_informes_y_estadisticas/informe_precios_biomasa_usos_termicos_2t_2020.pdf

[8] IDAE. Evaluación del potencial de energía geotérmica. https://www.idae.es/uploads/documentos/documentos_11227_e9_geotermia_A_db72b0ac.pdf

[9] IRENA. Global Atlas – Spain map of geothermal potential. https://irena.masdar.ac.ae/GIS/?map=714

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that will also define the feasibility of drilling. The Campus de Montegancedo contains a data centre in the CESVIMA facilities, which presents a potential sources of waste heat. Pozuelo de Alarcón does not present relevant hydro and wind potential.

Figure 2-8. Low temperature geothermal potential in Montegancedo Campus[10].

Figure 2-9. Medium temperature geothermal potential in Montegancedo Campus[10].

Currently, the buildings at Montegancedo campus are supplied by individual systems and draw electricity from the grid. No district heating and cooling network is planned at short term.
A table with the basic data summarized is included in Annex 1: Basic info tables (Table 4-2).

PRELIMINARY ASSESSMENT

The Montegancedo campus contains six buildings with different uses and activities, as summarized in Table 2-5. Their electricity and gas consumption for 2019 is represented in Figure 2-10 and Figure 2-11 respectively. Note: data for ETSI, CEDINT-CESVIMA, and USOC-CIDA buildings was still incomplete at the time of the report.

The energy consumption of the buildings in the Montegancedo Campus follows the usual profile of buildings driven by thermal comfort demands. Gas consumption is high in winter and nearly non-existent in summer. Electricity consumption is almost stable along the year with a peak in summer. This is related to a fairly constant use of the building with lighting and equipment consumption, with a peak in summer due to the operation of chillers for air-conditioning.
The most interesting features of this case are the presence of the CESVIMA and the CBGP buildings. The first contains a big data centre characterised by a high electricity consumption,

[10] IRENA. Global Atlas – Spain map of geothermal potential. https://irena.masdar.ac.ae/GIS/?map=714

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which can be seen as potential waste heat recovery source. On the other, the CBGP has high energy consumption for heating, cooling, and lighting due to the greenhouses.
Finally, Montegancedo Campus is still growing, and it has available land for installing a generation facility.

Table 2-5 Montegancedo Campus buildings summary.

Building	Acronym	Surface [m^2]	Uses
Escuela técnica superior de ingeniería informática + Polideportivo	ETSI	21,055 (offices) 630 (gym)	Classrooms, laboratories, offices, and gym.
Centro de apoyo a la innovación tecnológica	CAIT	7,439	Offices
Centro de tecnología biomédica	CTB	6,577	Laboratories and offices.
Centro de biotecnología and genómica de plantas	CBGP	7,390 (offices) 1,746 (greenhouses)	Laboratories, greenhouses, and offices.
Centro de I+D+I de la UPM enEficiencia energética, realidad virtual, ingeniería óptica y biometría + Centro de supercomputación y visualización de Madrid	CEDINT + CESVIMA	49,410	Data centre and offices.
Centro de operación y soporte de usuarios + Centro de investigación y desarrollo aeroespacial	USOC+CIDA	-	Offices and laboratorios.

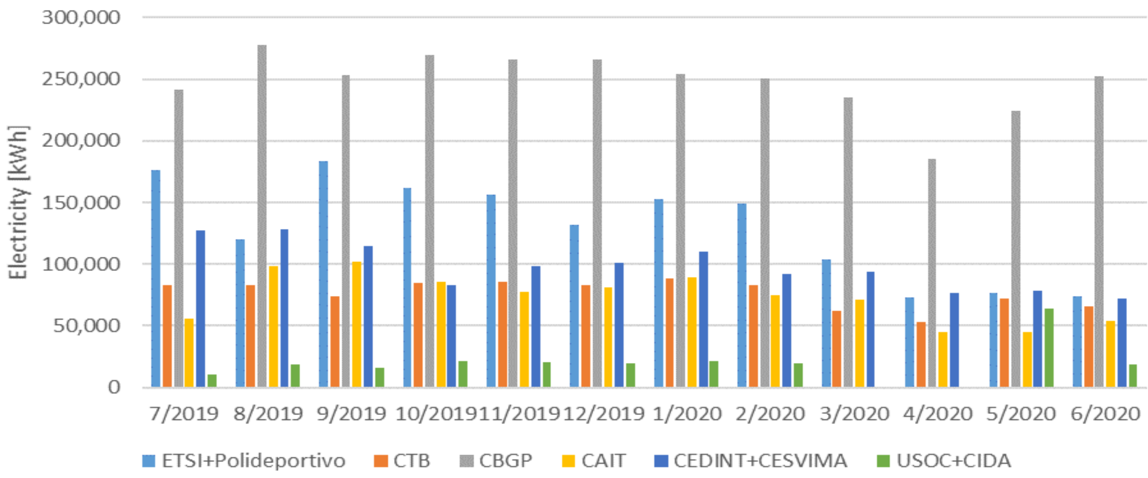

Figure 2-10. Electricity consumption of Montegancedo Campus buildings in 2019.

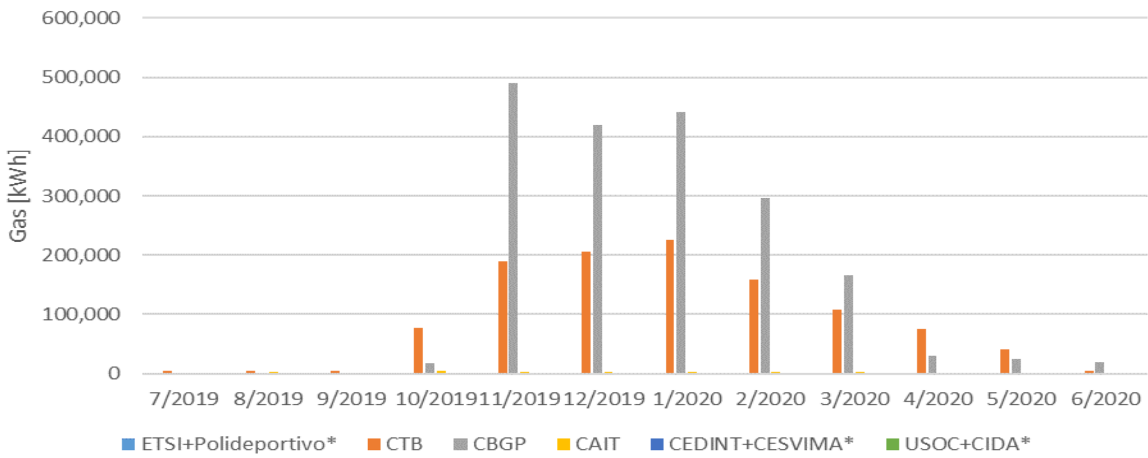

*Figure 2-11. Gas consumption of Montegancedo Campus buildings in 2019. (*Data incomplete)*

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Without an existing district heating network and with available land, the Montegancedo Campus demo-follower is flexible in the design for the generation plant. However, the buildings are already operating, hence the network has to adapt to the emitters used in the buildings and little intervention on the buildings design can be planned. Hence, the main solutions focus on the generation plant and the waste heat recovery of the data centres, considering demands from both heating and cooling. It is of special interest the tandem of two high consuming buildings, the greenhouse of CBGP and the data centre of the CEVISMA, which may form a micro-grid for waste heat recovery.

Considering the previous information, the technologies and solutions proposed to be studied in Montegancedo demo-follower are the following.

Table 2-6 Summary of technologies proposed for Montegancedo demo-follower.

Technologies proposed	By means of
Waste heat recovery of data centres	Waste heat recovery from the chiller condenser with booster heat pump. Waste heat recovery from the chiller condenser with FC.
Advanced Absorption chiller	Main supply of cooling with solar driven heat.
Solar technologies	Main heat source of the generation plant for RES district heating.
Hot water storage	Optimized water storage sized for acting as solar buffer. Consider seasonal energy storage.
Biomass boiler	Biomass boilers installation for covering peak loads
Renewable air-cooling unit (RACU)	Integrated in buildings.

The combination of the different technologies generates five main solutions which will be studied in the next steps (other solutions might arise during the activity):

Table 2-7 Summary of preliminary solutions proposed for Montegancedo demo-follower

Solutions proposed after preliminary assessment					
Technology	S1	S2	S3	S4	S5
PTC	x	x	x	x	
Fresnel	x	x	x	x	
TF-FTC	x	x	x	x	
Biomass	x	x	x	x	
Advanced Absorption Chiller	x	x			
RACU			x	x	
DC-FC-WHR		x	x	x	x
DC-HP-WHR		x	x	x	x
Hot water storage	x	x	x	x	

Table 2-8 Preliminary solutions proposed for Montegancedo demo-follower

Solutions proposed overall description	
Combination code	Montegancedo – S1
Justification	This combination represents the usual four pipes renewable district heating and cooling network, using solar energy as main heat source, biomass boilers for peak demand, and absorption chillers for cooling demand.
Expected impact	• 100 % RES district heating and cooling network. • Reduction of the primary energy and CO2 emissions compared with the existing individual systems. • Maximized solar resource.
Combination code	Montegancedo – S2
Justification	This combination represents a version of solution 1, which integrates the waste heat recovery from the data centre.
Expected impact	• 100 % RES district heating and cooling network. • Reduction of the primary energy and CO2 emissions compared with the existing individual systems.

	• Maximized solar resource. • Reduced size of generation plant due to part of the heat demand covered by the data centre waste heat recovery.
Combination code	Montegancedo – S3
Justification	This combination represents as solution for supplying heating and cooling simultaneously with a two pipe grid. Solar energy is the main heat source, biomass boilers cover the heat peak demand, and RACU in each building use the heat of the network to supply cooling.
Expected impact	• 100 % RES district heating and cooling network. • Reduction of the primary energy and CO2 emissions compared with the existing individual systems. • Maximized solar resource. • Reduced network investment cost.
Combination code	Montegancedo – S4
Justification	This combination represents a version of solution 3, which integrates the waste heat recovery from the data centre.
Expected impact	• 100 % RES district heating and cooling network. • Reduction of the primary energy and CO2 emissions compared with the existing individual systems. • Maximized solar resource. • Reduced grid investment cost. • Reduced size of generation plant due to part of the heat demand covered by the data centre waste heat recovery.
Combination code	Montegancedo – S5
Justification	The supercomputing centre in CEVISMA is high electricity consumer and source of waste heat at low temperature, while the greenhouses and laboratories in the CBGP is high heating and cooling demand. A micro-grid is proposed as a solution for waste heat recovery and industrial collaboration, with the data centre providing heat to provide heating and cooling to the CBGP.
Expected impact	• Overall reduced energy consumption and environmental impact. • Demonstration of feasible industrial collaborations.

The main goal is to demonstrate that DHC can supply heating and cooling in a more feasible way from an economic and environmental point of view than the current individual systems. Special focus will be drawn to the advantages of waste heat recovery from the data centre.

CONCLUSION

The Montegancedo Campus represents a case of a tertiary buildings cluster in development process. There is already existing building, although of recent construction, that set constraints on the supply temperature and demand, related to the requirements of the emitters installed. However, the absence of district heating and cooling network and the availability of land allows a flexible design of the generation plant. Moreover, it is a specially interesting case for the presence of the data centre together with the greenhouses, which allows to consider the waste heat recovery alternatives.

2.1.3 Playa del Inglés (Gran Canaria – Spain)

GENERAL DESCRIPTION

The Canary Islands is a Spanish archipelago in the Atlantic Ocean, in a region known as Macaronesia. The eight main islands are (from largest to smallest in area) Tenerife, Fuerteventura, Gran Canaria, Lanzarote, La Palma, La Gomera, El Hierro and La Graciosa.

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Figure 2-12. Canarias archipelago.

Gran Canaria island is called a "miniature continent" due to the different climates and variety of landscapes found, with long beaches and dunes of white sand, contrasting with green ravines and picturesque villages. A third of the island is under protection as a Biosphere Reserve by UNESCO. The number of annual visitors was 3.6 million in 2014 (of which 450,000 Spaniards). Most of the tourists visit the southern part of the island. The north tends to be cooler, while the south is warmer and sunny.

Figure 2-13. Gran Canarias Island.

Resorts are concentrated in the central eastern part of the southern coast in the Maspalomas area, which includes the towns of San Agustín, Playa del Inglés and Meloneras. The Maspalomas Dunes are located between Playa del Inglés ("The Englishman's Beach") and the distinctive 19th century Maspalomas lighthouse. Playa del Ingles is home to the Yumbo Centre, which was opened in 1982 and has almost 200 shops, including bars, restaurants, cafes, fashion boutiques, electronic outlets and jewellery stores[11].

As shown in the image below, a huge number of hotels and touristic services are located in few kilometers in this south-east part of the Gran Canaria island, in the area around the site known as "Playa del Inglés":

[11] https://en.wikipedia.org/wiki/Gran_Canaria

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Figure 2-14. Available hotels in Playa del Ingles

According to the Köppen climate classification, Gran Canaria is considered to have a desert climate (Bwh) due to its severe lack of precipitation. Gran Canaria has consistent warm temperatures in spring, summer and fall, and mild winters. Gran Canaria is noted for its rich variety of microclimates. Generally speaking, though, the average daytime high ranges from 20°C in winter to 26°C in summer. Some cool nights occur in winter, but lows below 10°C are unknown near the coast. Inland the climate is still mild but mountainous areas see the occasional frost or snow. Cloud cover and sunshine is often quite variable during the cooler months, and there can be several rather cloudy days at times in winter. Summers are generally quite sunny however, with the south of the island being most favoured[12].

	Enero	Febrero	Marzo	Abril	Mayo	Junio	Julio	Agosto	Septiem-bre	Octubre	Noviem-bre	Diciembre
Temperatura media (°C)	16	15.9	16.9	17.6	18.8	20.4	22.1	23.1	22.3	21.5	19.1	17.3
Temperatura min. (°C)	13.9	13.7	14.4	15	16.1	17.6	19.2	20.2	19.8	19.2	17.1	15.3
Temperatura máx. (°C)	18.4	18.5	19.9	20.5	21.8	23.6	25.9	26.8	25.4	24.2	21.5	19.6
Precipitación (mm)	18	20	18	13	10	4	0	1	9	24	18	32
Humedad(%)	70%	71%	69%	69%	67%	69%	66%	67%	73%	74%	72%	72%
Días lluviosos (días)	3	3	3	3	2	1	0	0	2	5	3	4

Figure 2-15. Weather Table for Playa del Inglés[13]

The high density of hotels, the continuous occupation during the year and the warm weather, configures the perfect case for a district cooling and, probably, heating, due to de DHW and swimming pool heating load. By now, the ITC (Canarian Technological Institute) is developing a georeferenced map of cooling and heating demand in Canary Islands tourist areas based on the size and category of the tourist establishment, the size of the swimming pools, and the number of users. It will also incorporate the availability of space in the vicinity and will generate an approximation with little detail of the type of fuel used in the chosen area.

[12] www.wikipedia.org/wiki/Gran_Canaria
[13] www.climate-data.org/europe/espana/canarias/playa-del-ingles-18298/#climate-table

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By now, and until the ITC finishes its work, the focus area is the one shown in the following figure:

Figure 2-16. Focus area in Playa del Inglés[14] (source: ITC)

The load profile, still under development, is preliminary the following:

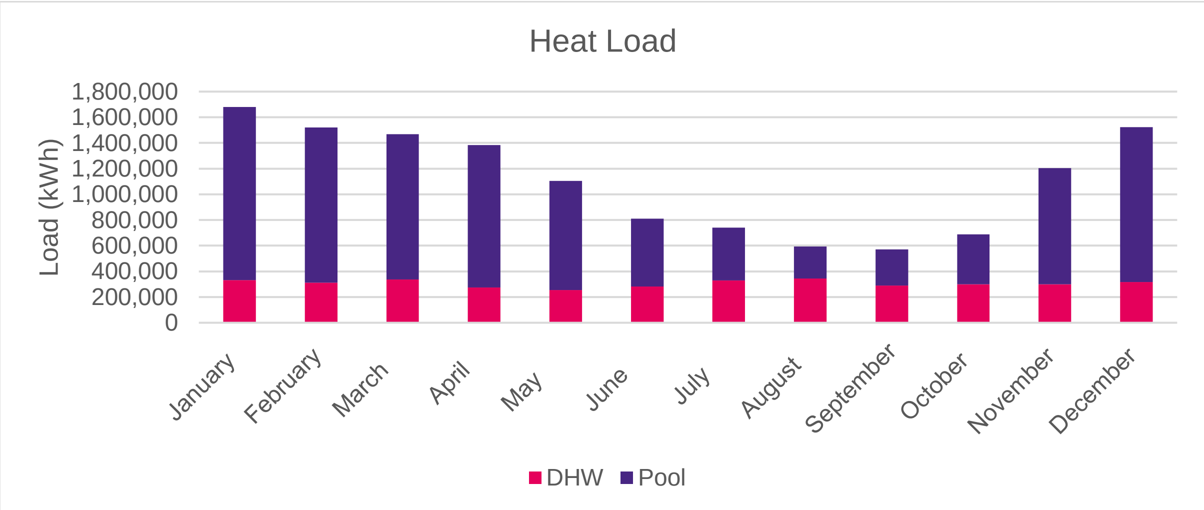

Figure 2-17. Preliminary heat load simulation results

A table with the basic data summarized is included in Annex 1: Basic info tables (Table 4-3).

PRELIMINARY ASSESSMENT

With a latitude 27º 44' north and 0 m above the sea level, Playa del Inglés has a global yearly solar radiation of 2,153.5 kWh/m^2, according to the CIEMAT's[15] solar radiation data base, as shown in the following figure:

[14] Source: ITC

[15] www.adrase.ciemat.es/mapa-zona-canarias/index.php

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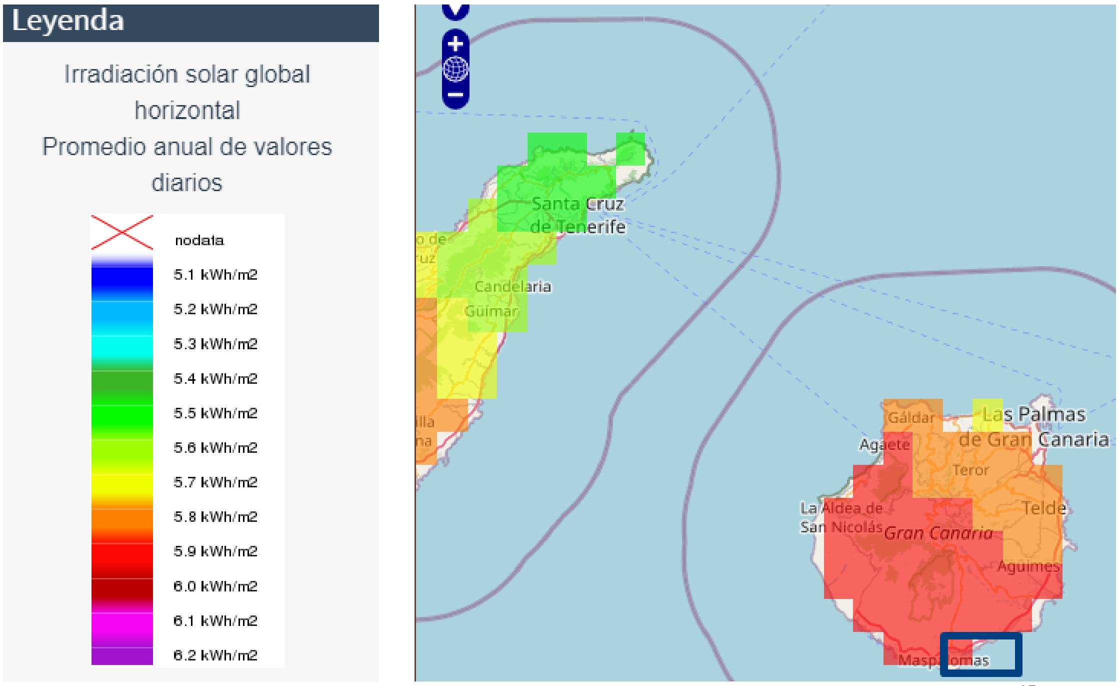

Figure 2-18. Solar radiation in Gran Canarias. Selected area indicated by blue rectangle[15]

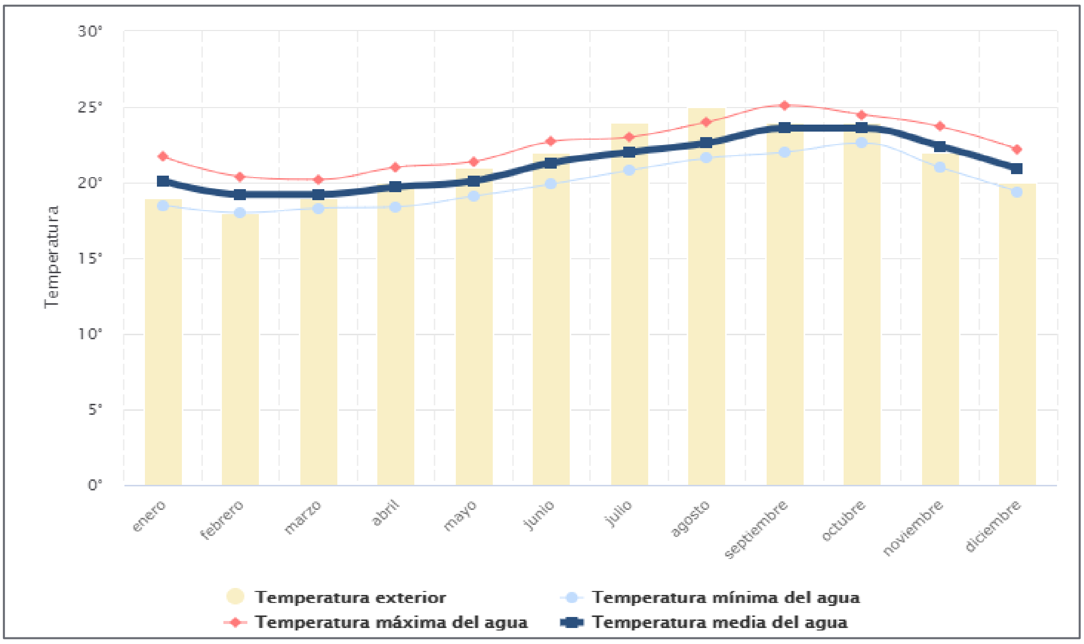

Figure 2-19. Seawater temperature in southern Gran Canarias's coast

Based on the preliminary simulations, a continuous base demand of DHW all along the year is expected, together with a high stational heating demand for outdoor pools, which are used the whole year. Winter load is up to 5 times the summer one. Regarding cooling demand, at least 6 months of required air conditioning are expected, with its peak in summer months, when heating loads are smaller.

Assuming this assumption of loads and looking for taking the maximum profit of boundary resources, sun and sea, solar driven absorption cooling could be a well fitted solution, specially recovering the absorption cycle waste heat (from absorber refrigeration) and/or using the sea for refrigeration purposes, in order to cover the main seasonal cooling demand, in phase with solar resources. Heating load may be covered directly with surplus solar heat in winter and with the absorption chiller refrigeration in summer, especially for pools, due to its low temperature requirement. This can be supported by an electrical heat pump that would be able to use the sea, but also rejected heat from the absorption chiller, as heat source, for higher

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temperature needs, like DHW. Electricity power shall be generated, at least partially, by PV on-site.
According to recent analysis done in Transhotel project by ITC, this solution with conventional technology is still not competitive with mechanical compression chillers. On the contrary, the expected increase in absorption COP of the Advanced Absorption Chiller and the expected reduction of thermal energy cost thanks to the TF-FTC solar collector, should be enough to reach the reference energy cost or even overcome it.

	Coste [€/kWh$_{th}$]	Emisiones [kgCO$_2$/kWh$_{th}$]
Enfriadoras de agua de absorción (100 kW) accionadas con energía solar térmica (excedentes energéticos)	**0,047**	**0,000**
Enfriadoras de agua de compresión mecánica accionadas eléctricamente de condensación por aire	0,033	0.262
Enfriadoras de agua de compresión mecánica accionadas eléctricamente de condensación geotérmica (aguas subterráneas)	0,020	0.159

Figure 2-20. ITC's cooling technologies comparison for Islas Canarias weather from Transhotel[16] project

Alternatively, also to have comparable results, a solution with reversible simultaneous heat pumps using sea as source/sink will also be analysed, fully integrated with PV.
Both solutions will need auxiliary peak devices, using natural gas boilers and electrical chillers.

Considering the previous information, the technologies and solutions proposed to be studied in Playa del Inglés demo-follower are the following:

Table 2-9 Summary of technologies proposed for Playa del Inglés demo-follower.

Technologies proposed	By means of
Solar technologies	Massive use of solar technology in a large thermal system to drive advanced absorption chiller in summer and to produce heat in winter
Advanced Absorption chiller	Use of the solar driven advanced absorption chiller, to produce a significant part of the summer cooling demand. Cooled by seawater and/or by an electrical heat pump.
Electrical Heat Pump	Coupled to the advanced absorption chiller condenser, instead of the cooling tower or the cooling well, this heat pump may produce heating recovering the rejected heat.
Hot water storage	Optimized water storage sized for acting as solar buffer.
Hybrid PV-Geothermal	Use of large reversible simultaneous heat pumps using sea as source/sink will also be analysed, fully integrated with PV.

The combination of the different technologies generates two main solutions which will be studied in the next steps (other solutions might arise during the activity):

Table 2-10 Summary of preliminary solutions proposed for Playa del Inglés demo-follower

Solutions proposed after preliminary assessment		
Technology	**S1**	**S2**
TF-FTC	X	
Hybrid PV-Geothermal	X	X
Advanced Absorption Chiller	X	
Gas Boiler	X	X
Electrical Chiller	X	X

[16] www.solarthermalworld.org/sites/default/files/news/file/2015-02-21/trnshotel_simulation_results_pilar_navarro.pdf

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Table 2-11 Preliminary solutions proposed for Playa del Inglés demo-follower

Solutions proposed overall description	
Combination code	**Playa del Inglés – S1**
Justification	This combination uses **TF-FTC** solar collector and the advanced solar absorption chiller using the sea for refrigeration purposes, in order to cover the main seasonal cooling demand phased with solar resource. Heating load may be covered directly with surplus solar heat, both in summer and winter, and supported by an electrical heat pump that would be able to use the sea, but also the absorption chiller rejected heat, as heat source. Electricity power shall be generated, at least partially, by PV on-site. Both heating and cooling systems will include large water storage devices, stablishing an optimized integration to reach the most cost-effective operation of the whole system It also includes gas boilers and electrical chillers for peak loads
Expected impact	• Maximise solar resource. • Use of seawater as thermal source • Reduction of heat island effect • Improvement of absorption chiller performance. • Avoidance of the CO_2/NOx emissions associated to the current electrical system • CAPEX and OPEX comparison with the BAU solution
Combination code	**Playa del Inglés – S2**
Justification	This combination integrates electrical heat pumps working simultaneously for heating and cooling as well as refrigerated with water, including also PV to cover part of the electrical needs. It also includes gas boilers and electrical chillers for peak loads The use of a simultaneous operation well water condensed electrical heat pump produces the heating and cooling base load during the whole year, driven as far as possible by PV energy. Both heating and cooling systems will include large water storage devices, stablishing an optimized integration to reach the most cost-effective operation of the whole system Finally, conventional gas boilers and electrical chillers cover the peak loads.
Expected impact	• Reduction of heat island effect • Reduction of CO2 emissions • Reduction of electricity consumption • More cost-effective heating and cooling • Increased competitiveness and sustainability of tourism sector • Prove feasibility of DC in warm climates

CONCLUSION

There is a high potential in Gran Canaria for implementing solar-based DHC networks, using the absorption option as a good candidate. DHC systems are not highly developed in this area and WEDISTRICT project is a good place for studying it. At this stage, the most promising place is still under study and, when the decision will be taken, the different alternatives identified will be assessed in order to obtain the most cost-effective solution for the site.

2.1.4 Tecnoalcalá (Alcalá de Henares – Spain)

GENERAL DESCRIPTION

In April 2003, at the hands of the Community of Madrid, the TECNOALCALÁ Scientific and Technological Park was established. Its main mission is to create a cluster where the priority is to support innovation and the transfer of technology and knowledge, offering quality flooring for the installation of innovative companies. The Park is developed on a 370,705m^2 plot, located on the campus of the University of Alcalá.

It was mainly created to promote the innovative process of the companies and the transfer of technology and knowledge from the University, it constitutes a fundamental element that allows

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the strengthening of relations between the academic and business fields. Tecnoalcalá Park encompasses companies from different sectors, the most representative of which is Information Technology, healthcare and industry. Currently, the Park has more than 40 companies that represents 92% of the available surface area.

Within WEDISTRICT project, one of the main demosites is located in this area, where a big solar laboratory supported by biomass will be deployed in order to evaluate different WEDISTRICT technologies for heat and cold generation. This demosite will supply heating and cooling needs to a building through a new heat and cold network, which will operate following the advanced digitalization system developed in the frame of the project. Tecnoalcalá demo-follower will explore the possibility of having a whole Technology Park covered by a DHC (District Heating and Cooling) network.

Figure 2-21. Aerial view of Tecnoalcalá demo-follower (left). Location of WEDISTRICT thermal station for Alcalá demosite (in green colour) which will be extended for Tecnoalcalá demo-follower

Tecnoalcalá is a partner of APTE, the Association of Science and Technology Parks of Spain, which is a non-profit association whose main objective is to collaborate, through the promotion and dissemination of science and technology parks, to the renewal and diversification of productive activity, to technological progress and economic development.

The whole Park is managed by MADRID ACTIVA. The company MADRID ACTIVA, S.A.U. is a commercial company attached to the Ministry of Economy, Employment and Competitiveness, whose owner of 100% of the shares is the Community of Madrid. MADRID ACTIVA aims to promote the economic, technological and industrial development of the Community of Madrid.

Tecnoalcalá is located in the city of Alcalá de Henares, located northeast of Madrid. It is known for the University of Alcalá, which is hosted in buildings in the old town that date back to the 16th century. Among them is the auditorium, a room with an elaborated Mudejar-style ceiling, where the King of Spain awards the Cervantes Prize for literature every year. Nearby is the Cervantes Birthplace Museum, where the famous author of Don Quixote lived.

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Figure 2-22. Alcala de Henares situation map

The city of Alcalá de Henares suits perfectly with this 100% Renewable District Heating and Cooling concept. The sustainability is at the heart of this study, so the "localness" of the resources is a key parameter. Spain is one of the most attractive countries for the development of solar energy, as it has the greatest amount of available sunshine than any country in Europe. In particular, the Direct Normal Irradiation in Alcalá de Henares is 1,980 kWh/m^2 year, which makes the solar resource a promising solution to be used.
Next figure Figure 2-23 shows the solar irradiation in Spain and where is located Tecnoalcalá demo-follower:

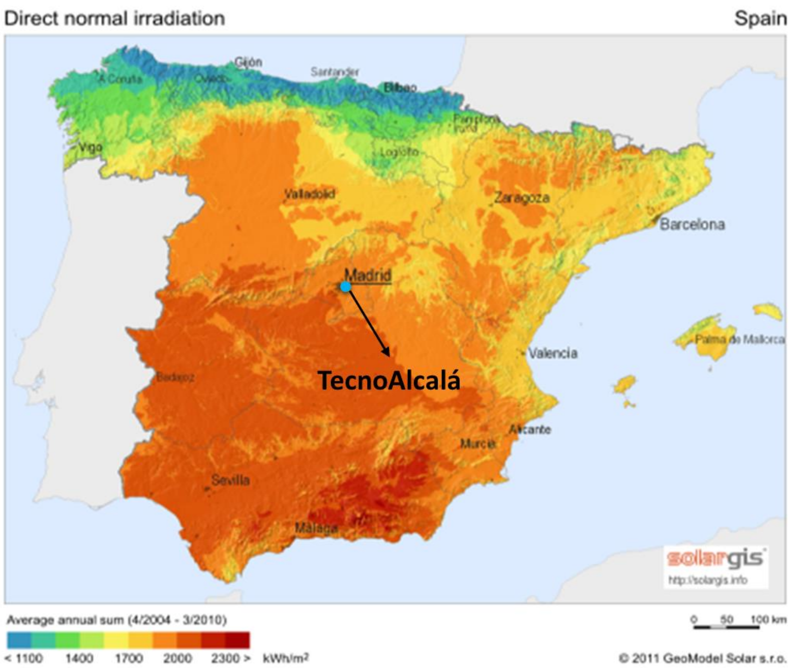

Figure 2-23. Solar Map in Spain[17]

The high solar potential is joined with high temperatures in Summer and low temperatures in Winter, as can be shown in the next Figure 2-24:

[17] www.solarpaces.org

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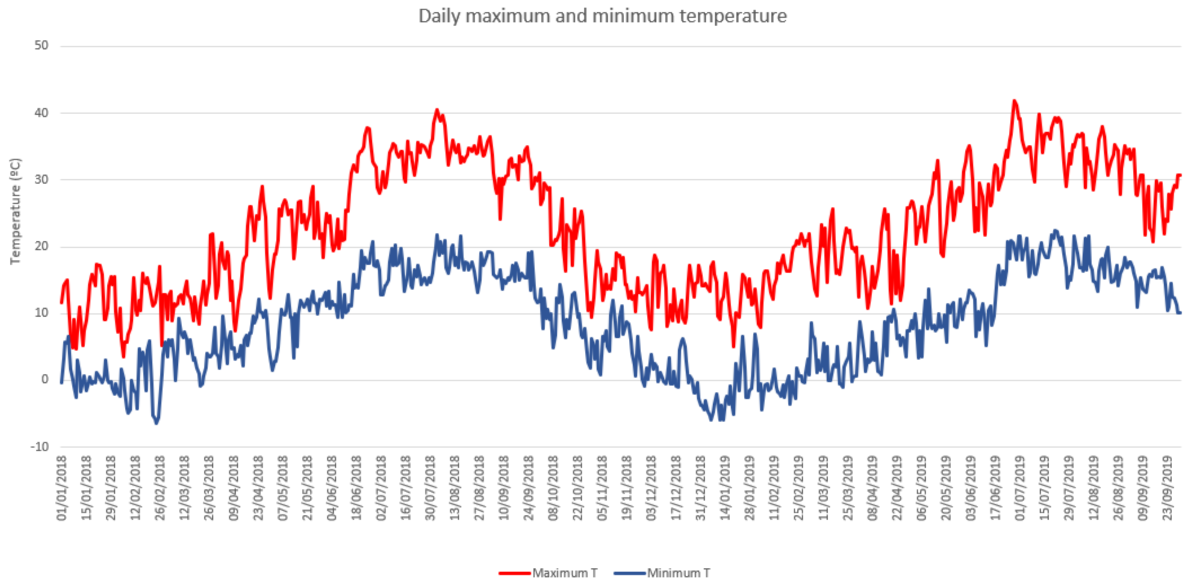

Figure 2-24. Daily temperature for Alcalá de Henares between 01/01/2018 and 30/09/2019

The data observed in 2018-2019 shows temperatures over 40ºC in summer and below 0ºC in Winter, meaning that this site requires both heating and cooling supply for keeping good indoor comfort temperatures.

Another good option for renewable assessment in Tecnoalcalá could be the implantation of geothermal system, considering the good resource potential for medium-low temperature, shown in the next image:

Figure 2-25. Geothermal source potential in Spain[18]

As mentioned before, more than 40 companies are located in the technological park, from different fields and with different uses (mainly offices and laboratories). Unfortunately, at the time of this document delivery, it was not possible to explore the current facilities existing in each of the buildings, nevertheless, some information has been gathered from different buildings which could be used as reference for the study. In the next step, a more detailed analysis of the different buildings will be performed.
A table with the basic data summarized is included in Annex 1: Basic info tables (Table 4-4).

[18] Source: Geoplat

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Figure 2-26. Example of building type in Tecnoalcalá demo-follower

Tecnoalcalá data center

There is one special building installed in Tecnoalcalá, which is a big Data Center located in the corner of the area. The Tecnoalcalá Data Center is one of the largest data processing centers in the world. The transformation of Nabiax's systems in Europe is carried out in this facility, together with the hosting and housing services for theirclients.

Developed in five phases, it consists of a total of 23 Information Technology (IT) rooms of 681 m² each, 50 MW installed and developed through the basic concepts of modularity, flexibility, redundancy, and efficiency. It has the Leed Gold certification granted by the Green Building Council and has been drawn up in accordance with the highest levels of reliability defined by the Uptime Institute to obtain the TIER IV certificate, which endorses it as a center that offers the highest security and possible redundancy. Its design, construction and operation obey the strictest levels of sustainability with significant reductions in water consumption, energy and CO_2 emissions compared to traditional Data Centers.

In the frame of this activity, the option of utilizing the waste heat generated by the building for being recovered in the District Heating will be assessed (through the fuel cell technology for boosting the temperature to suitable levels).

Figure 2-27. Data Center building sited in Tecnoalcalá demo-follower

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PRELIMINARY ASSESSMENT

In order to perform a very first preliminary assessment and propose different DHC RES-based solutions, data from a building reference has been used. This building consists of different administrative and laboratories areas, with a current installation of gas boiler for heating needs and chiller for cooling needs.

The heating and cooling demands are shown in the next figures:

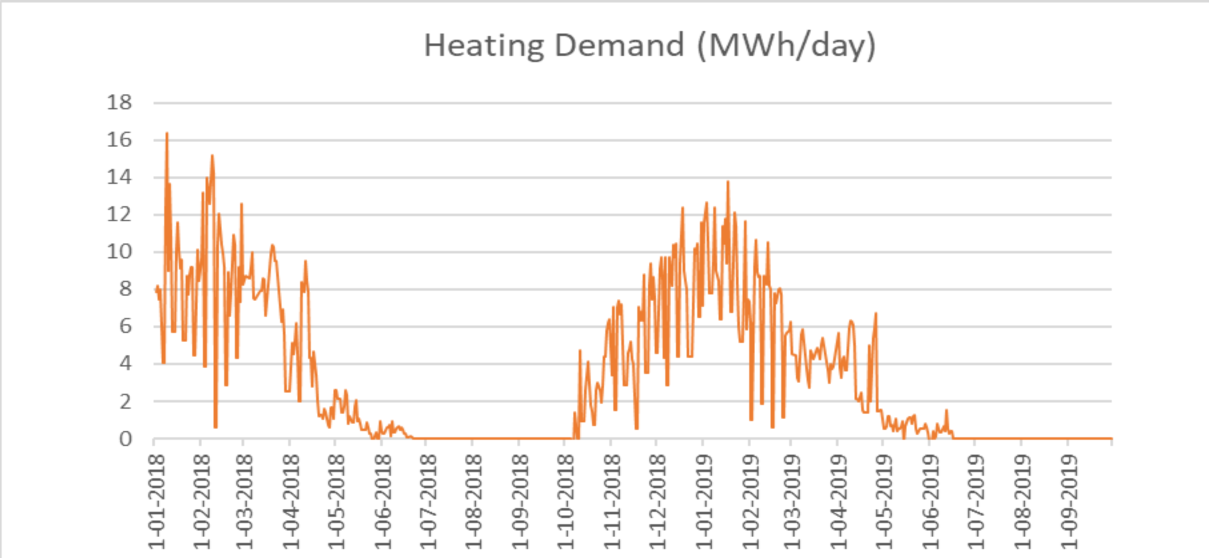

Figure 2-28. Daily heating demand for Tecnoalcalá representative building between 01/01/2018 and 30/09/2019.

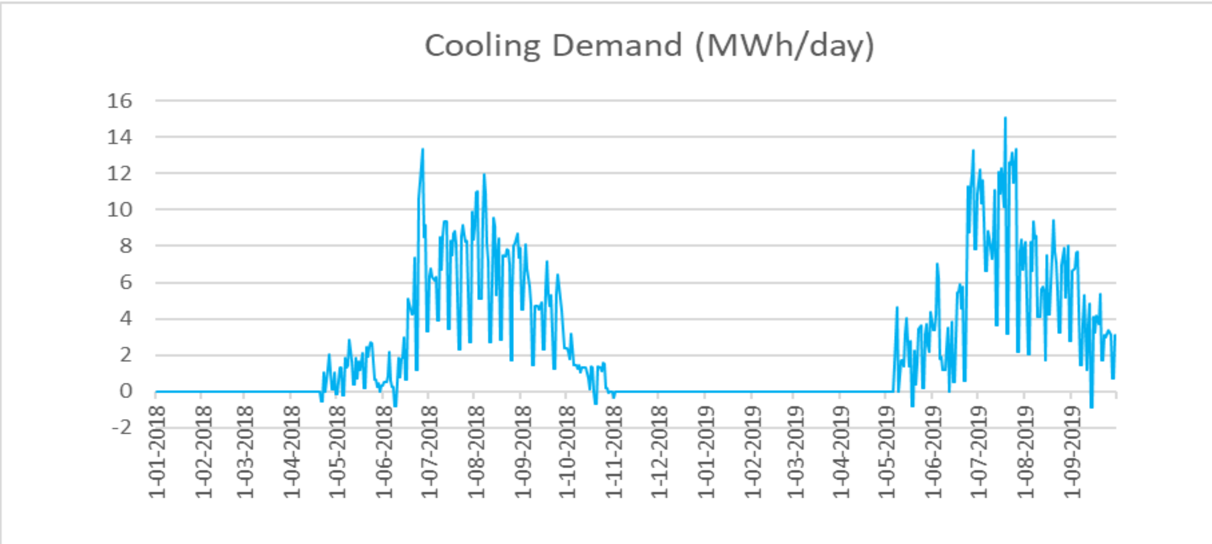

Figure 2-29. Cooling daily demand for Tecnoalcalá representative building between 01/01/2018 and 30/09/2019.

The global consumption with monthly data in a full year could be summarized in the next image:

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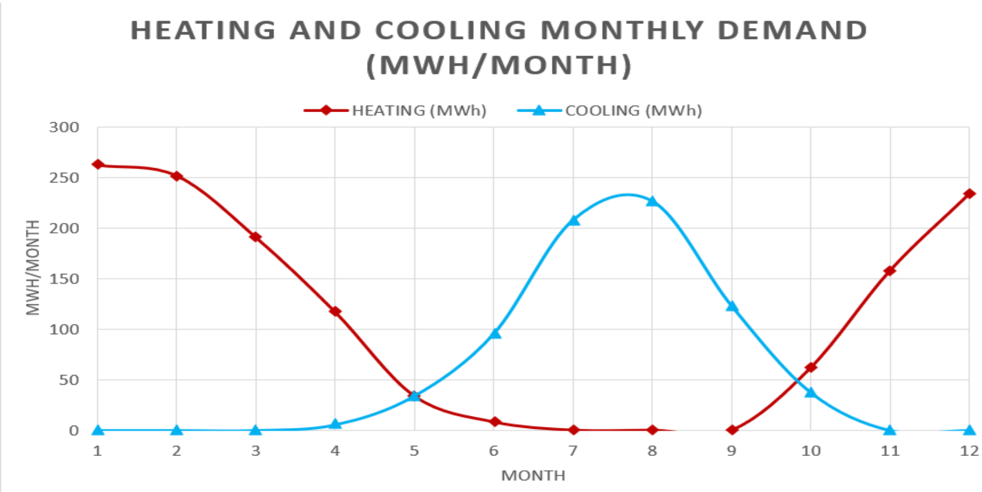

Figure 2-30. Monthly heating and cooling demand for Tecnoalcalá representative building in 2018.

Analysing the previous figure, it is shown the need for both heating and cooling with similar maximum loads (2018 data). There are three different seasons clearly defined:

- <u>Heating Season:</u> From November until April (both included) with higher values in December, January, and February.
- <u>Cooling Season</u>: From June until September (both included) with higher values in July and August.
- <u>Intermediate Season</u>: In May and October, where heating and cooling needs live together.

This data supports the idea of studying a complete district heating and cooling option. For such heat and cold generation, and taking into account the RES potential presented in the previous description, both solar and geothermal resources should be analysed. Both technologies require a big amount of available space, in the case of the solar option being aware of the possible shadows. Tecnoalcalá accounts for enough available space where both systems could be installed. In the next image, a summary of the area already in use, and the free area is shown:

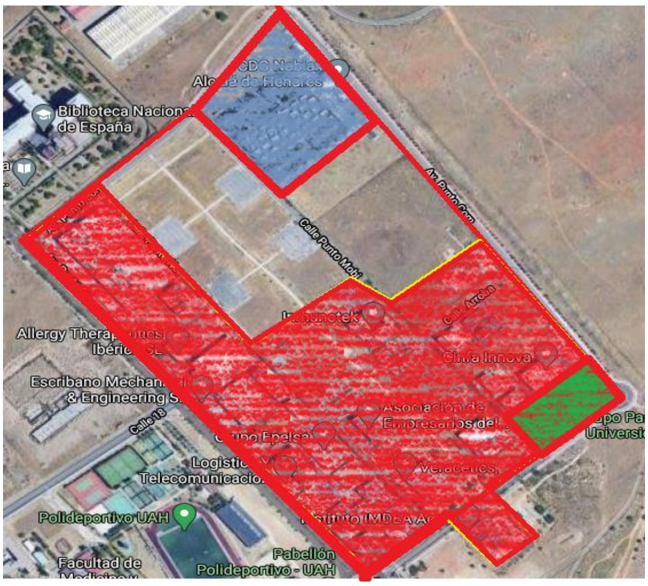

Figure 2-31. Areas use in Tecnoalcalá demo-follower (green: WEDISTRICT demosite; blue: Data center building: red: areas already in use)

Therefore, after the preliminary analysis, the suitable different technologies to be integrated in Tecnoalcalá demo-follower are the following:

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Table 2-12 Summary of technologies proposed for Tecnoalcalá demo-follower.

Technologies proposed	By means of
PTC	Integration of solar collectors for maximizing the solar resource in Tecnoalcalá, considering the huge potential in the site.
Fresnel	
TF-FTC	
Biomass	Biomass boilers installation for covering peak loads or energy not covered by solar collectors.
Molten Salts	Thermal storage integrated with concentration solar panels (PTC and Fresnel).
Hybrid PV-Geothermal	Installation of PV panels and Geothermal system (boreholes and heat pump) in order to cover heating and cooling demand, considering the good potential in the site and the needs of heating and cooling needs along the year.
Advanced Absorption Chiller	Integration of advanced absorption chiller for covering cooling loads and fed by renewable sources (solar power).
RACU	System integrated in the buildings and fed by the district heating system.
FC-WHR	Heat recovery fuel-cell based from the Tecnoalcalá Data Center located in the site.
HP + WHR	Heat recovery the Tecnoalcalá Data Center and heap pump (instead of fuel cell).
PV	PV panels integrated for covering electricity consumption from the thermal station (and equipment installed).
Water storage	Optimized water storage sized for acting as solar buffer.

The combination of the different technologies generates three main solutions which will be studied in the next step (other solutions might arise during the activity):

Table 2-13 Summary of preliminary solutions proposed for Tecnoalcalá demo-follower

Solution proposed after preliminary assessment			
Technology	**TECNOALCALÁ S1**	**TECNOALCALÁ S2**	**TECNOALCALÁ S3**
PTC	x		
Fresnel	x		
TF-FTC		x	
Biomass	x	x	
Molten Salts	x		
Hybrid PV-Geothermal			x
Advanced Absorption Chiller	x	x	
RACU	x	x	x
FC-WHR	x	x	x
PV	x	x	
Water storage		x	x
HP + WHR	(x)	(x)	(x)

Table 2-14 Preliminary solutions proposed for Tecnoalcalá demo-follower

Solutions proposed overall description	
Combination code	TECNOALCALÁ – S1
Justification	This combination integrates concentration solar panels (Fresnel/PTC) with molten salts storage for thermal buffer and biomass boiler for peak loads or energy not covered by the solar collectors. It will include cooling generation with the advanced absorption chiller technology, being an overall DHC system. Furthermore, waste heat from the existing data center will be considered (by means 2 subscenarios, using the FC or a HP) and RACU system integrated in particular buildings for air conditioning.

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	The possibility of installed PV panels will be studied in order to cover the electricity consumption of the own thermal station, taking into account the solar potential in the site.
Expected impact	● Maximise solar resource. ● Waste heat recovery to be injected in the DH. ● Improvement of absorption chiller performance. ● Evaluate availability of biomass and cover extra heating load. ● Avoidance of the CO_2 emissions associated with the current heating and cooling systems. ● Plan new development of tertiary buildings as equipped with RACU. ● CAPEX and OPEX comparison with the current status (based on individual heating/cooling equipment).
Combination code	TECNOALCALÁ – S2
Justification	This solution has a similar concept than solution 1 with the difference of using the TC-FTC system as solar collector. This technology operates at lower temperatures than PTC or Fresnel and, for this reason, it will integrate water storage as thermal buffer instead of the molten salts option. Again, FC-WHR will use the extra heat generated by the Tecnoalcalá Data Center (extending the WHR study thanks to a subscenario with HP instead of FC) and RACU system will be studied at building level. PV panels could be also installed for covering the electricity consumption of pumping and equipment within the installation.
Expected impact	● Maximise solar resource. ● Waste heat recovery to be injected in the DH. ● Improvement of absorption chiller performance. ● Evaluate availability of biomass and cover extra heating load. ● Avoidance of the CO_2 emissions associated with the current heating and cooling systems. ● Plan new development of tertiary buildings as equipped with RACU. ● CAPEX and OPEX comparison with the current status (based on individual heating/cooling equipment).
Combination code	TECNOALCALA – S3
Justification	This combination integrates the hybridation concept with PV panels and Geothermal system, considering the geothermal potential of the site, as shown previously. The heating and cooling loads are quite compensated along the year what makes geothermal energy a good solution considering environmental aspects as well, for a new DHC. FC-WH, HP + WHR and RACU systems will be integrated as part of the solution, as in the previous solutions proposed.
Expected impact	● Maximise geothermal and solar resources. ● Waste heat recovery to be injected in the DH. ● Avoidance of the CO_2 emissions associated to the current heating and cooling systems. ● Plan new development of tertiary buildings as equipped with RACU. ● CAPEX and OPEX comparison with the current status (based on individual heating/cooling equipment).

CONCLUSION

Tecnoalcalá demo-follower offers a good chance for assessing all WEDISTRICT technologies and their optimal combination for new DHC systems.

At this stage, there is not much information about the different buildings' consumption and current heating/cooling equipment, therefore it will be necessary to go more in deep for obtaining such information in order to generate the current status model. A particular building has been used as a reference case since in Spain most of the tertiary buildings are still operating with individual equipment, such as gas boilers, chillers and/or individual heat pumps. Spain in general and Alcalá de Henares in particular, accounts for a huge renewable potential: WEDISTRICT project is acting to demonstrate how RES systems offer interesting benefits (from environmental and economic points of view). In Tecnoalcalá demo-follower site, solar (supported by biomass) and geothermal renewable sources will be studied in the next phase. Besides this, the big data center constructed in the area will be assessed for integrating the waste heat recovery fuel-cell based.

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2.1.5 Independencia (Santiago de Chile – Chile)

GENERAL DESCRIPTION

In Chile’s southern towns, 94% of air pollution is linked to the use of firewood at homes during winter for heating and boiling of water. Particulate matter readings (PM2,5 and PM10) exceed the current emissions threshold established by law, endangering the inhabitants that currently live in these towns. For these reasons, Chile is actively seeking alternative technologies to solve the air pollution problems and therefore, improving the quality of life in these regions.

Independencia is one of Santiago’s boroughs chosen to receive technical assistance that allows their management to identify and pursue the development of district energy related projects. Preliminary studies have shown promising results for populated areas and key infrastructure like health and educational buildings, including heating and cooling loads.

With a latitude 33.42º south and 541m above the sea level, Independencia has a global yearly solar radiation of 1,945 kWh/m^2, according to the Energy Ministry weather data base, as shown in the following figure.

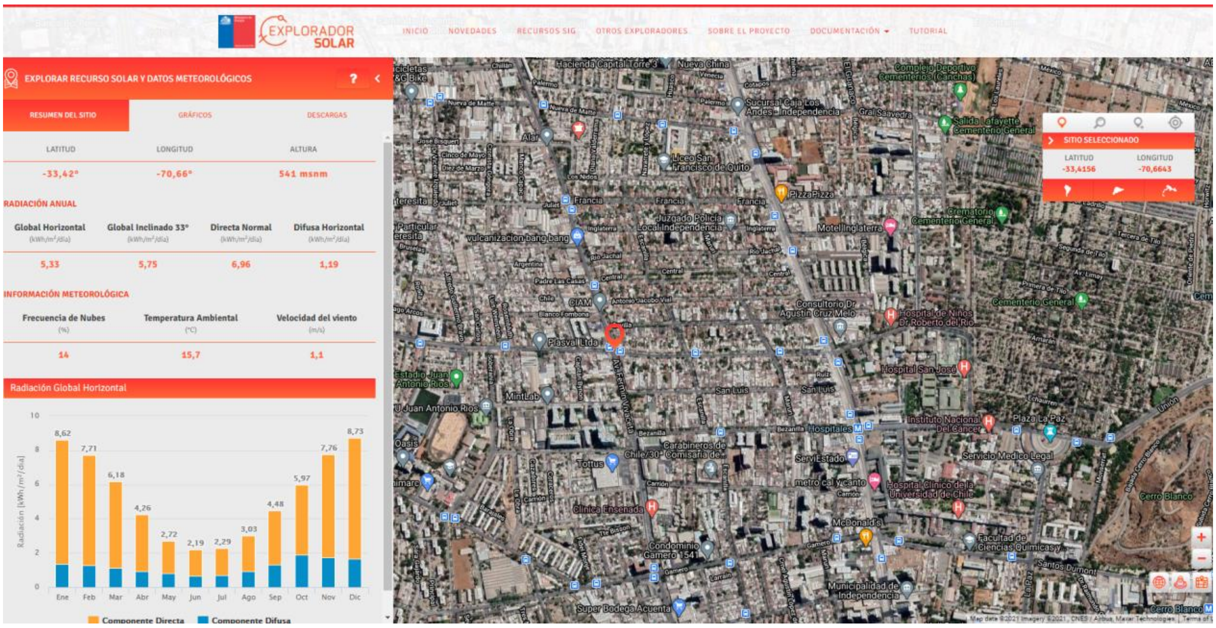

Figure 2-32. Screenshot of Energy Ministery “Explorador Solar” query for Independencia District[19]

Moreover, since the focus area is in the middle of the known as “Gran Santiago”, the metropolitan area of the Chilean capital, no biomass is available and, furthermore it’s a saturated area and its use is restricted. Due to this, biomass is not considered from the very beginning.

Finally, although there’s no preliminary study or information about it in Independencia, Santiago’s underground has water wells and rivers that have been used in recent projects as source/sink focus for heat pump-based heating and cooling systems. Furthermore, last year a new regulation was approved to incentivize this kind of systems.

The following map shows the location of some areas with promising results in the preliminary assessment:

[19] http://solar.minenergia.cl/exploracion

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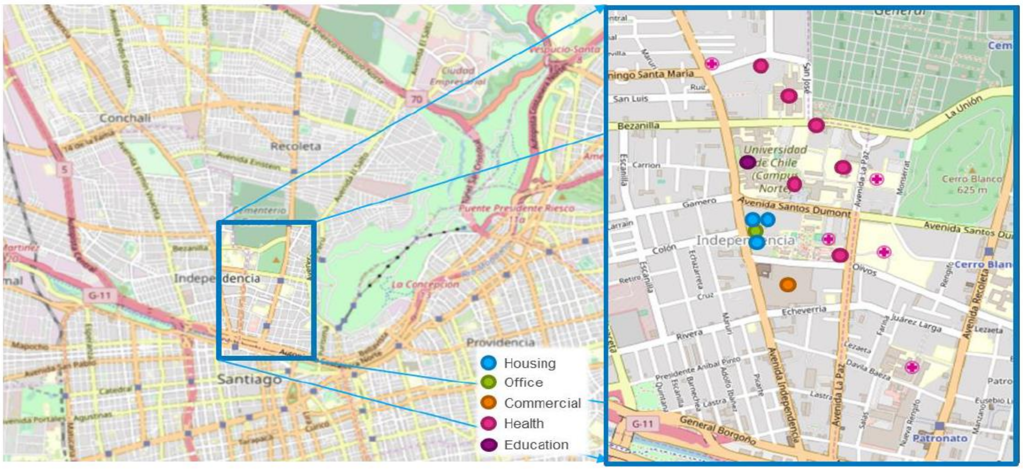

Figure 2-33. Location map of Independencia, Santiago. Chile

A table with the basic data summarized is included in Annex 1: Basic info tables (Table 4-5).

PRELIMINARY ASSESSMENT

A preliminary assessment was carried out few years ago under the ONU's District Energy in Cities Initiative, by the Belgium consultancy company Tractebel. Through this work, three different areas were identified and the most promising one was selected for this WeDistrict Virtual Demo.

As shown in the previous figure, a total of 10 buildings were identified in a close area, including housing, office, commercial, health and education, with a total surface of 300,000m^2, a cooling demand of almost 19GWh and a heating demand of 8 GWh. The estimated capacity of the DHC system would be 3MW heating and 7.5MW cooling, as can be seen in the following table:

Table 2-15 List and parameters of identified buildings

Client	Typology	Total surface [m²]	Annual heating demand [MWh]	Annual cooling demand [MWh]
San José Hospital	Health	48,000	1,546	2,780
Del niño Hospital	Health	8,750	282	507
Universidad De Chile Hospital	Health	54,000	1,739	3,127
Public Library	Office	2,500	46	69
Municipality	Office	6,000	111	165
Hospital - Clínica Odontológica	Health	2,800	90	162
Universidad De Chile	Education	93,600	2,144	3,200
Mall Barrio Independencia	Commercial	55,000 (*)	0	7,893
Residential building 1	Residential	20,000	1,149	0
Residential building 2	Residential	10,000	574	0
	Sum	300,650		

It should be taken into account that:

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- Six of the expected clients are hospitals, which have a high annual demand for cooling purposes, including room temperature control for patients, equipment and specialized rooms.
- For office buildings the use of reversible heating/cooling systems has been considered.
- Shopping mall management did not demand for heating in their buildings, they did have cooling demand though.
- For these reasons, the collective demand of heating is significantly lower than cooling demand.
- But, DHW demand was not considered in this preliminary study, so that heating demand is expected to increase dramatically and to extend all along the year, in a different way that the one shown in the following figure.

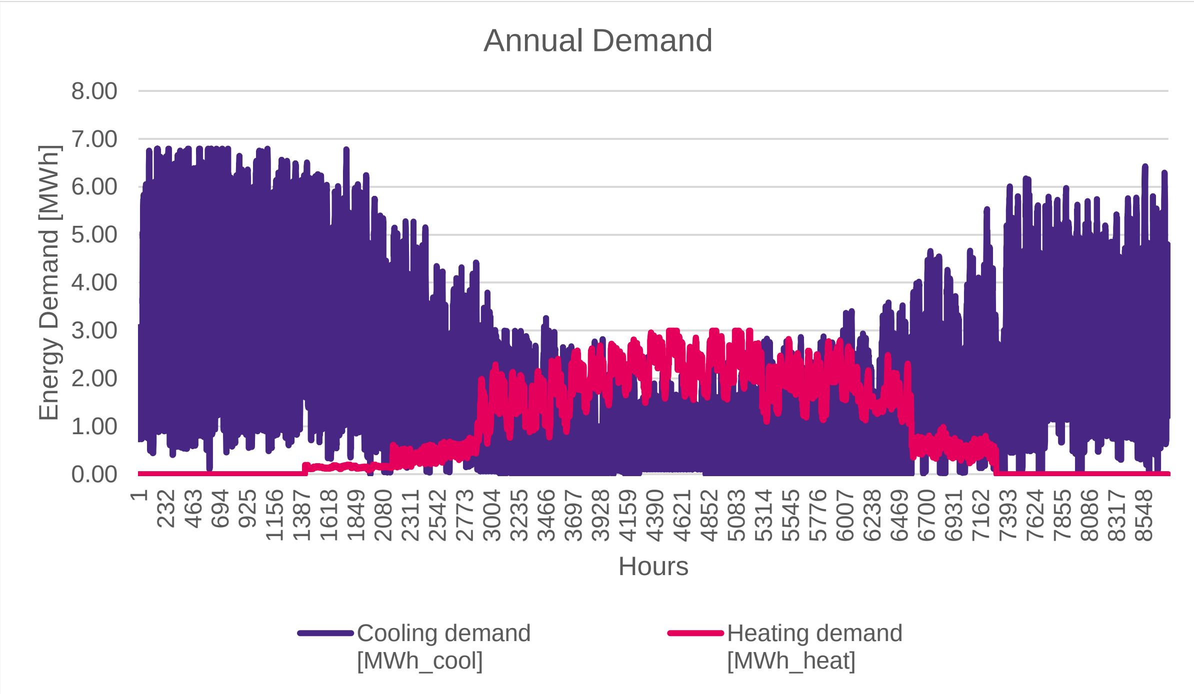

Figure 2-34. Heating and Cooling hourly annual demand

The preliminary assessment considered 4 scenarios of district energy, three of them for heating and cooling and the fourth one only for cooling. Combining CAPEX and OPEX analysis, the most promising solutions were the only cooling with chillers (air cooled) and the heating and cooling with heat pumps.

Table 2-16 CAPEX for different scenarios

Option costs [MUSD]	Development	Thermal plant	Distribution system	Connection system	Indirect	Others	Total CAPEX
District cooling with chillers	5.3	1.8	4.0	0.8	0.9	2.0	14.8
District heating with heat pumps	5.0	1.0	3.0	0.6	0.5	1.4	11.6
District heating and cooling with heat pumps	5.5	1.4	5.8	1.1	1.0	2.5	17.4
District trigeneration with gas turbine and absorption chiller	5.8	2.6	6.0	1.1	1.3	2.9	19.8

Table 2-17 Energy price for different scenarios

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Option	OPEX [USD/MWh]	Fuel [USD/MWh]	CAPEX [USD/MWh]	Others [USD/MWh]	Energy Price [USD/MWh]
District cooling with chillers	16	9	13	17	54
District heating with heat pumps	23	14	24	30	91
District heating and cooling with heat pumps	15	10	11	13	50
District trigeneration with gas turbine and absorption chiller	30	14	12	16	66

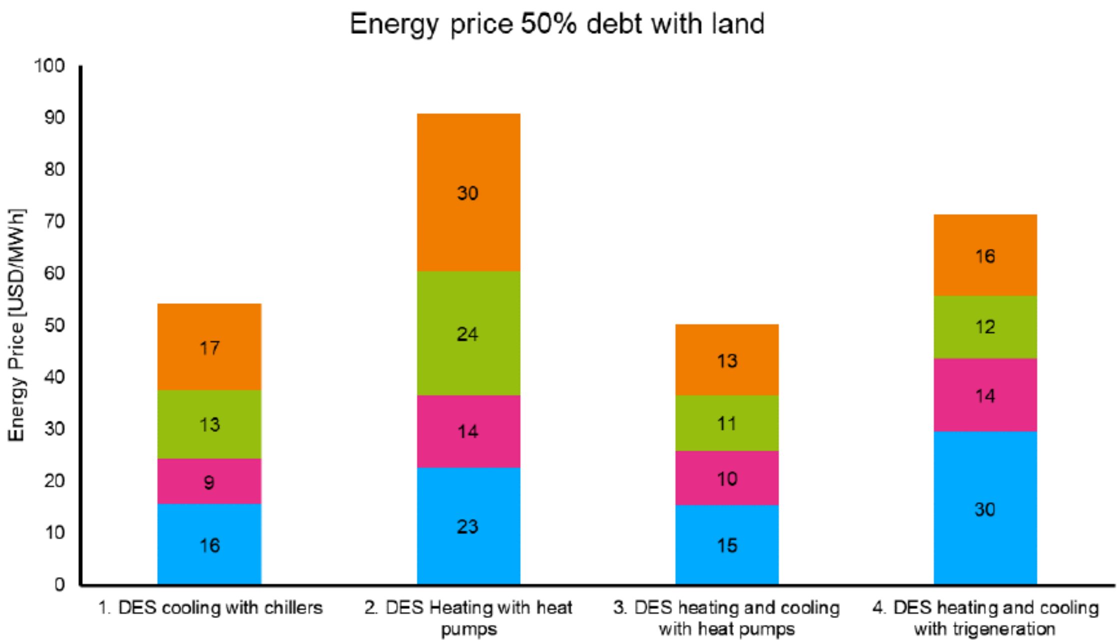

Figure 2-35. Energy price for different scenarios

Taking into account this preliminary analysis, the non-considered DHW load and the availability of a huge solar resource as well as the potential access to underground water, solar absorption cooling and electrical heat pumps both working simultaneously for heating and cooling as well as refrigerated with water, should be considered both together and separately. Furthermore, the integration of PV with the electrical needs should also be taken into account.

Considering the previous information, the technologies and solutions proposed to be studied in Independencia demo-follower are the following:

Table 2-18 Summary of technologies for Independencia demo-follower.

Technologies proposed	By means of
Solar technologies	Massive use of solar technology in a large thermal system to drive advanced absorption chiller in summer and to produce heat in winter
Advanced Absorption chiller	Use of the advanced absorption chiller solar driven, to produce a significant part of the summer cooling demand. Cooled by underground well water or by an electrical heat pump
Electrical Heat Pump	Coupled to the advanced absorption chiller condenser, instead of the cooling tower or the cooling well, this heat pump may produce heating recovering the rejected heat
Simultaneous Electrical Heat Pump	To cover the heating and cooling base load, a well water condensed Simultaneous Electrical Heat Pump shall be the optimum complement to the Advanced Absorption chiller
Hot water storage	Optimized water storage sized for acting as solar buffer

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The combination of the different technologies generates two main solutions which will be studied in the next steps (other solutions might arise during the activity):

Table 2-19 Summary of preliminary solutions for Independencia demo-follower

Solution proposed after preliminary assessment		
Technology	S1	S2
PTC		
Fresnel		
TF-FTC	X	
Biomass		
Molten Salts		
Hybrid PV-Geothermal	X	X
Advanced Absorption Chiller	X	
RACU		
FC-WHR		
Gas Boiler	X	X
Electrical Chiller	X	X

Table 2-20 Preliminary solutions proposed for Independencia demo-follower

Solutions proposed overall description	
Combination code	INDEPENDENCIA – S1
Justification	This combination integrates solar absorption cooling and electrical heat pumps both working simultaneously for heating and cooling as well as refrigerated with water, including also PV to cover part of the electrical needs. It also includes gas boilers and electrical chillers for peak loads
Expected impact	The use of the advanced absorption chiller solar driven, to produce a significant part of the summer cooling demand, coupled through its condenser to a water to water heat pump, instead of the cooling tower or the cooling well, to produce heating recovering the rejected heat. In parallel, a simultaneous operation well water condensed electrical heat pump produces the heating and cooling base load during the whole year, driven as far as possible by PV energy. Both heating and cooling systems will include large water storage devices, stablishing an optimized integration to reach the most cost-effective operation of the whole system. Finally, conventional gas boilers and electrical chillers cover the peak loads
Combination code	INDEPENDENCIA – S2
Justification	This combination integrates electrical heat pumps working simultaneously for heating and cooling as well as refrigerated with water, including also PV to cover part of the electrical needs. I will also include large water storage devices, stablishing an optimized integration to reach the most cost-effective operation of the whole system. It also includes gas boilers and electrical chillers for peak loads
Expected impact	The use of a simultaneous operation well water condensed electrical heat pump produces the heating and cooling base load during the whole year, driven as far as possible by PV energy. Both heating and cooling systems will include large water storage devices, stablishing an optimized integration to reach the most cost-effective operation of the whole system. Finally, conventional gas boilers and electrical chillers cover the peak loads

CONCLUSION

The preliminary assessment has shown promising results in terms of economic feasibility, even with the exclusion of the DHW demand analysis, and as far as we know, although the buildings involved in this project are owned by very different players, from both public and private sector, there is already, at least, one ESCO company trying to develop a DHC systems to integrate all of them as costumers.

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2.2Retrofitting DH/C demo-followers

The second type of demo-followers selected corresponds to existing DH/C facilities where new solutions could fit to improve the features of the current system and explore the impact of WEDISTRICT technologies in different kinds of scenarios. The demo-followers which will be studied are listed:

- **Parc de l'Alba (Barcelona – Spain)**
- **Cyprus University (Nicosia – Cyprus)**
- **Żyrardów (Żyrardów – Poland)**
- **Valladolid (Valladolid – Spain)**
- **Mrągowo (Mrągowo – Poland)**
- **Focsani (Focsani – Romania)**

Next, the description of the different retrofitting category demo-followers is shown:

2.2.1 Parc de l'Alba (Barcelona – Spain)

GENERAL DESCRIPTION

The "Parc de l'Alba" (also known as Directional Centre) is a new urban development located in Cerdanyola del Vallès, a city of 57,000 inhabitants in the area of Barcelona. The park aims to become a model of sustainable growth; therefore it has partially implemented a high efficiency energy system that produces electricity, heat and cold with a DH&C network.

As a southern climate location, the Parc de l'Alba has a good potential for solar energy harvesting, with an annual direct nominal irradiation (DNI) of 1,765 kWh/m^2/year[20], which would be even suitable (although not optimal) for CSP. Regarding the biomass potential, Cerdanyola is placed near different forest and agricultural areas, which is translated to different possible suppliers of biomass according to ICAEN[21]. The prices of pellet and woodchip in 2017[22] were estimated around 0.057 €/kWh and 0.028 €/kWh, respectively. The low geothermal potential expected in the area is low, with values ranging 35-50 W/m[23,24]. This will also determine the drilling feasibility. Cerdanyola does not have significant wind and hydro potential. Finally, the Parc de l'Alba currently contains two data centres connected to the district network, with a total electrical installed capacity of 10.7 MW. While these are currently connected as consumers of district cooling, they could be used as a source of waste heat. One can note that no other industries are present in the immediate area.

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[20] Global Solar ATLAS. https://globalsolaratlas.info/

[21] ICAEN. Productors y subministradors de biomasa. http://icaen.gencat.cat/es/energia/renovables/biomassa/BiomassaCAT/empreses/productors/

[22] Diputació de Barcelona. Preus productes forestals 2017. https://www.diba.cat/documents/357755/10663850/201702+Preus+productes+forestals+15.jpg/6b3ca9e7-190c-447e-b66f-ffdb445bb0b4

[23] IDAE. Evaluación del potencial de energía geotérmica. https://www.idae.es/uploads/documentos/documentos_11227_e9_geotermia_A_db72b0ac.pdf

[24] IRENA. Global Atlas – Spain map of geothermal potential. https://irena.masdar.ac.ae/GIS/?map=714

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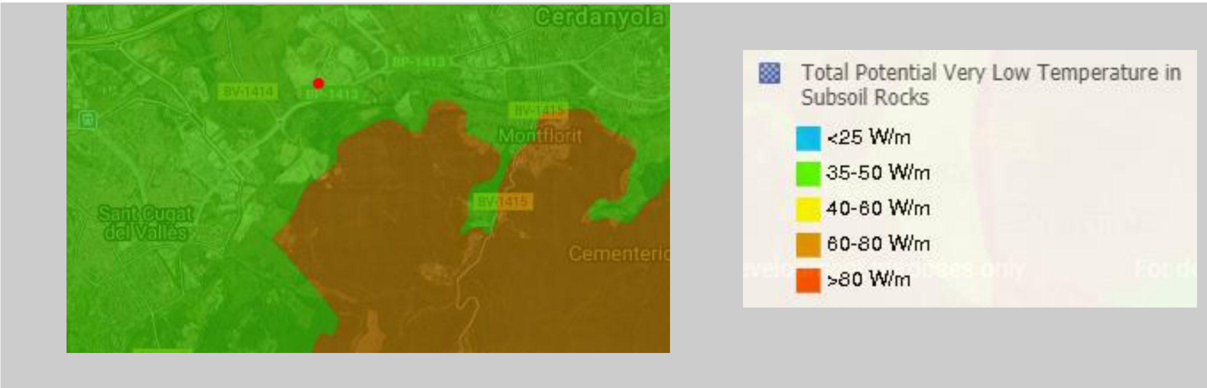

Figure 2-36. Low temperature geothermal potential in Parc de l'Alba[25] (red dot indicates location of the generation plant).

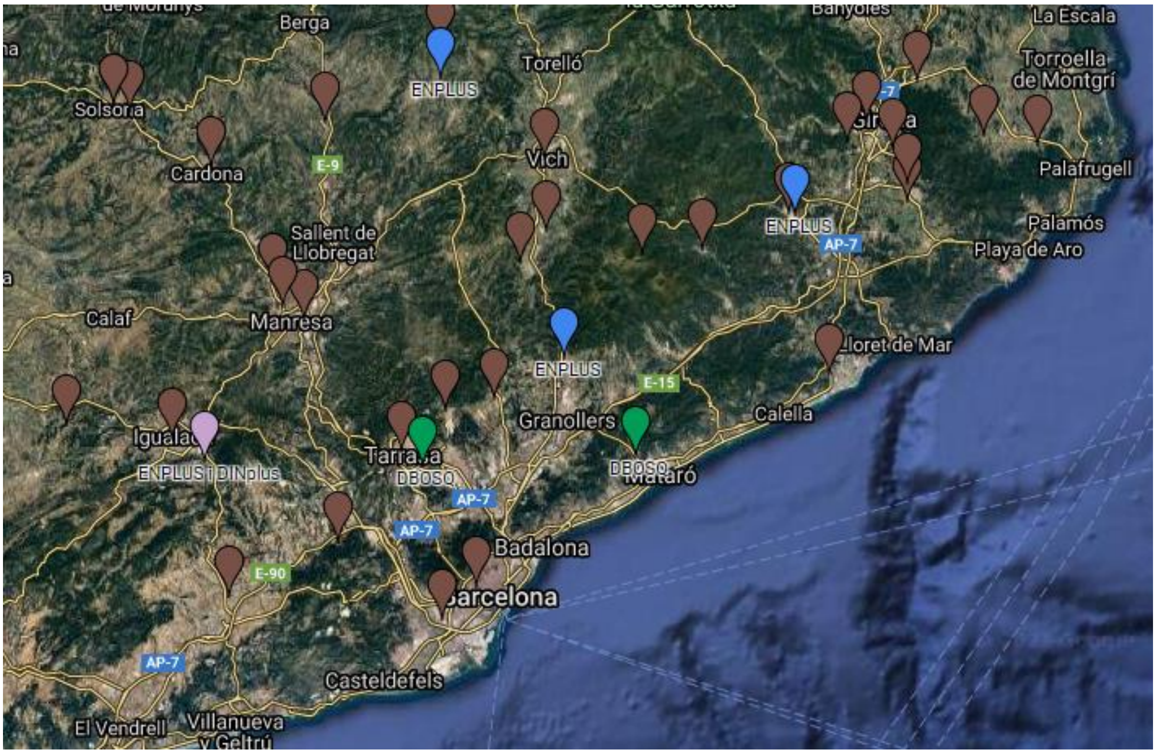

Figure 2-37. Biomass suppliers close to Parc de l'Alba.

Currently there are 2 data centres and 3 office buildings connected, although further services and industrial buildings are expected, and a residential development is planned. One can notice the presence of the Alba Synchrotron facility, as potential additional client for energy supply. These building have a very high cooling and electricity demand, that is the reason why the Parc de l'Alba could be a cooling dominated network. Moreover,

As it is in a partial implementation stage, the "Parc de l'Alba" is operating with a single generation plant (ST-04 in Figure 2-39). This supplies heating and cooling mainly with combined heat and power engines, backup gas boilers, absorption chillers, and compression chiller. This plant is ready to increase its capacity when the energy demand grows, with space available within the facility. Moreover, two more production plants are planned to be implemented according to the pace of the urban development (ST-05 and ST-07 in Figure 2-39).

[25] IDAE. Evaluación del potencial de energía geotérmica. https://www.idae.es/uploads/documentos/documentos_11227_e9_geotermia_A_db72b0ac.pdf

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°857801

The basic table with information summarized is included in Annex 1: Basic info tables (Table 4-6).

Figure 2-38. Parc de l'Alba main generation plant (foreground) and Synchrotron (background)

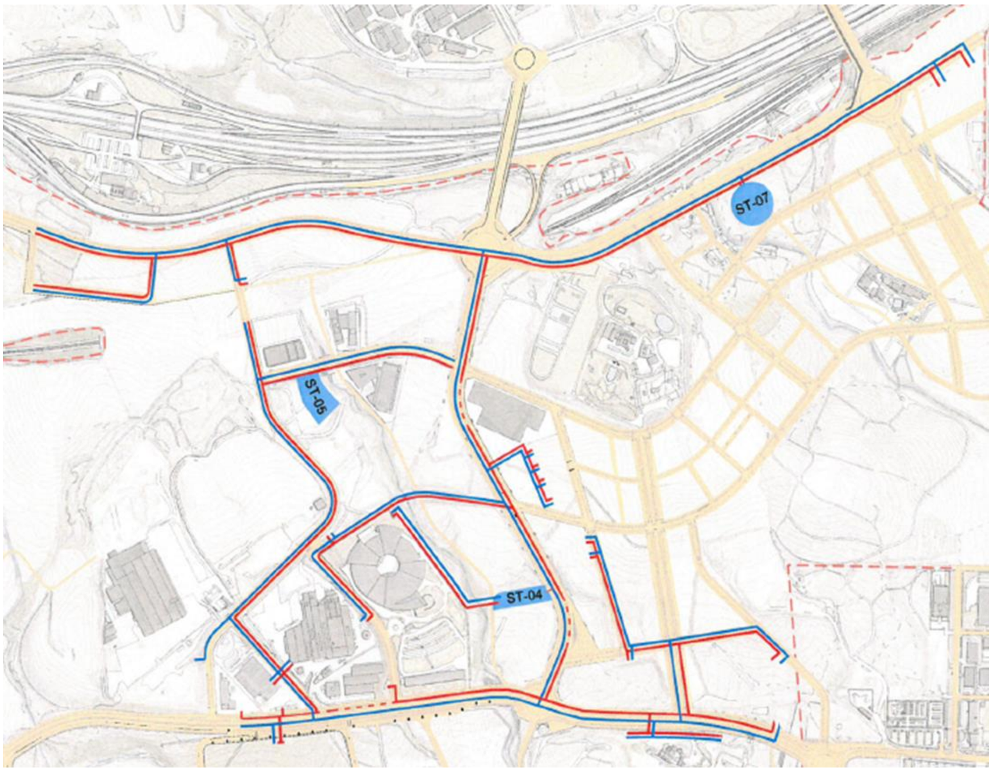

Figure 2-39. Parc de l'Alba current network layout.

A table with the basic data summarized is included in Annex 1: Basic info tables (Table 4-6).

PRELIMINARY ASSESSMENT

Currently, Parc de l'Alba DHC has six buildings connected, as summarized in Table 2-21. The most singular feature of the demo-follower is the presence of the Synchrotron light lab, which is a major cooling and electricity consumer. Moreover, two data centres are connected to the network, although these only used the DHC as backup for their own cooling equipment, hence having minor impact on the demand of the grid.

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The Parc de l'Alba DHC is part of a new urban development. Deployed in stages, more services building are regularly connected to the existing network as the residential areas developped.

Table 2-21 Parc de l'Alba buildings summary.

Building	Number	Total surface [m^2]
Synchroton light lab	1	30,896
Office buildings	3	49,090
Data centres	2	12,085

Table 2-22 summarizes the total energy supplied to the connected buildings by the Parc de l'Alba generation plant in 2019. Figure 2-40 and Figure 2-41 show the profiles of monthly demand in heating, cooling and electricity:

Table 2-22 Total energy supplied by the Parc de l'Alba in 2019.

Heating	4,044 MWh
Cooling	25,118 MWh
Exported electricity	29,100 MWh
Electricity sold within the district	23,500 MWh
Imported electricity	11,700 MWh

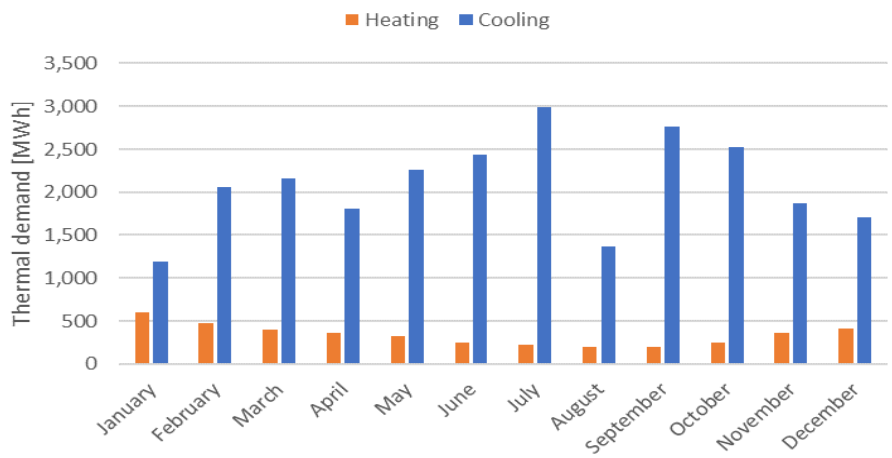

Figure 2-40. Parc de l'Alba - Monthly distribution of thermal demand.

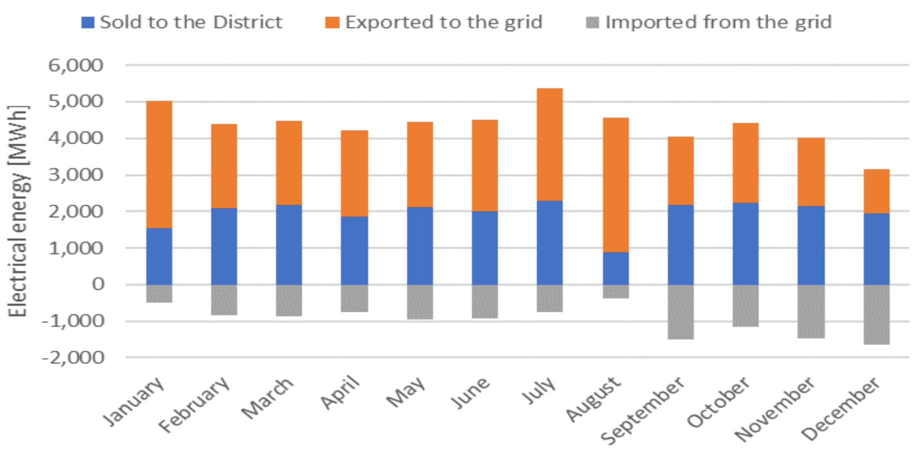

Figure 2-41. Parc de l'Alba - Monthly distribution of electricity demand

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°857801

So far, to cover these demands, the Parc de l'Alba DHC is running with a single generation plant. The equipment installed in this facility are summarized in Table 2-23. The CHP engines are used to supply the absorption chillers or to cover the heating demand, with the electricity sold to the Synchrotron or exported to the grid. The cold water storage is used to buffer the cooling demand, with the compression chiller covering the peak demand of cooling. The total gas and electricity consumption of the plant is summarized in Table 2-24.

Table 2-23 Parc de l'Alba - Equipment of the generation plant

Equipment	Total installed capacity
CHP engines	10.05 kW_{el}
Double effect absorption chiller	5 kW_{th}
Single effect absorption chiller	3 kW_{th}
Compression chiller	5 kW_{th}
Back-up natural gas boilers	5 kW_{th}
Chilled water storage tank	4,000 m^3

Table 2-24 Generation plant gas and electricity consumption in 2019.

Gas	10,600,000 m^3
Electricity	11,688 kWh

The Parc de l'Alba demo-follower is an existing district heating and cooling network showing already a good generation efficiency. The analysis will focus on identifying the potential of incorporating renewable energies and waste heat recovery to cope with the increasing demand that will come with the new residential areas to be built and connected to the DHC system.
Considering the previous information, the technologies and solutions proposed to be studied in Parc de l'Alba demo-follower are the following:

Table 2-25 Technologies proposed for the Parc de l'Alba demo-follower.

Technologies proposed	By means of
Waste heat recovery of data centres	Waste heat recovery from the chiller condenser with booster heat pump. Waste heat recovery from the chiller condenser and FC.
Advanced Absorption chiller	Compare WEDISTRICT absorption chiller with the performance of the existing single and double effect absorption chillers.
Solar technologies	Integration of solar panels in the central station to cover extra heating load. Considering: DNI of 1,765 kWh/m2/year Average annual sunny days 64.5 days / year. Average annual temperature 15.5ºC Average minimal temperature in January 5.3ºC Average maximum temperature in July 28.4 ºC
Hot water storage	Optimized water storage sized for acting as solar buffer
Biomass boiler	Biomass boilers installation for covering peak loads
Renewable air-cooling unit (RACU)	Integrated in buildings.

The combination of the different technologies generates four main solutions which will be studied in the next steps (other solutions might arise during the activity):

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Table 2-26 Summary of solutions proposed for Parc de l'Alba demo-follower.

Solutions proposed after preliminary assessment				
Technology	**S1**	**S2**	**S3**	**S4**
PTC	x	x		
Fresnel	x	x		
TF-FTC	x	x		
Biomass	x	x		
Molten Salts				
Hybrid PV-Geothermal				
Advanced Absorption Chiller	x			
RACU		x	x	
DC-FC-WHR			x	x
Other 1 □ DC-HP-WHR			x	x
Other 2 □ Hot water storage	x	x		

Table 2-27 Description of solutions proposed for Parc de l'Alba demo-follower.

Solutions proposed overall description	
Combination code	Parc de l'Alba – S1
Justification	This combination integrates renewable energies and improves the efficiency of the cooling production, by operating under solar cooling concept with WEDISTRICT improved efficiency absorption chiller. The biomass boiler reduces the gas consumption of the peak plant and increases the capacity of the plant to cover the increase of demand. It considers that the existing CHP is still the main heat supply, as it is also the main electricity supply to the Synchrotron. Sub-cases will be generated, isolating the contribution of each of the added technologies in order to find the optimal solution. These will be divided between demand with currently connected building and forecasted demand with the new residential development.
Expected impact	• Reduce the fossil fuel consumption. • Improvement of absorption chiller performance. • Maximise solar resources . • Evaluate availability of biomass and cover extra heating load.
Combination code	Parc de l'Alba – S2
Justification	This combination integrates renewable energies and improves the efficiency of the cooling production, by using renewable air cooling units for supplying the residential and office buildings, hence reducing the cooling demand to the existing absorption chillers. The biomass boiler reduces the gas consumption of the peak plant and increases the capacity of the plant to cover the increase of demand. It considers that the existing CHP is still the main heat supply, as it is also the main electricity supply to the Synchrotron. Sub-cases will be generated, isolating the contribution of each of the added technologies in order to find the optimal solution. These will be divided between demand with currently connected building and forecasted demand with the new residential development.
Expected impact	• Reduce the fossil fuel consumption. • Improvement of absorption chiller performance. • Maximise solar resources. • Evaluate availability of biomass and cover extra heating load. • Plan new development of residential buildings equipped with RACU. • Compare investment and operation cost of four-pipes configuration (DHC to buildings) and two pipes (DH + RACU to buildings).
Combination code	Parc de l'Alba – S3
Justification	Exploit the available waste from the DC already connected into the DHC to reduce the heat demand of the plant. Considers two scenarios, WHR with current state of the art DC and with refurbished green DC.
Expected impact	• Reduction of generation plant heat demand. • Reduction of overall district primary energy and CO_2 emissions. • Increase of DC efficiency and profitability.
Combination code	Parc de l'Alba – S4
Justification	Exploit the available waste from the DC to minimize the impact on the heating and cooling demand caused by the connection of the new residential development. The

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	constant supply of heat by the DC covers part of the heating demand of the residential building in winter and supplies the heat required to operate the RACU covering the cooling demand of these buildings.
Expected impact	● Minimize increase of generation plant heat and cooling demand due two new residential buildings. ● Reduction of overall district primary energy and CO_2 emissions. ● Increase of DC efficiency and profitability. ● Compare investment and operation cost of four-pipes configuration (DHC to buildings) and two pipes (DH + RACU to buildings).

CONCLUSION

The Parc de l'Alba demo-follower represents a specific case of growing DHC network. Note that it has significantly higher cooling than heating, mainly due to the presence of the Synchrotron. Moreover, this facility makes that a significant part of the cooling load is not dependent on the weather conditions.

The main focus of this case would be: (1) the improvement of the current facilities, (2) the exploitation of the available waste heat from the big data centres already connected to the grid, and (3) to plan the increase of generation capacity to cover the new demands from the residential area under development.

2.2.2 University of Cyprus (Nicosia – Cyprus)

GENERAL DESCRIPTION

University of Cyprus (UCY) is a retrofitting DHC demo-follower. Its DHC was built in 1999, and so far, two expansions have been completed in 2007 and 2010. The next expansion is planned in 2022. Figure 2-42 shows the most updated aerial photograph of the UCY Campus.

Figure 2-42. University of Cyprus – Aerial campus photograph.

The UCY has three types of energy demands:

- Cooling of 17 buildings, in total an area of 91,422 m^2 (excl. student residences)
- Heating of 29 buildings, in total an area of 98,520 m^2 (incl. student residences)
- Domestic hot water

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For the 2022 expansion, the following technologies are planned to be installed at UCY:

- A 5 MWp PV plant with a 2.35 MWh capacity electric battery
- Various heating and cooling storage systems

Schematics of the district cooling and heating networks are shown in Figure 2-43 and Figure 2-44:

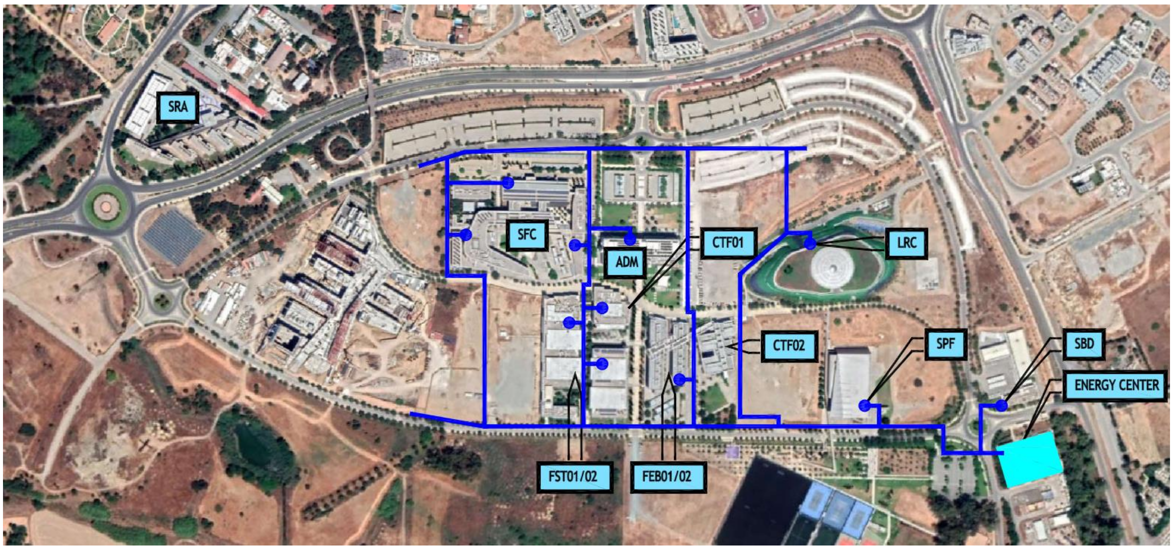

Figure 2-43. UCY_DC. University of Cyprus – District cooling schematic.

The District Cooling schematic illustrates the 17 (10 individual + 7 in the Social Facilities, "SFC") buildings receiving cooling within the UCY Campus with a total area of 91,422 m^2.

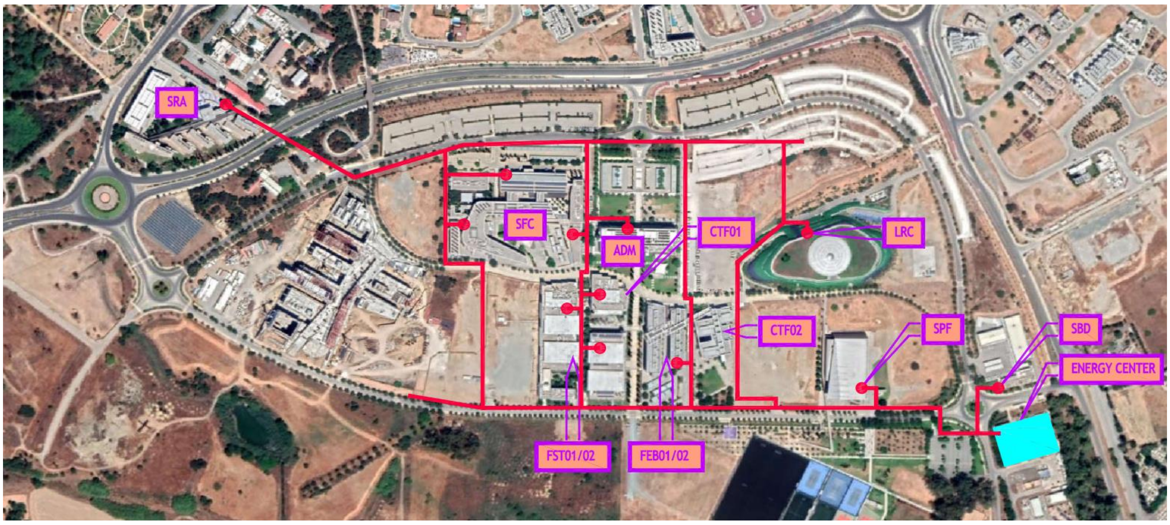

Figure 2-44. UCY_DH. University of Cyprus – District heating schematic.

The District Heating schematic illustrates the 29 buildings (incl. 12 Student Residences, "SRA") receiving heating within the Campus with a total area of 98,520 m^2.
A table with the basic data summarized is included in Annex 1: Basic info tables (Table 4-7).

Next, Sankey diagram in Figure 2-45 illustrates the energy flows for heating purposes (data from 2015).

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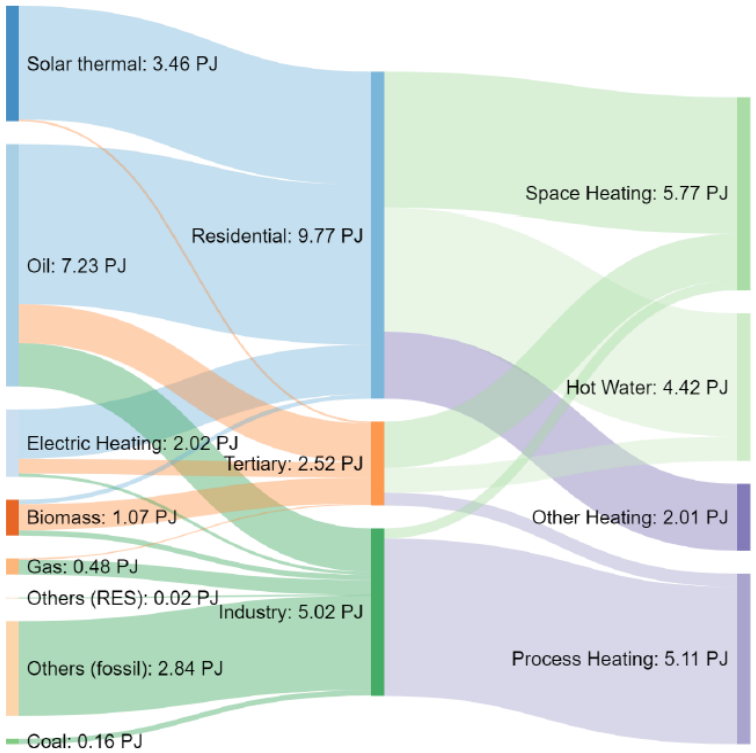

Figure 2-45. Sankey diagram of energy flows for heating purposes in Cyprus in 2015[26].

In Figure 2-46 and Figure 2-47, respectively, the overall energy consumption and average CO_2 emission in Cyprus are listed for a given time period (2009-2017). From the data available, it is noted that the energy consumed in Cyprus mainly comes from oil- and petroleum products, while both electricity and heat (e.g., space heating, hot water etc.) emits a noticeable amount of CO_2 [27]. In addition, it is noted that, apart from University of Cyprus (UCY), no other district heating systems exist in the island of Cyprus.

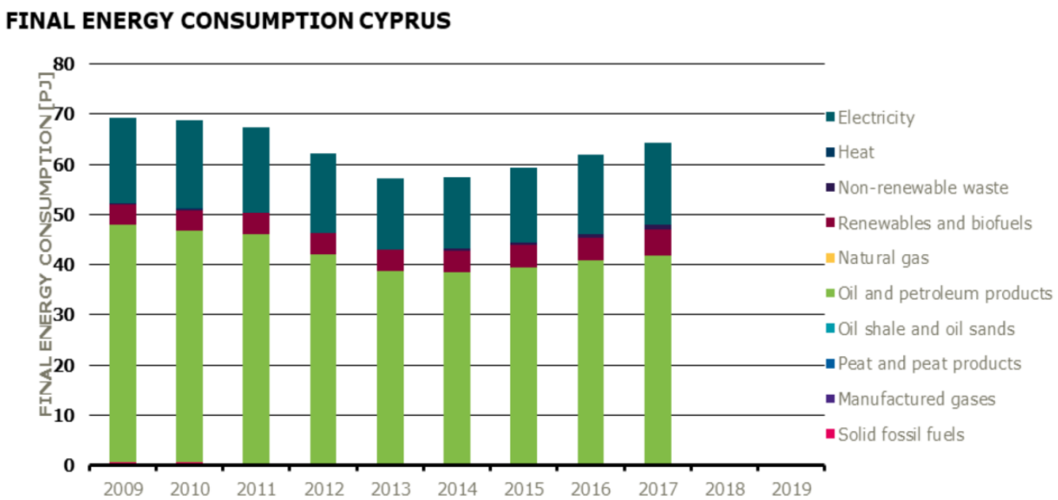

Figure 2-46. Final energy consumption by fuel and year in Cyprus[28].

[26] Heat Roadmap Europe
[27] WEDISTRICT Project - Deliverable D2.3 "District Heating and Cooling Stock at EU level"
[28] Data extracted from Euroheat & Power

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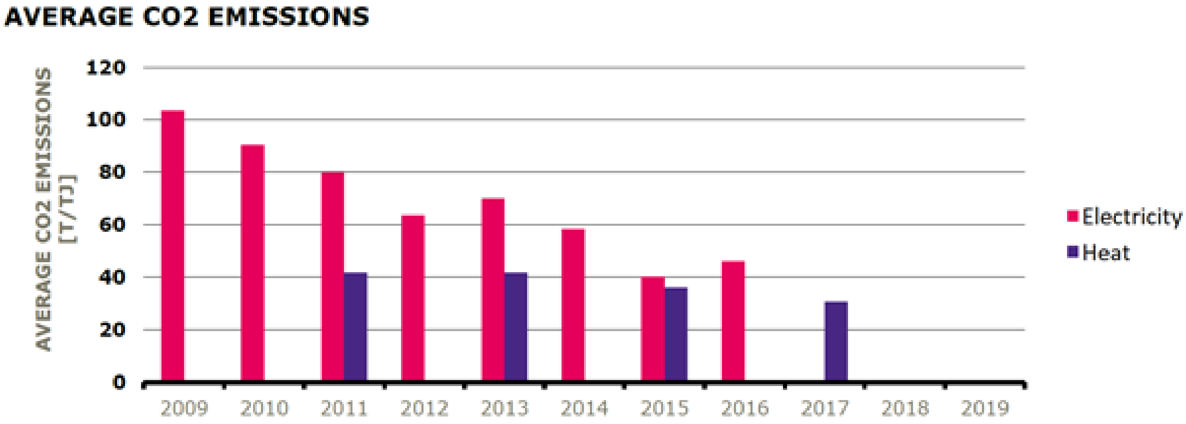

Figure 2-47. Average CO2 emissions in Cyprus[29].

Month	H_Gh	H_Dh	H_Bn	Ta
	[kWh/m2]	[kWh/m2]	[kWh/m2]	[°C]
January	80	36	103	10,6
February	95	43	106	10,6
March	144	59	143	13,1
April	171	73	150	17,1
May	205	78	187	22,3
June	217	74	204	26,9
July	217	78	201	29,7
August	217	63	224	29,4
September	162	59	164	26,2
October	129	44	159	22,3
November	91	36	119	16,3
December	76	29	118	12,0
Year	1802	672	1878	19,7

H_Gh: Irradiation of global radiation horizontal
H_Dh: Irradiation of diffuse radiation horizontal
H_Bn: Irradiation of beam
Ta: Air temperature

Figure 2-48. Solar radiation potential in Nicosia, Cyprus[30].

In Cyprus, the annual solar radiation potential is in the range of 1,878 kWh/m²/year, as shown in Figure 2-48. It is a relatively high radiation representing a great potential for solar power as well as solar heating applications. The data shows an intense solar radiation peak in the summertime. This peak is expected to trigger a certain need for cooling. Therefore, thermal energy storage solutions are considered great assets in Cyprus, e.g., potentially storing heat (and cooling) during the summer to deliver heat in wintertime.

[29] Data extracted from Heat Roadmap Europe and EEA
[30] Data extracted from Meteonorm

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PRELIMINARY ASSESSMENT

The following bullets, figures and tables summarise the preliminary assessment:

- UCY is considered a relatively new university, as it is only 25 years old. It is publicly funded.
- UCY informs to have a DCH system, unique in Cyprus, designed in the 90s.
- UCY experiences an accelerating development with constantly having new buildings constructed. Thus, UCY is currently in the process of designing a new Energy Center for green technologies, following the State of the Art. Plans are to include a PV field to produce electricity to Campus (5 MWe initially, to be upgraded to 10 MWe).
- UCY informs of smaller installations as well as solar water heating and PV. Plans are to not export electricity, however, to use electricity for cooling needs as well.
- UCY seeks the optimal mix for heating/cooling; a modular design method.
- For the implementation of electricity (chillers), historical reliable data is accessible, as well as heating/cooling demands in kWh, predicting how Campus will grow in the coming years.
- UCY is currently working on projections on future campus loads, as new buildings will become available, and they are available if further information is needed.

The UCY Master Plan is shown in Figure 2-49. Building information is given in Table 2-28.

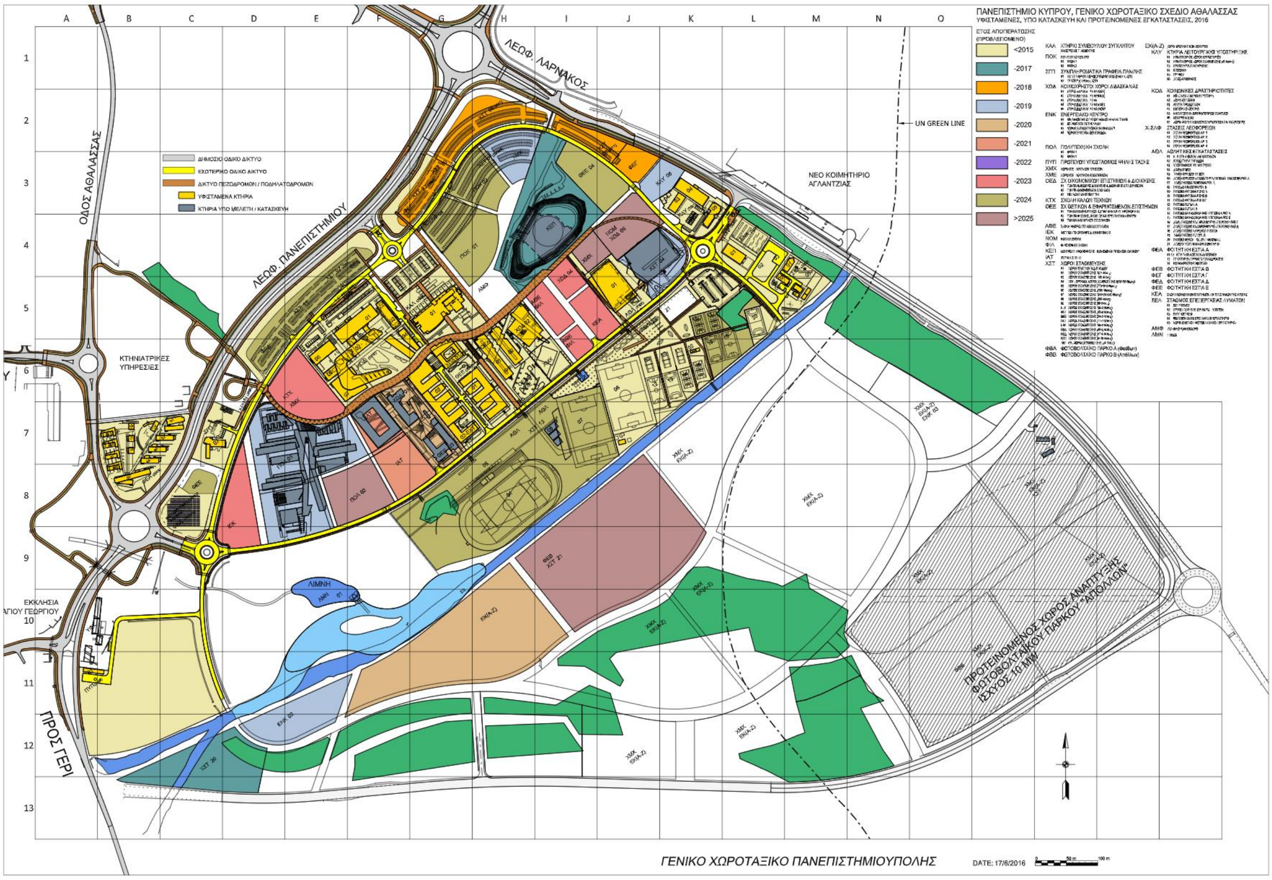

Figure 2-49. UCY_Master_Plan. University of Cyprus Master Plan - General spatial plan of university.

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Table 2-28 Buildings and annual consumption/purchase for Year 2019 at University of Cyprus.

Building Complex					Connected to DH?	Connected to DC?	Annual consumption			Ann. purchase
Abbrv	**Name**	**Type**	**Bldgs**	**Area**			**Heating**	**Cooling**	**Electricity**	**Heating oil [litres]**
ADM	Administration Building	Office space	1	10,602	Yes	Yes	-	-	631,243	-
FST-01	Faculty of Pure and Applied Sciences 01	Dry laboratories, office space, classrooms	1	12,051	Yes	Yes	-	-	1,100,182	-
CTF-01	Common Teaching Facility 01	Classrooms	1	-	Yes	Yes	-	-		-
SBD	Services Building	Office space, stores	1	3,672	Partly	Partly	-	-	N/A	-
FEB-01	Faculty of Economics and Business 01	Office space	1	18,576	Yes	Yes	-	-	1,127,607	-
FEB-02	Faculty of Economics and Business 02	Office space	1	-	Yes	Yes	-	-		-
CTF-02	Common Teaching Facility 02	Classrooms	1	-	Yes	Yes	-	-		-
FST-02	Faculty of Pure and Applied Sciences 02	Wet laboratories, office space, classrooms	1	10,663	Yes	Yes	-	-	2,763,049	-
SPF	Sports Facilities	Indoor sports hall	1	6,816	Yes	Yes	-	-	468,337	-
SRA	Student Residences	-	12	7,098	Yes	No	-	-	427,339	-
SFC	Social Facilities	Restaurant, cafes, shops	7	13,216	Yes	Yes	-	-	1,435,730	-
LRC	Learning Center - Library	Office space, library, reading areas	1	15,826	Yes	Yes	-	-	1,653,556	-
	Energy Center								**1,753,126**	**884,956**
	Chillers								**3,699,404**	

A graphical summary of the heating oil purchase* as well as electricity consumption in order to evaluate the heating/cooling along the year is shown below (data from 2019):

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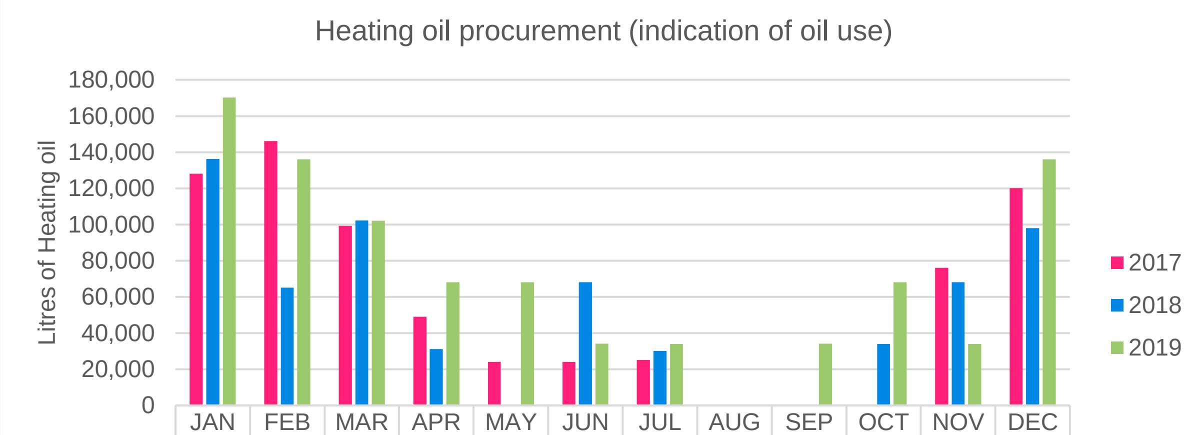
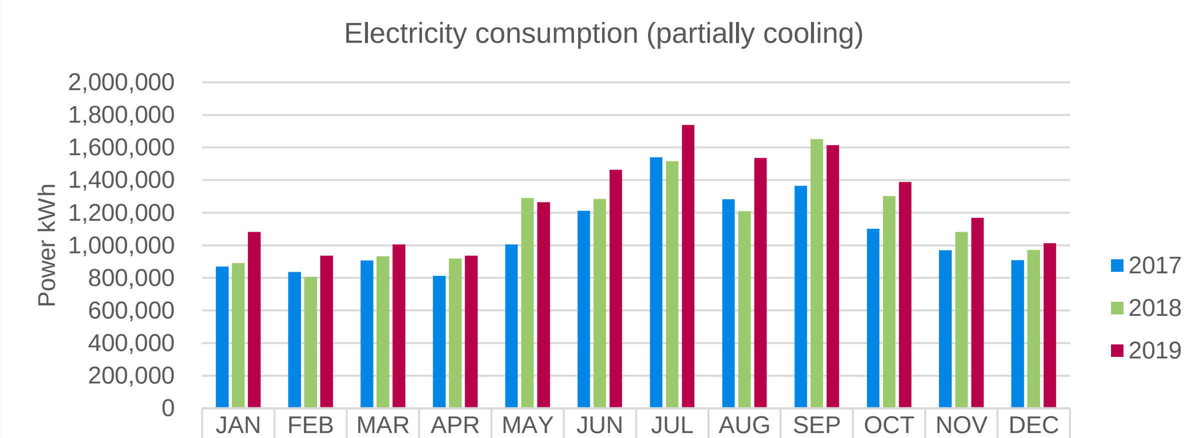


	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2017	128,1	146,1	99,18	49,04	24,02	24,01	25,05	0	0	0	76,08	120,1
2018	136,1	65,09	102,2	31,07	0	68,05	30,06	0	0	34,02	68,06	98,09
2019	170,2	136,0	102,1	68,08	68,05	34,07	34,02	0	34,07	68,09	34,01	136,0

Figure 2-50. Heating oil purchase in 2017, 2018 and 2019 at University of Cyprus, Nicosia, Cyprus.

Note that Figure 2-50 represents the heating oil *purchase*, not *consumption*. In order to account for the consumption, the actual storage capacity of 90.000 litres should be considered. Thus, in other words, the *consumption = purchases ± 90,000 litres*.



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2017	868,6	836,6	906,4	813,2	1,004	1,210	1,540	1,281	1,364	1,102	970,2	908,9
2018	890,7	806,2	932,2	917,8	1,289	1,285	1,516	1,210	1,652	1,302	1,082	971,7
2019	1,081	935,8	1,005	937,2	1,264	1,463	1,739	1,536	1,613	1,388	1,167	1,012

Figure 2-51. Electricity consumption in 2017, 2018 and 2019 at University of Cyprus, Nicosia, Cyprus.

In the following, the current energy system is described:

- Four oil boilers of each 1,750 kW heating power with a nominal efficiency of 88%. (This 88% is because these are non-condensing boilers, and no heat reclaim is made through the boiler exhaust either[31]).

31 In addition, it is noted that, these are 25-year-old boilers, so they may be slightly less efficient than new ones. A good biomass boiler should have a low 90s percent efficiency, while oil and gas boilers should be at least 95-97%. This shows a good reason to refurbish or, even better, change the equipment. Though, this is also noted to be outside the scope of the WEDISTRICT project.

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- Eight air-cooled chillers, each nominated to 1,000 kW cooling with an ESEER = 4.12. (A European Seasonal Energy Efficiency Ratio (ESEER) of 4.12 corresponds to a Coefficient of Performance (COP) value of approx. 1.21[32]).

The new Energy Center plans to include:

- Solar heating
- Air-cooled chillers
- Ice storage (cold storage)
- Tri-generation (combined cooling, heating, and power generation)
- Oil-fired boilers

Considering the previous information, the technologies and solutions proposed to be studied for UCY as a demo-follower are listed in Table 2-29 in the following:

Table 2-29 Technologies proposed for Cyprus University demo-follower.

Technologies proposed	By means of
Solar Heating Technologies; TF-FTC	Investigation of integration of WEDISTRICT solar thermal panels (TC-FTC, Tracking Concentrator for Fixed Tilt Collector) to cover the heating load of the Campus; utilization of the high solar radiation potential in Cyprus.
PV / PV-Thermal (PVT)	Investigation of PV for electricity generation. UCY informs that their plans of expansion include a PV field to produce electricity to Campus (5 MWe initially, later to be upgraded to 10 MWe). Comparison of possible PV and PVT solutions (possibly with tracking mirrors) to investigate the possibility of increasing the electrical and thermal outputs. The WEDISTRICT PV-geothermal hybrid will also be considered.
Geothermal System	Investigation of the option of a geothermal system layout as well as the WEDISTRICT PV-geothermal hybrid solution.
Heat Pump	Investigation of the performance and operation of an absorption heat pump compared to a (conventional) compression heat pump (several WEDISTRICT thermocycle technologies are available for comparison).
Advanced Absorption Chiller	Investigation of the performance and operation of the WEDISTRICT advanced absorption chiller, compared to the planned air-cooled chillers.
Renewable Air-Cooling Unit (RACU)	Investigation of the option of integrating RACUs in the buildings to deliver cooling instead of the chiller solution(s).
Biomass Boiler	Investigation of the low-emission biomass boiler as either a direct substitution of the existing (relatively old) oil-fired boilers, or simply as a back-up solution, for the coverage of peak loads. The biomass performance is to be compared to the performance of the planned oil-fired boilers, included in the Energy Center.
Energy Storage	Investigation of various energy storage solutions including: ● Utilization of an optimized water storage sized for acting as solar buffer ● Utilization of ice (cooling) storage solution(s) ● Utilization of an electric battery (2.35 MWh capacity already planned)

The combined solutions, presented in Table 2-30 and explained in detail in Table 2-31, are proposed in the UCY preliminary assessment. The symbol '(x)' indicates optional selections for a possibly better direct comparison between the solutions.

Table 2-30 Solutions proposed after the preliminary assessment for Cyprus University demo-follower.

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32 ESEER = (EER@100% load × 0.03) + (EER@75% load × 0.33) + (EER@50% load × 0.41) + (EER@25% load × 0.23) = (3.09 × 0.03) + (3.62 × 0.33) + (4.16 × 0.41) + (4.89 × 0.23) = 4.118; [Ref: Provided data sheets of the installed Chillers 3, 4, 5, 6, 7, 8]. Chillers 1 and 2 are informed to have inferior energy performance characteristics, and they are used only if necessary. Conversion factor applied: EER = 3.412 × COP; [Ref: Fundamentals of Thermal-Fluid Sciences, Cengel et al., McGraw-Hill, 3rd ed., 2008, page 246]. Additional literature on this topic: Eurovent paper: "Effect of the Certification on Chillers Energy Efficiency" *and* Centro Studi Galileo paper: "ESEER of different installation solutions of chillers".

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Solution proposed after preliminary assessment			
WEDISTRICT Technologies	S1	S2	S3
TF-FTC	x	x	x
PV / PVT	x	(x)	(x)
PV-Geothermal Hybrid		x	
Heat pump (A-W or A/A)	x	x	x
RACU		x	(x)
Advanced Absorption Chiller		x	(x)
Biomass			x
Energy storage, in general	x	x	x
Tri-generation (CCHP*), in general	x	x	x
Air-cooled chillers	x		
Oil-fired boilers	x		

**CCHP: Combined Cooling, Heating and Power Generation.*

Table 2-31 Overall description of the solutions proposed for Cyprus University demo-follower.

Solutions proposed overall description	
Combination code	UNIVERSITY OF CYPRUS – S1
Justification	The proposed solution S1 reflects the solution planned for DHC at UCY after the expansion and refurbishment in 2022. This is intended to be used as a benchmark solution. Thereby solution S1 integrates and combines the technologies of FTC, PV, Heat pumps, Energy storage, CCHP and Air-cooled chillers as well as oil- or biomass fired boilers for backup. This solution is suitable for UCY since it includes the technologies that are being considered for the production of District Heating, (fixed tilt solar collectors, geothermal system), district cooling (Air-to-water or Air-to-air heat pumps, Ice (i.e., cold) storage and Air-cooled chillers) and power production (Photovoltaics) – all three (trigeneration; in the form of a combined cooling, heating, and power plant), which are in the scope for 29 buildings, including student residences.
Expected impact	• Investigation of the installation of the new DHC equipment / plant capacity to cover the expected DHC and electricity demands of the new Campus buildings. • Investigation of the possible improvements of the WEDISTRICT solar thermal panels (TC-FTC), compared to traditional solar heating technologies. • Investigation of the possible improvements regarding PV or PV-T system layouts. • Investigation of the installation of Heat pump technologies. • General advising on energy equipment planning for the expansion of the UCY Campus buildings.
Combination code	UNIVERSITY OF CYPRUS – S2
Justification	The proposed solution S2 is a variation of the planned setup using RACU and/or Advanced Absorption Chilling instead of the planned Air-cooled chillers to deliver cooling. In addition, part of the heating will be covered by Geothermal heating instead of the planned Oil-fired boilers. Note that FTC, PV, HP, Energy Storage and Trigeneration are still in this configuration.
Expected impact	• Investigation of the possible improvements related to district cooling from RACU and/or Advanced Absorption Chillers, as opposed to Air-cooled chillers. • Investigation of the impact of geothermal heating to cover peak load heating as opposed to using Oil-fired boilers. • Investigation of the possible improvements regarding PV or PV-T system layouts in combination with the WEDISTRICT Geothermal Hybrid. • General advising on planning of buildings' energy equipment alternatives.
Combination code	UNIVERSITY OF CYPRUS – S3
Justification	The proposed solution S3 is a variation of the setup using RACU, and/or Advanced Absorption Chilling, instead of Air-cooled chillers for cooling. In addition, the option of the WEDISTRICT Low-Emission Biomass Boiler technology is investigated for the purpose of heat provision, instead of the proposed geothermal (hybrid) heating in S2. Note that FTC, PV, HP, Energy Storage and Trigeneration are still in this configuration.

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Expected impact	• Investigation of the improvement related to district cooling from Advanced absorption chillers as opposed to air-cooled chillers (considering results from S2). • Investigation of the impact of using biomass boilers to cover peak load heating as opposed to geothermal heating or heating from oil-fired boilers. • General advising on planning of buildings' energy equipment alternatives.

CONCLUSION

At this stage, UCY has provided a lot of useful data, currently being analysed. The next expansion of the UCY campus is planned in 2022, for which the following new equipment are being considered:

- Solar heating (fixed tilt solar collector types)
- PV plant(s) with electric battery storage
- Heat pump technologies
- Air-cooled chillers (with ice/cold storage)
- Heating and cooling storage systems (energy storage in general)
- Tri-generation (combined cooling, heating, and power generation)
- Oil-fired boilers (for back-up)

Within WEDISTRICT, it is planned to simulate the current energy demands of the campus as well as the planned expansion (S1), followed by the suggested WEDISTRICT technology combinations. No limitations (e.g., limited land area) are noted. UCY leaves it to WEDISTRICT to propose (one or more) technology combination(s) of relevance to the expansion of the campus, and initially two alternative combinations are proposed (S2, S3).

2.2.3 Żyrardów (Żyrardów – Poland)

GENERAL DESCRIPTION

Żyrardów is a town in central Poland with approximately 41,400 inhabitants. Żyrardów has almost 200 years of history. The town was developed during the 19th century into a significant textile mill town in Poland.

Regarding the targets related to the energy sector, Poland has established an objective of 21% of renewable energy on the final energy consumption by 2030. This aims at achieving a more sustainable energy sector in Poland. Moreover, 70% of all households in Poland are to be connected to DH networks by 2030[33]. District Heating's are one of the best solutions to increase the share of renewable energies regarding the heat sector.

The next figure shows the predominance of the fossil fuels in the heat production field.

[33] WEDISTRICT - Deliverable D2.3 "District Heating and Cooling Stock at EU level"

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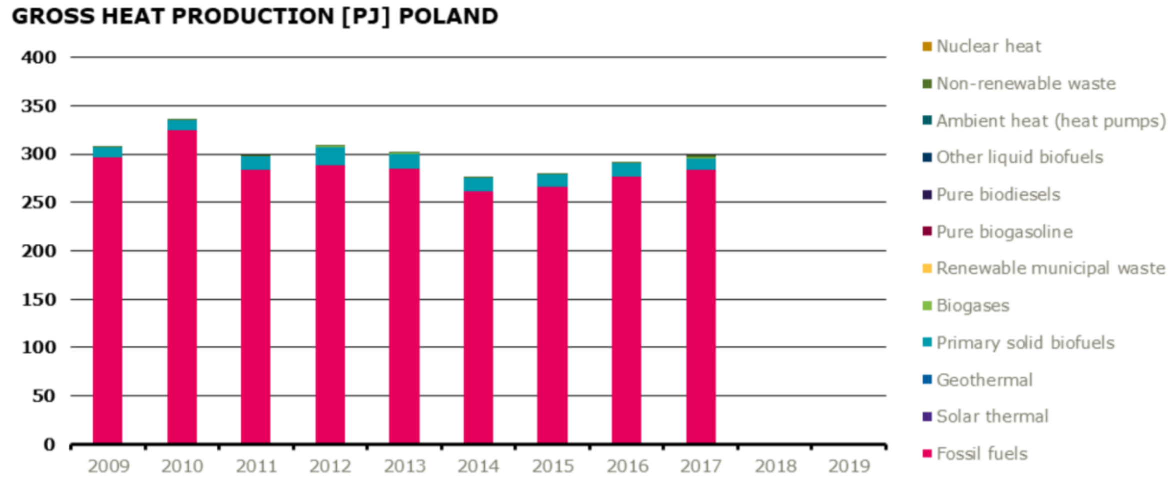

Figure 2-52. Gross heat production by fuel and year in Poland.

Regarding the installed heating capacity, the individual boilers represent a 64% of the total power, followed by the 25% of DHs with boilers (mainly based on fossil fuels) and 10% of DHs with CHP.

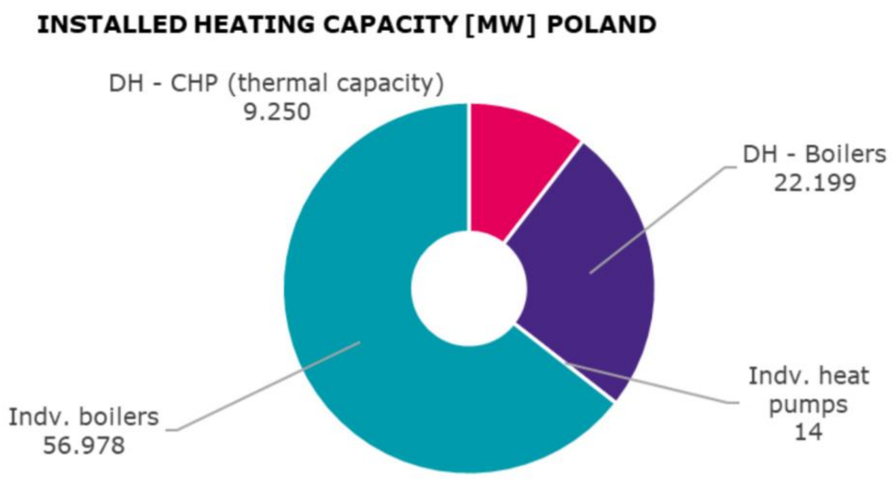

Figure 2-53. Installed heating capacity installed in Poland in 2015.

In case of Żyrardów the district heating system covers around half of the city and is still developing. There are two thermal plants in Żyrardów. One hard coal fired with water boilers (around 63 MW in fuel) which belongs to PEC "Żyrardów" company and one 10 MW gas fired boiler which belongs to other company Geotermia S.A. located around 2 km from the main heat plant.

In the map the area in red circle is the 63 MW power plant driven by coal boilers. The blue circle represents the location of the smaller 10 MW power plant. The district heating system supplies energy in all the green marked area.

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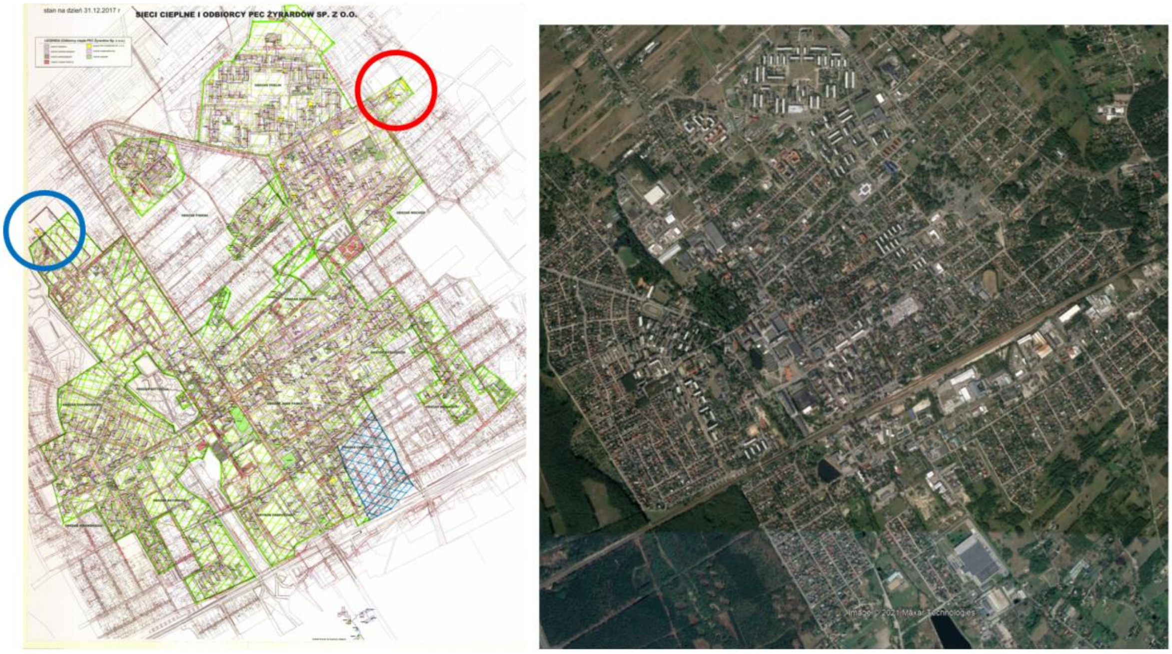

Figure 2-54. Left - Żyrardów District Heating map. Right - View of Żyrardów

The DH network has a length of around 43 km. In 2013-2016 almost all sections of DH made in "traditional technology" were replaced by pre-insulated pipes (currently 99,9% of the network is made in pre-insulated technology). The energy losses in the network represent around 13-14% of the produced energy. The district heating was also expanded by so called "rings" which reduced markedly the electric energy consumption.

Figure 2-55. Żyrardów District Heating installation

A table with the basic data summarized is included in Annex 1: Basic info tables (Table 4-8).

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PRELIMINARY ASSESSMENT

The supply temperature varies seasonally depending on the outdoor temperature. In winter it can reach almost 122ºC when the outdoor temperature is -20ºC while in summer the temperature is quite constant around 70ºC.

The return temperature is between 60-70ºC during the winter, and 45-55ºC during the summer.

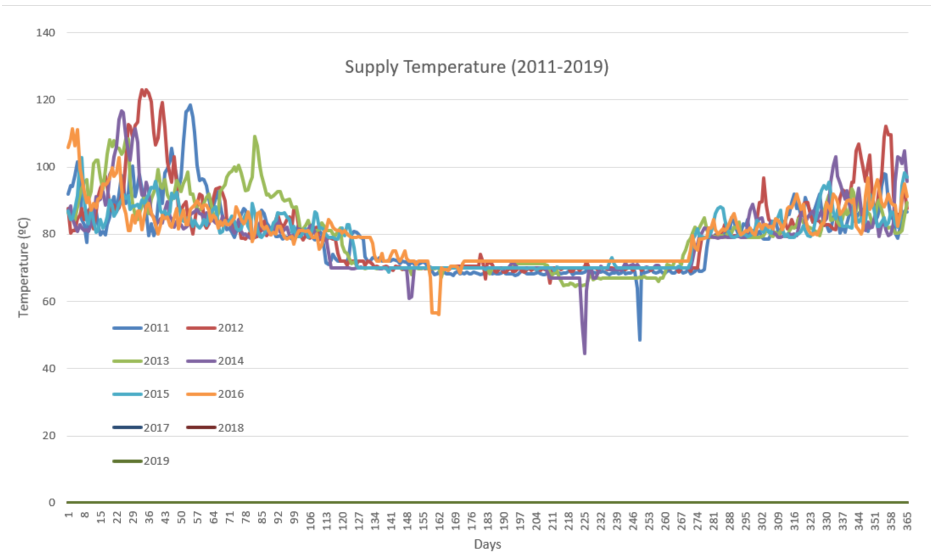

Figure 2-56. DH supply temperature

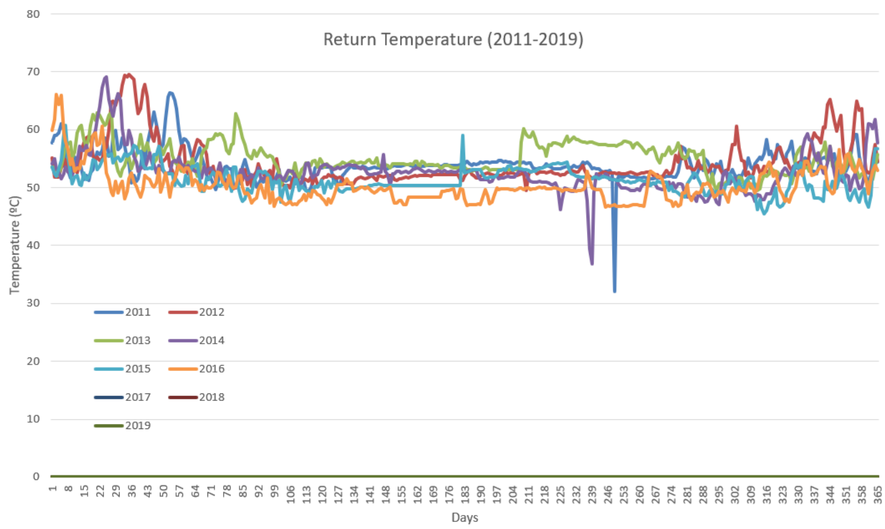

Figure 2-57. DH return temperature

Produced thermal energy: The yearly curves of the produced thermal energy are as follows:

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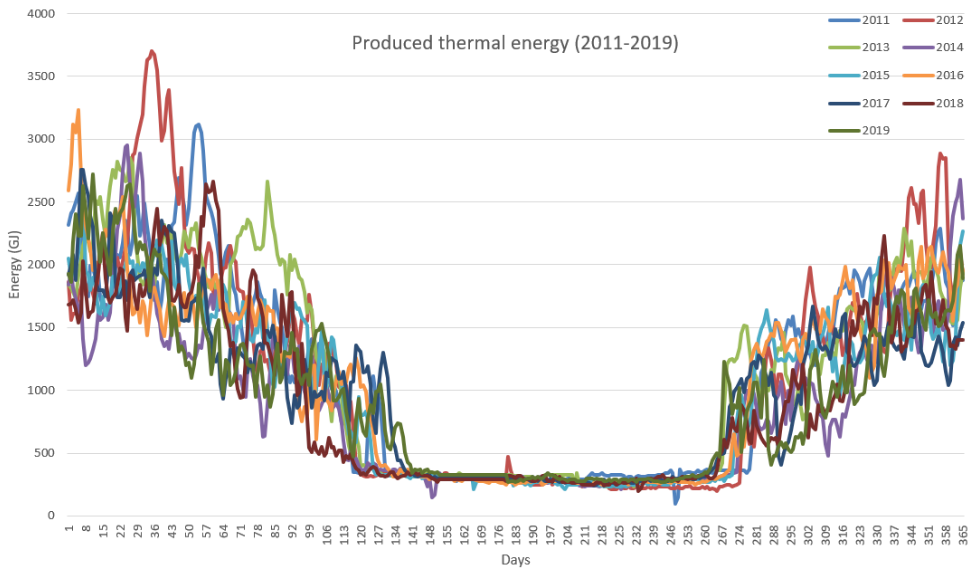

Figure 2-58. Produced thermal energy

The peak demand is in winter. In summer the produced thermal energy covers the domestic hot water (DHW) demand, which is quite constant over the years. Table 2-32 represents the heat production from 2011-2020 also for gas heating station in 2014-2020.

Table 2-32 Produced thermal energy

Year	Thermal Energy from main heat station (GJ)	Thermal Energy from gas heat station (GJ)
2011	418,352	
2012	429,235	
2013	420,528	
2014	338,478	51,280
2015	327,576	53,846
2016	347,672	55,241
2017	379,471	47,790
2018	339,472	69,956
2019	347,504	49,893
2020	351,243	50,111

Below, are compared the produced energy of the 63 MW power plant driven by coal boilers with the 10 MW gas fired boiler.

Table 2-33 Comparison between coal and gas boilers´ thermal energy production

Year	Energy from coal heat utility (GJ)	Energy from gas heat utility (GJ)	Total Thermal Energy (GJ)
2015	327,576	53,846	381,422
2016	347,672	55,241	402,913

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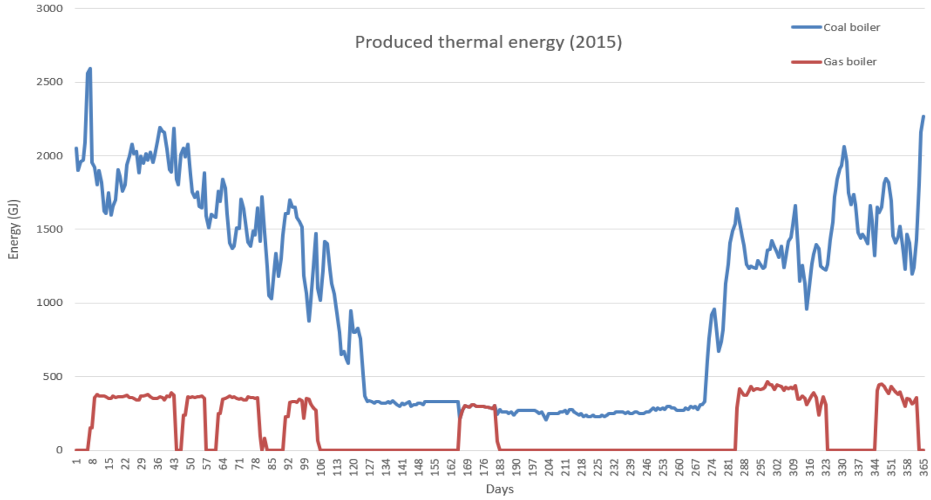

Figure 2-59. Produced thermal energy in 2015 by coal and gas fired boilers

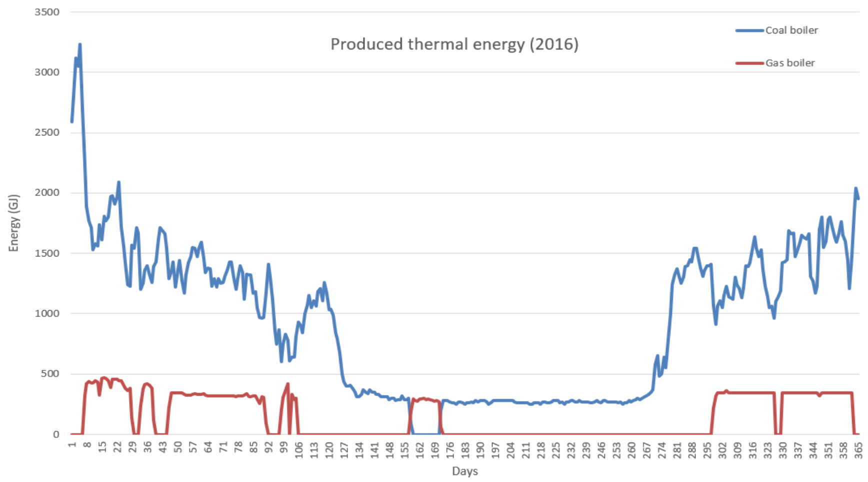

Figure 2-60. Produced thermal energy in 2016 by coal and gas fired boilers

Almost in all years where gas heating station worked there is a very similar amount of produced energy by the gas boiler (around 54,000 GJ), which represent a 14% of the total amount and is a consequence of the contract between PEC "Żyrardów" and Geotermia Mazowiecka S.A.
When the gas boiler is operating, the daily produced energy is quite constant, between 350 and 400 GJ, which is the energy that the 10 MW gas boiler produces in 12 hours period working at full capacity.
In summer there are usually 2-4 weeks where the coal boilers are switched off and the gas boiler is switched on to produce thermal energy for DHW. The capacity of the gas boiler completely covers this demand of energy during the summer. These 2-4 weeks period are used for maintenance work at main heat plant.

Heat power: The monotonous load curves that appear below are not very precise, since the data that was gathered is a daily average heat power, so the hourly peaks are not registered here.
It has been possible to have access to hourly data for some days and we have seen that between the daily average value and the peak power there could be a difference of 10% to 30%. Therefore, 46 MW peak power could be "converted" into almost 60 MW, which is more realistic when compared it with the installed power. Recently (February 2021), which is not shown in the graph, the peak demand exceeded 50 MW due to longer periods of outdoor

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temperature below -10 C. Thus, it might be assumed that for longer periods with temperature below -20C, 60 MW peak might be reached once per 10 year for instance.

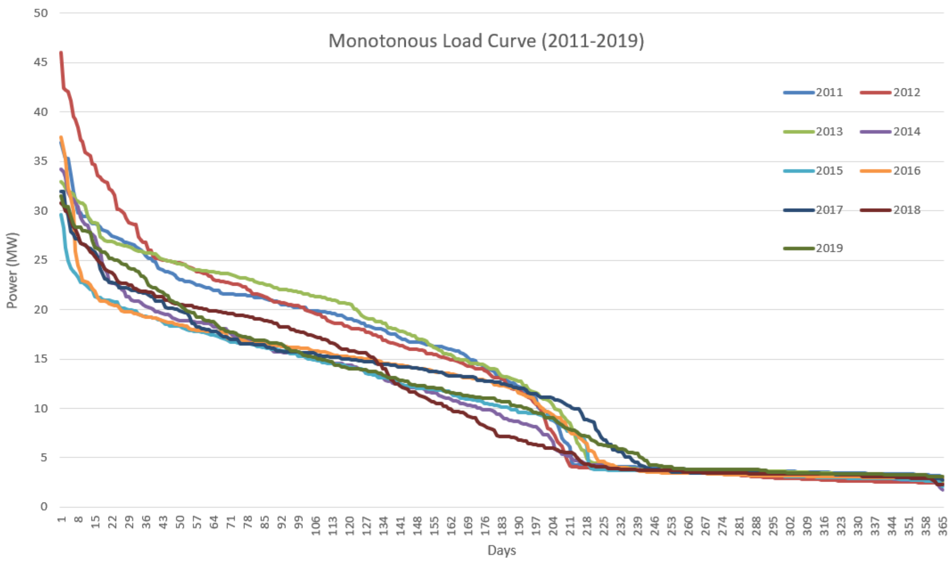

Figure 2-61. Monotonous load curve

Considering the previous information, the technologies and solutions proposed to be studied in Żyrardów demo-follower are the following:

Table 2-34 Technologies proposed for Żyrardów demo-follower.

Technologies proposed	By means of
Solar technologies	Integration of solar panels in the central stations to cover extra heating load.
Biomass boiler	Biomass boilers installation for replacing partially or totally the existing fossil fuel fired boilers
Hot water & Molten salt storage	Optimized water and molten salt storage for acting as solar buffer and to maximize the biomass boiler energy production.
Geothermal	Integrate Geothermal heat pumps as a renewable energy source. The PV installation coupled with these HPs will be analyzed.
CHP	Three 1 MWe gas engines (3 x 2.5 MW in fuel) located in different places in Żyrardów.
Peak gas boilers	Gas boilers installation to cover peaks from November to March

The combination of the different technologies generates three main solutions which will be studied in the next steps (other solutions might arise during the activity):

Table 2-35 Solutions proposed after the preliminary assessment for Żyrardów demo-follower.

Solution proposed after preliminary assessment			
Technology	**S1**	**S2**	**S3**
PTC		x	
Fresnel		x	
TF-FTC		x	
Biomass	x		x
Molten Salts		x	
Hybrid PV-Geothermal			x
CHP			x
Gas boilers	x	x	

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Table 2-36 Overall description of the solutions proposed for Żyrardów demo-follower.

Solutions proposed overall description	
Combination code	**ŻYRARDÓW – S1**
Justification	This combination integrates biomass boilers and the installation of new gas boilers to cover the heating peak demands.
Expected impact	• Increase at 90% the thermal production by renewable energies. • Evaluate tech-economic feasibility of the proposed solutions. • Evaluate availability of biomass. Analyze the biomass sector in Poland. • Maximise biomass boiler energy production.
Combination code	**ŻYRARDÓW – S2**
Justification	This combination integrates solar technologies and thermal storage systems based on hot water and molten salts. Besides, the existing coal fired boilers are replaced by gas boilers.
Expected impact	• Increase at 30% the thermal production by renewable energies. • Increase energy efficiency of current installation. • Evaluate tech-economic feasibility of the proposed solutions. • Evaluate space requirements for the solar panels. • Evaluate the optimized combination of the chosen technologies.
Combination code	**ŻYRARDÓW – S3**
Justification	This combination integrates biomass boilers, geothermal heat pump system (coupled with PV system) and CHP.
Expected impact	• Increase at 90% the thermal production by renewable energies. • Evaluate tech-economic feasibility of the proposed solutions. • Maximise geothermal heat pump system for DHW in summer. • Evaluate the operation strategy modes.

CONCLUSION

There are no renewable energy systems in Żyrardów District Heating. The property is thinking about retrofitting the power plant using biomass and gas, and removing the coal fired boilers. They are also considering the cogeneration and geothermal systems for the DH.
Cooling technologies are not considered since there is no cooling demand.
Solar installations as fresnel, parabolic trough collectors and low concentration flat collectors might encounter limitations, for instance low irradiation, lack of space and high costs. Therefore, the property has not considered this kind of renewable sources. However, an energy-economic analysis should be done in order to find the most suitable solution in a hypothetical retrofitting solution.

2.2.4 Valladolid (Valladolid – Spain)

GENERAL DESCRIPTION

Valladolid demo-follower consists of an existing District Heating biomass-based (100% renewable energy). It was built in 2016 and operates since 2018. The District Heating is currently serving a total of six buildings, four public buildings of different size, including offices for public administrations, and two housing communities. In total, the DH covers an area of 53,400 m^2.

A table with the basic data summarized is included in Annex 1: Basic info tables (Table 4-9).

The demo-follower is located in the urban area of Valladolid, administrative capital of autonomous region of Castile and Leon at 250 km northwest of Madrid. Valladolid has a total population of 299,300 approx. (in 2020) making it north-western Spain's biggest city. The city lies along the Pisuerga River, the demo-follower and the connected buildings are located near that river.

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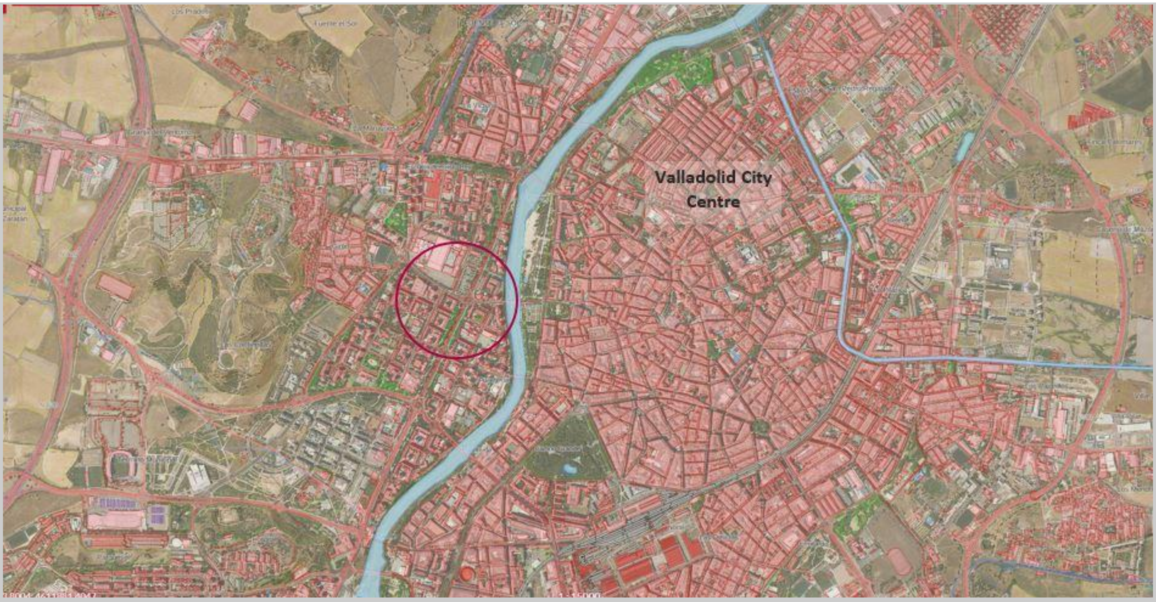
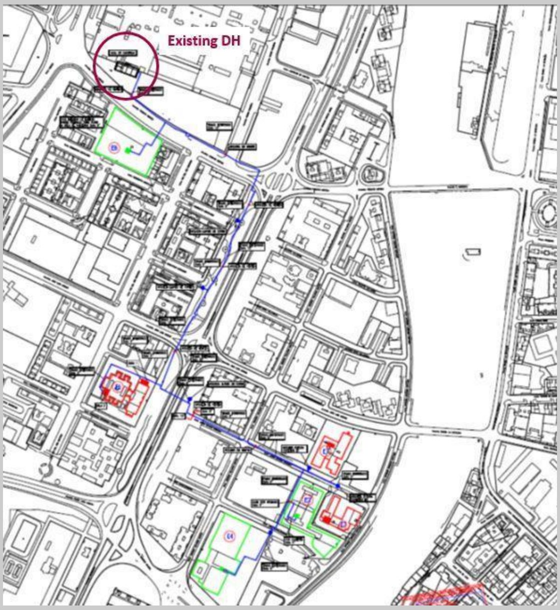


Location of DH in Valladolid City



DH network layout. Initial phase


Current view

Figure 2-62. Location, layout and current view of Valladolid Central Station (biomass-based)

Valladolid (latitude 42°) is located at roughly 735 metres above sea level. It has a continental climate with cold and windy winters, due to altitude and an inland location, and hot summers, raising maximum temperatures up to 30 ºC. It is not a very rainy region, rain being more frequent in autumn and spring. Average monthly temperatures are shown in Figure 2-63:

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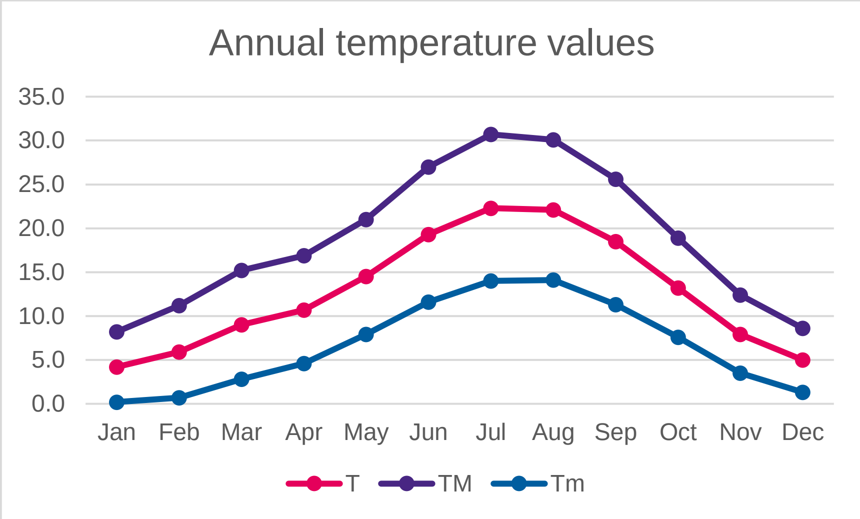

Figure 2-63. Normal temperature values in Valladolid in a year

T	*Average monthly/annual temperature (°C)*
TM	*Average monthly/annual maximum daily temperatures (°C)*
Tm	*Average monthly/annual minimum daily temperatures (°C)*

The Figure 2-64 and Figure 2-65 below show information of the solar radiation in Valladolid. As can be seen, the availability of direct normal radiation is quite good for Valladolid. Seasonal analysis shows that Valladolid had less sunshine in autumn and winter but high potential for solar energy in summer.

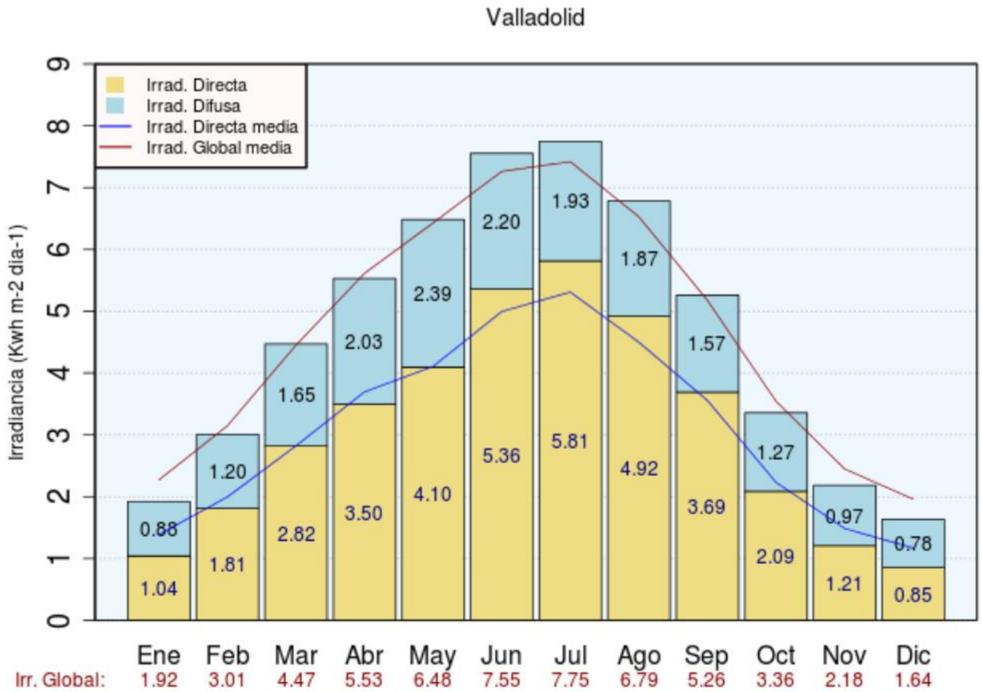

Figure 2-64. Solar radiation Valladolid [1983-2005][34].

[34]https://www.aemet.es/documentos/es/serviciosclimaticos/datosclimatologicos/atlas_radiacion_solar/atlas_de_radiacion_24042012.pdf

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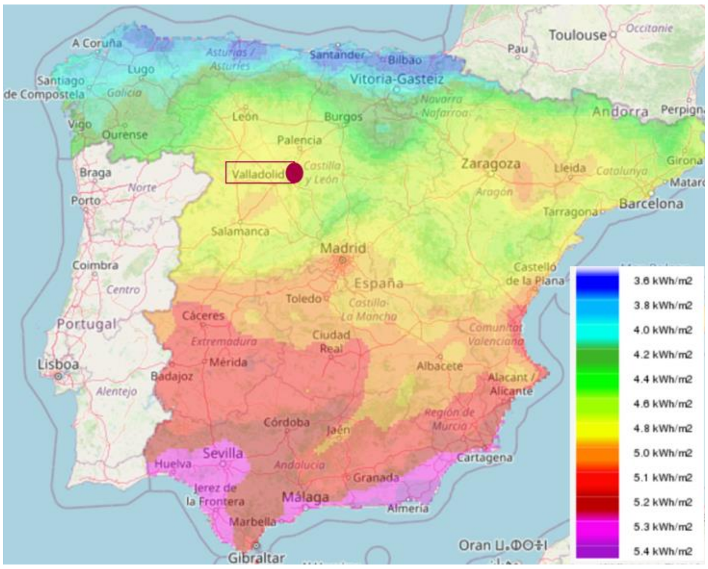

Figure 2-65. Solar global radiation map (monthly average of a long period). Spain - Valladolid[35].

PRELIMINARY ASSESSMENT

Valladolid installations are composed of two biomass boilers of 3.48 MW each, having a peak power capacity of 6.96 MW. The district heating provides only heating to the connected buildings (4 public buildings devoted to administrative offices and 2 housing communities). DHW and cooling is not covered by Valladolid district heating network.

In 2020, the total heat consumption of all the buildings connected to the DH network was of 3 GWh. The thermal consumption breakdown by month is provided in the Figure 2-66 below. In addition, the figure provides the contribution of each building to the overall thermal energy consumption.

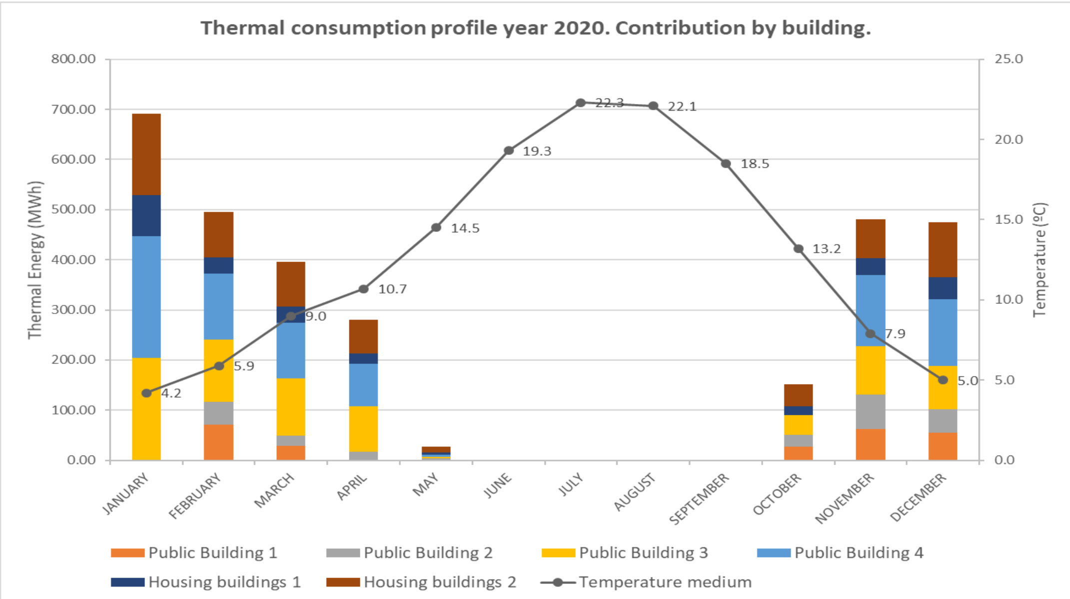

Figure 2-66. Thermal energy consumption profile in Valladolid district heating in year 2020, broken down per month (MWh/month).

[35] Source: ADRASE portal http://www.adrase.com/acceso-a-los-mapas/mapa-zona-peninsula.html

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The contribution of each building to the general consumption is showed in the Figure 2-66. The amounts of energy shown in the figure were recorded by energy meters placed at the sub-station of each building. In addition, the grey line presents the historical medium temperature evolution in Valladolid, obtained from the State Meteorology Agency (AEMET)[36].

As can be seen in Figure 2-66, the district heating is working from January to May and from October to December. It is stopped during the months of summer (June to September), when heating is not necessary in a climate like Valladolid's see Figure 2-63.

The peak of heating consumption is reached in January with almost 700 MWh, followed by February, November and December, which are all close to 500 MWh of heat consumption, being the coldest months in Valladolid. March requires approximately 400 MWh of heating energy, and April, May and October have milder thermal energy needs, in all cases below 300 MWh. Regarding the building's contribution, the buildings with higher heating needs are the public buildings 3 and 4, and the two Housing Communities.

Regarding the fuel consumption for producing the heat, the biomass consumption profile from December 2019 to November 2020 is provided in Figure 2-67. A total of 1,250.2 tons of woods chips were consumed by the boilers from January to November 2020. There is no data for December 2020 yet, but if we use the data from December 2019 as reference to complete the series, the estimated amount of biomass used to produce the 3 GWh demanded heat in 2020 is approximately 1,500 tons should be related to the thermal energy consumption profile provided in Figure 2-66 above, being January and February the months reaching the higher consumption of biomass. Since there is no district cooling nor DHW, there is no fuel consumption at all from June to September.

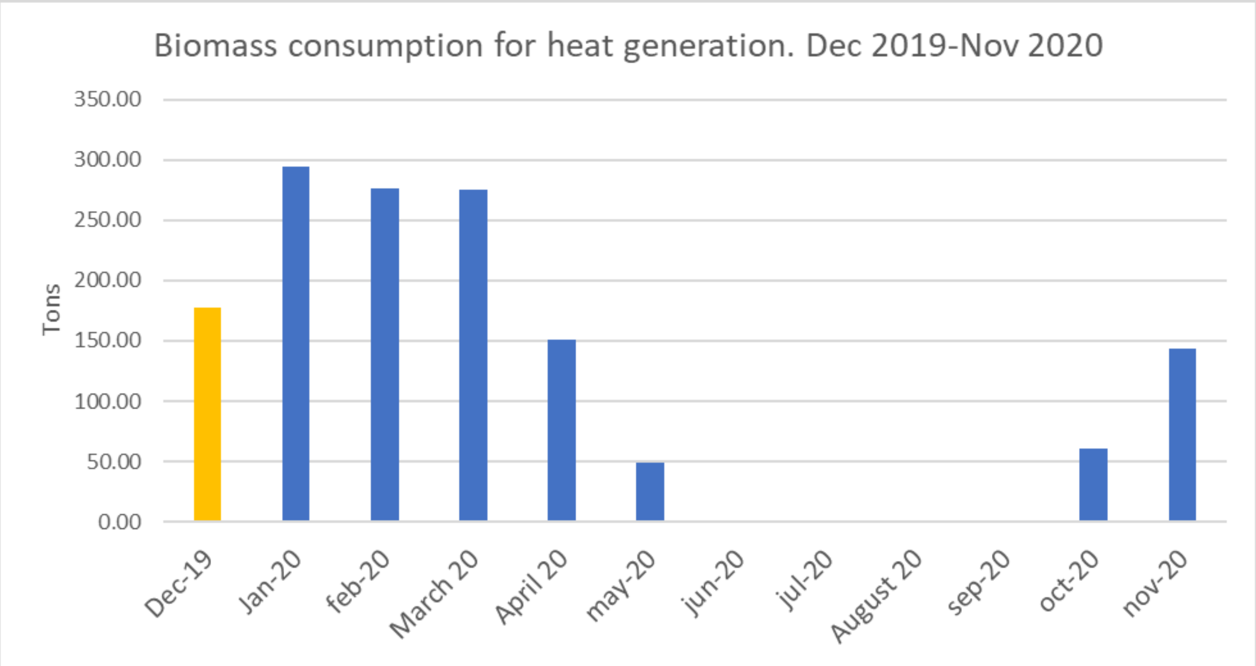

Figure 2-67. Biomass (wood chips) consumption profile in Valladolid District heating during 2020 for generating the heat in the biomass boilers. Since there are no records of December 2020 yet, data from December 2019 has been plotted as reference.

The estimated monthly breakdown for the thermal energy produced in the biomass boilers in 2020 is provided in Figure 2-68 below:

[36] http://www.aemet.es/es/serviciosclimaticos/datosclimatologicos/valoresclimatologicos?l=2422

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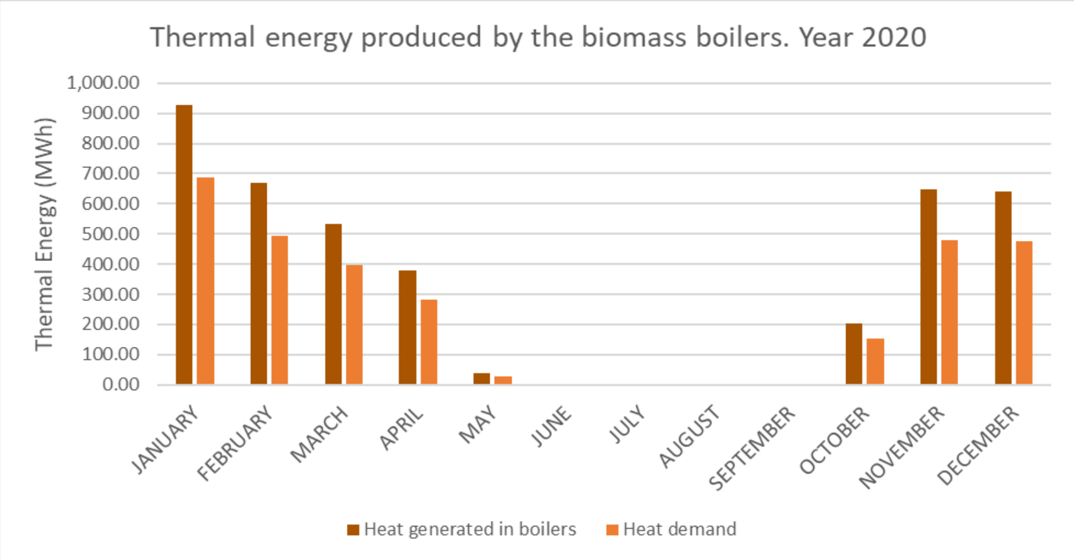

Figure 2-68. Thermal energy produced by the biomass boilers (brown bars) in the thermal plant of Valladolid District Heating in year 2020 to respond the demanded heating of all the buildings connected (orange bars).

All data presented above refers to 2020, and therefore It should be taken carefully, as it might be impacted by Covid crisis.

In addition to the fuel expenses to produce the heat, Valladolid thermal plant reported an electrical consumption of 123.5 MWh_e (from October 2019 to September 2020) to cover the electrical consumption of the equipment. No electricity consumption was devoted to thermal applications, since Valladolid heat source is currently operated 100% on biomass, with no share of electrical supply. The breakdown of electricity consumption per month is provided below. Again, since there is no data available from October 2020 to December 2020 yet, the equivalent months of 2019 have been taken as reference to complete the year series.

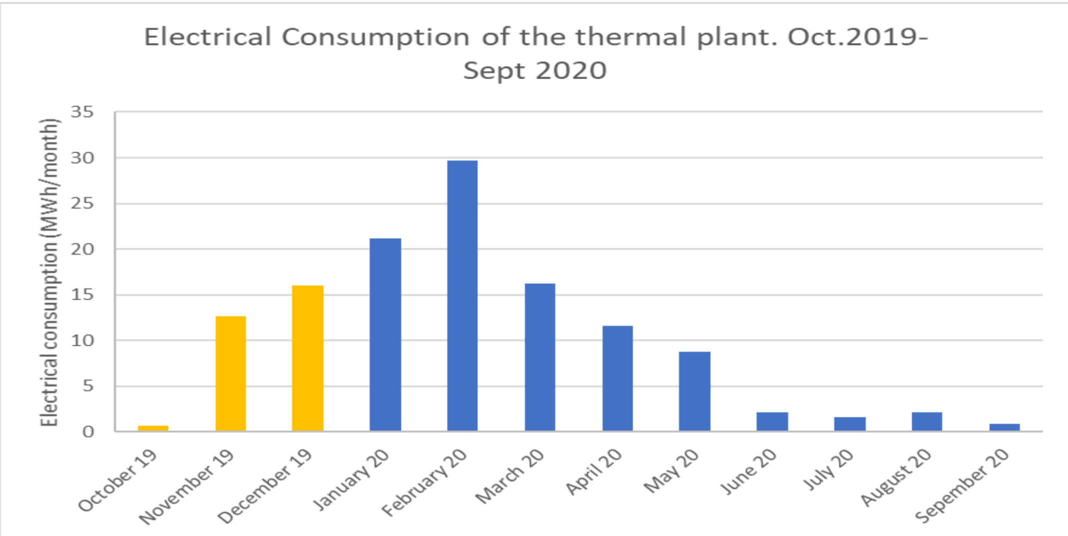

Figure 2-69. Electricity consumption by the thermal plant of Valladolid District heating in year 2020. There are no records from October-December 2020 yet, and therefore, records from October-December 2019 have been plotted as reference.

On the 2020 data shown in Figure 2-69, the peak of electricity consumption by the DH thermal plant was reached in February and amounted almost 30 MWh_e. The months of January, March, November, and December also present significant electrical consumption, whereas the summer months (June-November) show very low electrical consumption. The energy consumption reflects the intense use of the equipment (boilers and especially pressure units) in winter and autumn to catch up with the heating demand.

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A preliminary assessment of Valladolid District Heating led to the following proposals:

- Extension of the existing District Heating to add new customers
- Integration of district cooling in the existing facilities and in the potentially extended facilities (with new customers)
- Free cooling recovery from the river
- Integration of PV system for electricity consumption

The table below summarises the technical solutions that could be assessed by WEDISTRICT simulations:

Table 2-37 Summary of technologies for Valladolid demo-follower.

Technologies proposed	By means of
Low emissions biomass boiler	Extension of the current facilities using low emissive biomass boilers (if available space). Since the logistics for the biomass supply are already solved.
Economizer/ flue gas heat recovery system	Increase efficiency of existing biomass boilers by recovering the heat (partially or totally) in the flue gas released to the atmosphere
Solar technologies	Integration of solar thermal panels in the central station (if space available) to cover heating load or cooling load of new customers.
PV panels + Heat pump	Integrate PV panels in the roof plus a heat pump to generate heat. Excess electricity from the heat pump can be used to cover electricity needs of the thermal plant (or even sell electricity to the central grid).
PVT panels	Simulate the efficiency of PVT panels compared to PV panels + Heat pump tandem or solar thermal panels
Hot water/Molten salts storage	Optimized water storage sized for acting as buffer for added new renewable technologies (new solar or biomass)
Advanced Absorption chiller	Add WEDISTRICT absorption chiller to the current/extended thermal plant to allow cooling in summer (now there is only district heating available). Compare its performance with the performance of commercial single and double effect absorption chillers.
Renewable air-cooling unit (RACU)	Integrate RACU in specific locations of the buildings to allow cooling.
Free cooling using river water	Analyse the possibility of exploiting the water from the river, improving the efficiency of a heat pump or absorption chiller.

The combination of the different technologies generates three main solutions which will be studied in the next step (other solutions might arise during the activity):

Table 2-38 Summary of preliminary solutions for Valladolid demo-follower.

Solution proposed after preliminary assessment			
Technology	VALLADOLID S1	VALLADOLID S2	VALLADOLID S3
PTC	x	x	
Fresnel	x	x	
TF-FTC	x	x	
Biomass boiler	x	x	
Molten Salts	x	x	
Advanced Absorption Chiller		x	x
RACU		x	
Conventional absorption chiller (single/ double)		x	x
PV	x	x	x
PVT	x	x	
Heat pump	x		x
Free cooling			x
Thermal storage	x	x	
Economizer/ flue gas heat recovery system for existing boilers	x	x	

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Table 2-39 Preliminary solutions proposed for Valladolid demo-follower.

Solutions proposed overall description	
Combination code	VALLADOLID – S1
Justification	The first solution proposed is the extension of the existing District Heating. The preliminary assessment seems to point out that the thermal plant is working below capacity and more buildings could be connected to Valladolid District heating. The first step proposed is to simulate the addition of new clients to the current installations. Moreover, in order to increase the energy efficiency of the existing boilers, the integration of an economizer/ flue gas heat recovery system (to recover heat from boiler's flue gas) will be assessed. In addition, it is also proposed the extension of the current thermal plant by adding new renewable sources in order to cover the connection of potential new clients. Based on the results of radiation for Valladolid (Figure 2-64), it makes sense to study the integration of solar technologies. In this sense, WEDISTRICT can offer various technologies. The best configuration of technologies will be assessed: ● Addition of new biomass boilers (low emission): if there is enough space in the current DH boilers room. ● Addition of photovoltaics (PV) panels on the roof of the thermal plant and/or the roof of the surrounding buildings. The PV panels can be connected to a heat pump to generate heat on the one hand, and on the other hand, cover electricity needs of the thermal plant (presented in Figure 2-68). If there is excess of electricity from the PV panels, it can be pushed to the electrical distribution network and supply surrounding buildings. ● It is suggested to investigate the use of PV-T panels instead of PV panels as an optimization. ● Addition of thermal solar panels field if land is available ● Addition of thermal storage: for PTC or Fresnel, molten salts storage would be integrated; for TF-FTC, water storage. In addition to resource availability, also the availability of space has to be assessed in more detail in order to select the best alternatives for the study. The optimal operation of the plant will also be assessed: for example, if solar technologies are added, propose prioritise solar to biomass in order to save fuel.
Expected impact	● Increase efficiency of current installation. ● Increase generation plant capacity to cover new residential building development. ● Include DHW demand, currently not covered, if necessary ● Evaluate availability of biomass and cover extra heating load. ● Maximise solar resource ● Evaluate hybridization of various renewable technologies ● Avoidance of the CO_2 emissions associated with the potential new customers, who are currently consuming fossil fuel heating.
Combination code	VALLADOLID – S2
Justification	The second solution is the Integration of district cooling. Valladolid climate is very hot in summer and as a consequence, the use of individual air conditioner systems to reach comfort conditions in buildings is a general practice in summer, especially in public buildings, where offices and other public services are placed. Valladolid District Heating is currently serving four public buildings, so we estimate that there is a significant demand for cooling during the summer (from June to September). In addition, as has been presented in the previous section, the boilers in Valladolid are shut down from June to October. Therefore, in order to increase the efficiency of the current District Heating, the alternative of integrating district cooling to the system seems to be a promising option. Regarding the district cooling technologies, the project WEDISTRICT presents various alternatives that can be assessed: ● Addition of absorption chillers connected to the existing biomass-district heating plant, and to potential extended district heating based on additional renewable sources. ● If less cooling demand is to be covered, addition of air cooling-RACU to specific locations (such as offices). The RACU would be fed by the district heating network (extended or not extended). ● Addition of photovoltaics (PV) panels on the roof of the thermal plant and/or the roof of the surrounding buildings. In order to cover the electricity consumption of the own Central Station.
Expected impact	● Provide cooling and DHW service, currently not covered ● Remove the individual cooling systems from buildings (and avoid associated CO_2 emissions)

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	● Use the thermal plant during the months of summer, increasing the overall efficiency of the system. ● Maximise biomass resource ● Increase the comfort of the connected buildings in summer, and reduce the electricity bills ● If solar panels are added to respond to cooling demand, maximise solar resource
Combination code	VALLADOLID – S3
Justification	Exploit the nearby river (River Pisuerga) to implement free-cooling/heat condensing. The water can be pumped up and used to ensure the condensation of the refrigerant in the heat pumps. The heat pumps can be connected to PV panels to maximise solar resources. The condensing circuit of an absorption chiller could also be studied by this option.
Expected impact	● Remove the individual cooling systems currently in use (and avoid associated CO_2 emissions) ● Exploit the free-resource of river water ● Increase comfort capacity of connected buildings in summer ● Increase efficiency of the heat pumps ● Reduce electricity bills associated to conventional cooling systems

CONCLUSION

The main features of Valladolid District heating are:

- It is currently running 100% on renewable energies (biomass).
- It has great potential to include new clients (to be extended).
- It is only covering heating needs (the installation is turned off from June to October).
- It is located in an area with high demand for cooling due to high temperatures in summer (from June to October).
- It is located in an area with high solar resources.

Therefore, we propose to assess the expansion of the district heating with different alternatives of renewable sources to cover the integration of potential new clients. In addition, will be assessed the integration of district cooling, to increase the efficiency of the thermal plant that is currently working only 8 months per year, and cover the cooling needs of the connected buildings (existing and potential new clients). It is worth the inclusion of solar technologies in the study given the high availability of solar resources in Valladolid and expected high efficiency of the solar technologies in this location.

2.2.5 Focsani (Focsani – Romania)

Focşani is the capital city of Vrancea County in Romania on the shores of the Milcov River with around 98 000 inhabitants. Focsani City has an administrative area of about 4,815 ha, meaning around 1% of the area of Vrancea County. It is a medium dimension City, having a population density of about 20.48 inhabitants/ha.

The total inhabitants of Focsani City are around 73,868 as per the last census data of 2011.The Municipality of Focşani is the legal owners of the DH Company ENET SA, which is the operator of the cogeneration and heating plants, the transmission (23.21 trench km) and distribution network (60.93 trench km) and the DHW (6.093 km trench including recirculation) system in Focsani, since 2001, proposes the heat tariffs and subsidies and ANRE analyses and approves these annually, according to the specific regulations.

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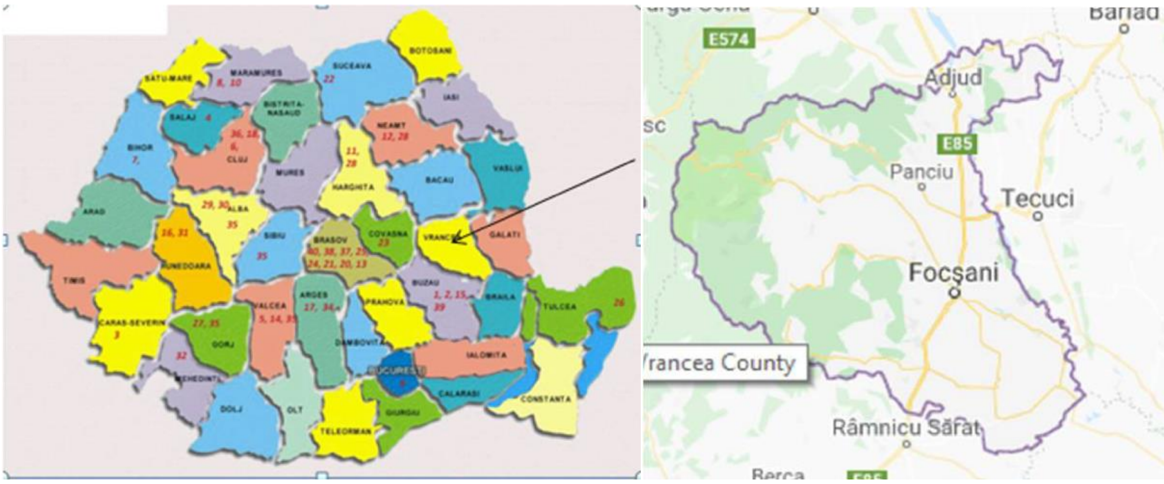

Figure 2-70. Location of Focsani in Romania and the Vrancea County

The Vrancea region has the average solar irradiation of an eastern European countries. Regarding geothermal energy, the potential in Romania is located in the west and south areas of the country, especially for low enthalpy geothermal energy, the Vracea beeing a region with a relatively lower potential than the average of the country. Geothermal potential is depicted in Figure 2-71. The highest renewable potential may be based on biomass, that holds 65% of the available renewable potential in Romania, with a potential of the order of 38,000 kton/year[37].

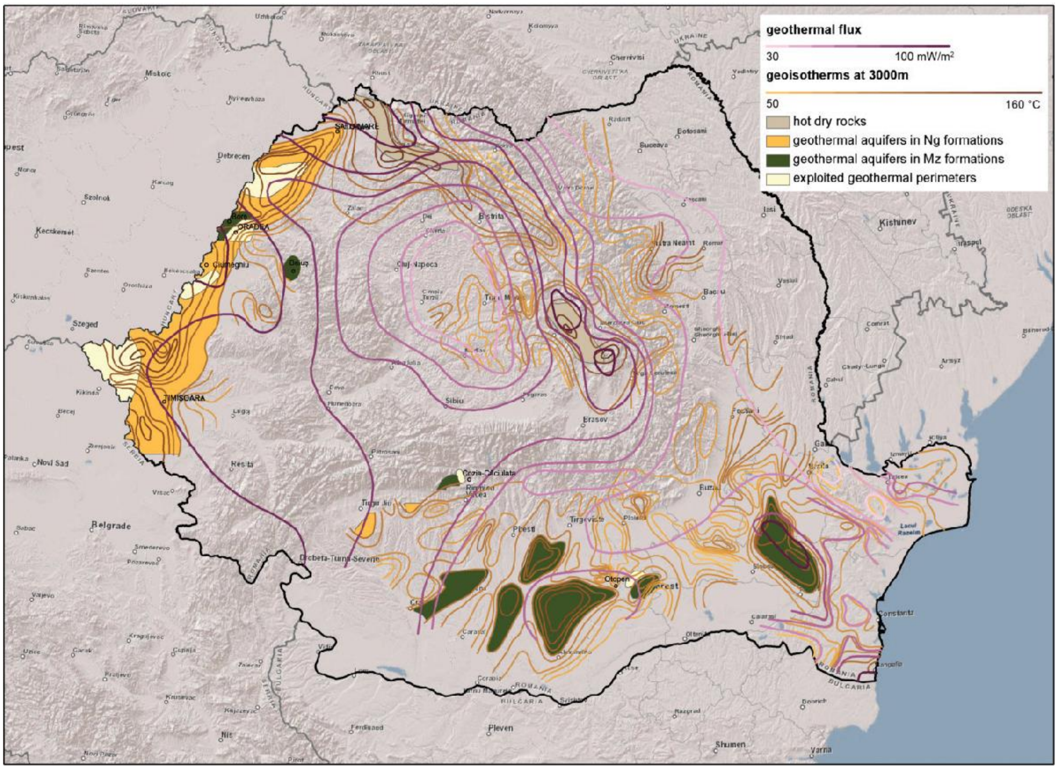

Figure 2-71. Geothermal resources in Romania[38]

The main problem is the high rate of disconnection of flats from the DH network with an average 650 flats per year within the period 2013-2018 but considered a longer period between 2005 and 2018 it was around 850 flats per year. Only 55% of the apartments where a district

[37] www.s2biom.eu
[38] www.egec.org

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heating connection would be possible are currently supplied with district heating. Flats not connected to DHC systems have individual gas heating systems, which is the most common practise in the country[39]. The last past years have seen a cut in district heating facilities and number of users. The retrofitting of existing facilities is one of the actions to be taken to improve the competitiveness of district heating services versus individual boilers.

The reason for the low connection rate is the low amount of energy delivered per heating line length of the DH system with approx 1.02 GWh/km trench, which is far below the international DH benchmark of 2 GWh/km trench. This low value is due to the high DH losses of 36.9% (2018).

For that reason, the Focsani municipality has planned and started the modernization and rehabilitation of the heating networks and heating sub-stations. Based on the Master Plan developed in 2009, the municipality has already successfully rehabilitated the DH system including substations and also the facilities with the installation of 2 x 6.8 MWe gas engines and a 50 Gcal/h gas boiler.

Figure 2-72. Evolution of the DH substation in the DH retrofitting.

A table with the basic data summarized is included in Annex 1: Basic info tables (Table 4-10).

PRELIMINARY ASSESSMENT

The energy consumption of the District Heating in Focsani is shown in the Figure 2-73, with a total annual energy delivery of: 86 GWh/y heat and 84 GWh/y of electricity sent to the grid. It is estimated an energy delivery in 2050 of 126 GWh for heat and 51 GWh of net electricity to the grid. The addition of heat pumps for heating water in summer reduce the net electricity balance, for the switching off the gas boilers in summer, being electricity the main input those months. Figure 2-74 and Figure 2-75 show the energy balance in winter and summer in 2018. It can be noted the difference as the gas boilers are much less used on summer, with the elimination of the direct space heating demand, but keeping the cogeneration production of electricity and thermal energy for heating water.

[39] WEDISTRICT Project - Deliverable D2.3 "District Heating and Cooling Stock at EU level"

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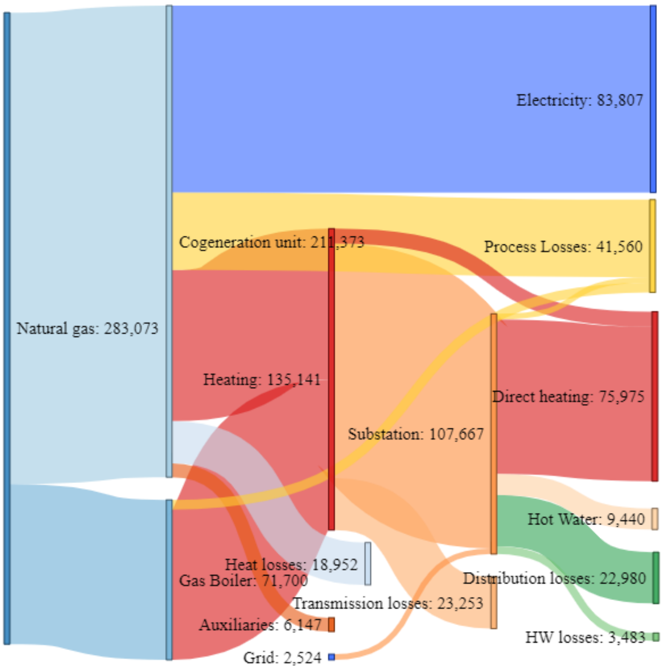

Figure 2-73. Sankey diagram of the energy consumption in Focsani DHC in 2018 (Unit: MWh).

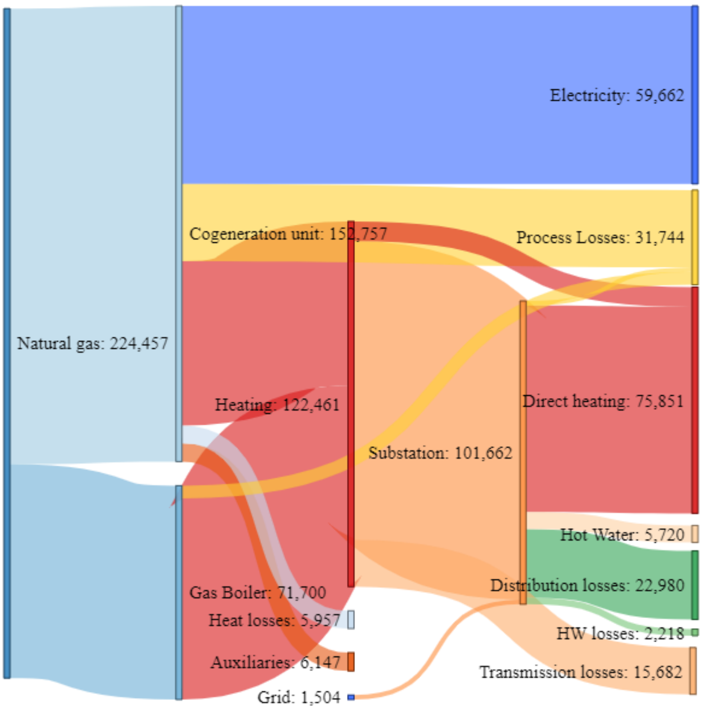

Figure 2-74. Sankey diagram of the energy consumption in Focsani DHC in winter period (7 months) of 2018 (Unit: MWh).

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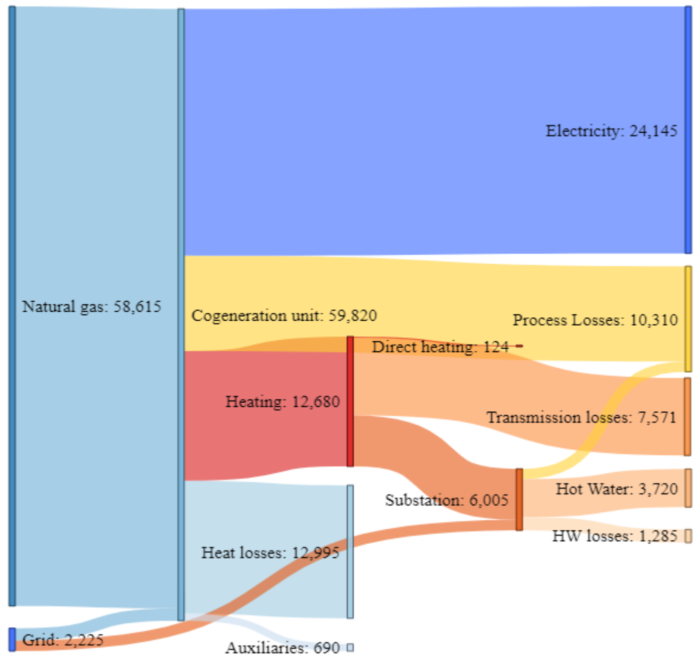

Figure 2-75. Sankey diagram of the energy consumption in Focsani DHC in summer period (5 months) of 2018 (Unit: MWh).

Figure 2-76 depicted the expected energy balance in 2050. It shows how the total consumption of natural gas is expected to reduce by increasing the efficiency of the system, while the total amount of end-user energy consumption increases.

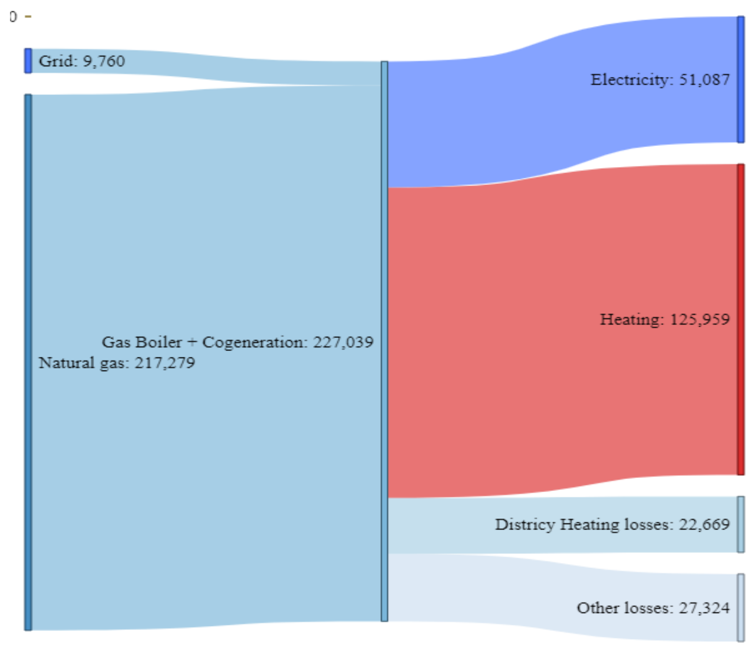

Figure 2-76. Sankey diagram of the energy consumption in Focsani DHC in 2050.

The current planned district heating does not include potential cooling demand, which will be fulfilled individually by the end-users through classical mechanical cooling systems.

The external energy supply in the future is planned under the hypothesis that it will be based on natural gas and electricity from the grid, that would ideally come from cheap renewable

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sources. The application of technologies based on biomass, and, optionally, geothermal technologies would also be explored. The analysis of hybrid thermal-PV technologies will be evaluated as well from the analysis of the solar resource in the region, especially during the summer period.

The main impacts of the proposed alternative solution might be:

- Diversification and combination of additional energy sources, giving an alternative to extend the operation of all installations to the whole year, avoiding their shutdown in winter or summer periods, or oversizing.
- Extension of the facilities to develop cooling services, providing a broader portfolio of services, and stimulating the integration of more flats of the community in the network.

Considering the previous information, the technologies and solutions proposed to be studied in Focsani demo-follower are the following:

Table 2-40 Preliminary solutions proposed for Focsani demo-follower.

Technologies proposed	By means of
Advanced Absorption chiller	Compare WEDISTRICT absorption chiller with the performance of the existing single and double effect absorption chillers.
Solar technologies	Integration of solar panels in the central station to cover extra heating load.
Molten salt storage	Molten salt storage to support cooling options or additional services requiring T > 100 ºC.
Biomass boiler	Biomass boilers installation for thermal energy supply
Renewable air-cooling unit (RACU)	Integrated in building.
Hybrid PV-Geothermal	Analysis of low enthalpy geothermal support to the district heating and cooling

The combination of the different technologies generates three main solutions which will be studied in the next steps (other solutions might arise during the activity):

Table 2-41 Summary of preliminary solutions for Focsani demo-follower.

Solutions proposed after preliminary assessment			
Technology	S1	S2	S3
PTC		x	
Fresnel		x	
TF-FTC		x	
Biomass	x	x	x
Molten Salts and Energy Storage	x	x	x
Hybrid PV-Geothermal			x
Advanced Absorption Chiller	x	x	x
RACU	x		

Table 2-42 Summary of technologies for Focsani demo-follower

Solutions proposed overall description	
Combination code	**FOCSANI – S1**
Justification	This combination integrates biomass with advanced WEDISTRICT cooling technologies to analyse the upgrade to district heating and cooling.
Expected impact	• Add cooling capabilities to the system • Reduce energy differences between summer and winter • Increase the utilization factor of existing boilers. • Evaluate availability of biomass and cover extra heating load. • Plan new development of residential buildings equipped with RACU.
Combination code	**FOCSANI – S2**

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Justification	This combination integrates biomass and solar thermal technologies with advanced WEDISTRICT cooling technologies to analyse the upgrade to district heating and cooling.
Expected impact	● Add cooling capabilities to the system ● Reduce energy differences between summer and winter ● Increase the utilization factor of existing heaters. ● Evaluate the possibility of additional solar thermal capabilities to the district heating and cooling ● Evaluate availability of biomass and cover extra heating load. ● Plan new development of residential buildings equipped with RACU.
Combination code	**FOCSANI – S3**
Justification	This combination integrates hybrid PV and geothermal technologies and the additional cooling capabilities of the installation
Expected impact	● Add cooling capabilities to the system ● Reduce energy differences between summer and winter ● Increase the utilization factor of existing heaters. ● Evaluate the possibility of additional low-enthalpy geothermal sources and PV system for thermal and electric balance. ● Evaluate availability of biomass and cover extra heating load.

CONCLUSION

To conclude, the next steps will consist in the evaluation of the cooling demand to upgrade of the district heating to district heating and cooling system. The objective will be to explore the utilization of the existing thermal systems, which are so far shutdown in summer. The current facility is based on natural gas heaters and cogeneration units. The analysis will check the impact of adding additional WEDISTRICT technologies as:

- Biomass boilers: to provide additional thermal capacity.
- Cooling services: adding cooling capabilities, thermal energy will be demanded in summer, requiring the utilization of gas boilers and additional thermal energy.
- Check applicability of solar technologies and its contribution, mainly in summer, to cover peak loads for cooling, that are coincident with solar irradiation availability.
- Check the utilization of geothermal and PV technologies.
- Evaluation of energy storage and implementation based on WEDISTRICT technologies.

2.2.6 Mrągowo (Mrągowo – Poland)

GENERAL DESCRIPTION

Mrągowo is a resort town in the Warmian-Masurian Voivodeship of northeastern Poland, with 21,889 inhabitants (2019). It is the capital of Mrągowo County and the seat (though not part of) the Gmina Mrągowo. The town is located in the historical region of Masuria, within the Masurian Lake District, about 60 km (37 mi) east of Olsztyn.

Figure 2-77. Location of Mrągowo in the north-east of Poland.

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In Poland there are 412 district heating facilities, providing heat to near 16.5 million citizens, and with a capacity of 55 GW (https://www.euroheat.org/knowledge-hub/district-energy-poland/). The dominant fuel is hard coal and coal products, whose share in the structure of fuels over this period has shifted from 86.7% in 2011, to 81.6% in 2017. The direct use of renewables is positive.

The increase in the share of "Heat only Renewables" in the energy supply composition of generated District Heat results from the inclusion of geothermal heat production. The use of natural gas in cogeneration has increased from 3.9% in 2011, to 4.6% in 2015, to 5.2% in 2017 and it continues to grow.

Between 2013-2015, heat production for District Heating was decreasing in Poland. It is the result of a thermo-modernisation process in existing buildings and limited new market developments. After 2015, the residential investment market grew but new investments partly concentrated on acquiring energy power plants, on a micro-scale. That is why investment in the residential sector, services sector and municipality buildings is increasing.

The heating demand of the Mrągowo municipality is covered in a 70% by district heating by the company Miejska Energetyka Cieplna Spółka zoo. The city hospital, the city hall, the twon hall and primary and secondaty schools, for instance, are heated by the district heating based on boilers WR-10, and WR-5, with a total power of 40.7 MW (3 boilers of aprox. 10 MW and 3 boilers of aprox. 5 MW), with hard coal. The total number of buildings connected is 247, covering an area of around 416,000 m^2. The system is under retrofitting, initiating the process for its substitution of part of the production by biomass technologies.
A table with the basic data summarized is included in Annex 1: Basic info tables (Table 4-11).

The view of the city with the facility in the front is depicted in Figure 2-78. Some other pictures of the facility are shown in next figures. Figure 2-79 shows the view of one of the WR-10 boilers. Figure 2-80 shows a general overview of the heat generation buildings, including the chimneys that are currently releasing the exhausted gases from the boiler groups. Figure 2-81 shows the coal park that accumulates the coal feedstock to feed the boilers.

Figure 2-78. View of the Mrągowo municipality with the coal boiler facility on the front[40]

[40] http://www.mec.Mrągowo.pl/

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Figure 2-79. A 11.6 MW coal boiler facility[41]

Figure 2-80. View of the facility buildings with the coal park at the right and the chimney[41]

Figure 2-81. View of the carbon park

[41] http://www.mec.Mrągowo.pl/

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PRELIMINARY ASSESSMENT

The energy consumption of the district heating is of the order of 87,000 MWh/year, for a total consumption of 10,500 ton/y of hard coal. For a total capacity of 40.7 MW, the utilization factor is of the order of 2,000 h/y at full capacity. One must take into account that the heating peak demand is 25.5 MW, while the heat water supply peak demand is 1.8 MW. The heat production of the facility will be used for direct heating between 135 and 70 ºC and hot water between 70 and 45 ºC according with the Sankey diagram shown in Figure 2-82. Losses on the distribution networks are not included.

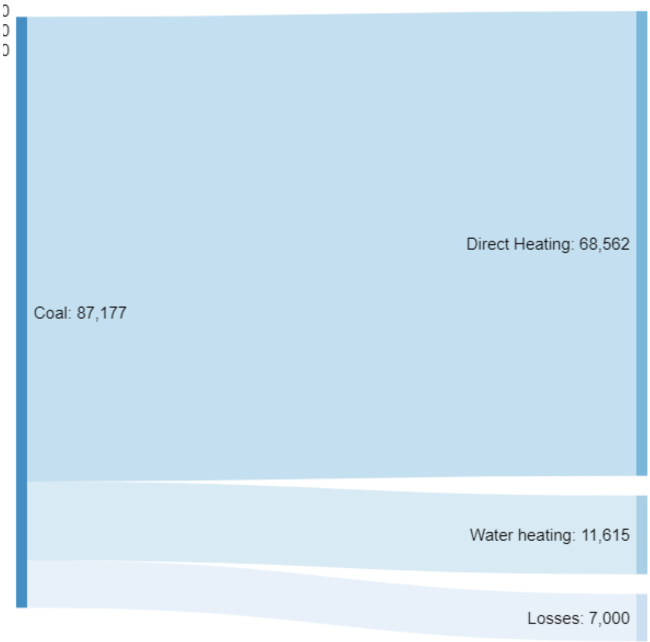

Figure 2-82. Sankey diagram of the site.

The geothermal energies in the area is not very much developed, being the resources less than in the rest of Poland. In principle, geothermal has low potential in Mrągowo (Figure 2-83):

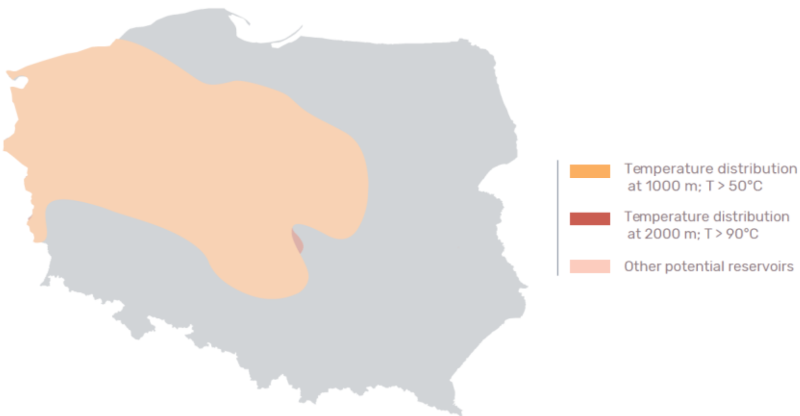

Figure 2-83. Geothermal resources in Poland[42].

[42] https://www.egec.org/wp-content/uploads/2019/11/Country-Fiches-PL-final.pdf

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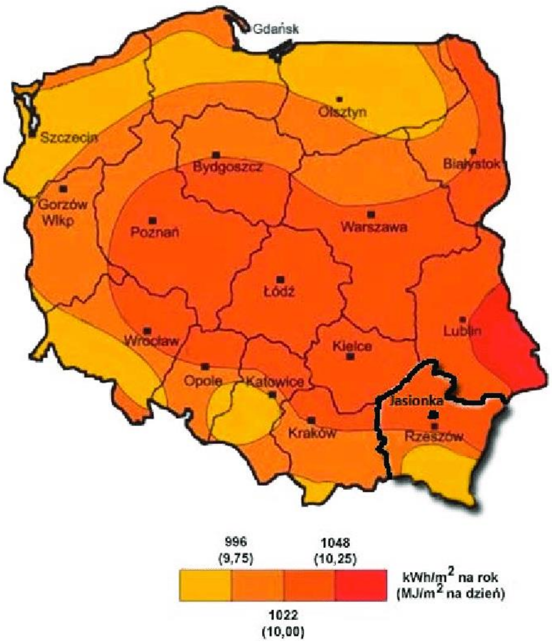

Figure 2-84. Solar map of Poland[43].

The application of technologies based on biomass will be explored including the possibility to use solar technology in the summer period to support hot water needs. The possibility of cooling will be pre-evaluated, as the need of cooling usually is less demanded in that area.

Considering the previous information, the technologies and solutions proposed to be studied in Mrągowo demo-follower are the following:

Table 2-43 Preliminary solutions proposed for Mrągowo demo-follower.

Technologies proposed	By means of
Solar technologies	Integration of solar panels in the central station to cover extra heating load.
Molten salt storage	Molten salt storage to support cooling options or additional services requiring T > 100 ºC.
Biomass boiler	Biomass boilers installation for thermal energy supply
Cooling alternative	The possibility of cooling alternatives will be pre-evaluated, and analysed in detail with WEDISTRICT technologies

The combination of the different technologies generates three main solutions which will be studied in the next steps (other solutions might arise during the activity):

Table 2-44 Summary of preliminary solutions for Mrągowo demo-follower.

Solutions proposed after preliminary assessment			
Technology	**S1**	**S2**	**S3**
PTC		x	x
Fresnel		x	x
TF-FTC		x	x
Biomass	x	x	x
Molten Salts and Energy Storage		x	x
Advanced Absorption Chiller			x
RACU			x

[43] https://iopscience.iop.org/article/10.1088/1755-1315/95/4/042017/pdf

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Table 2-45 Summary of technologies for Mrągowo demo-follower

Solutions proposed overall description	
Combination code	**Mrągowo – S1**
Justification	This combination integrates biomass to analyse the upgrade to district heating
Expected impact	• Increase the utilization factor of existing heaters. • Evaluate availability of biomass and cover extra heating load. • Lower significatively CO2 emissions.
Combination code	**Mrągowo – S2**
Justification	This combination integrates biomass and solar thermal technologies the upgrade to district heating.
Expected impact	• Reduce energy differences between summer and winter • Increase the utilization factor of existing heaters. • Evaluate the possibility of additional solar thermal capabilities to the district heating. • Evaluate availability of biomass and cover extra heating load.
Combination code	**Mrągowo – S3**
Justification	This combination integrates biomass and solar thermal technologies with advanced WEDISTRICT cooling technologies to analyse the upgrade to district heating and cooling
Expected impact	• Add cooling capabilities to the system • Reduce energy differences between summer and winter • Increase the utilization factor of existing heaters. • Evaluate the possibility of additional solar thermal capabilities to the district heating and cooling • Evaluate availability of biomass and cover extra heating load for cooling. • Plan new development of residential buildings as equipped with WEDISTRICT cooling technologies.

CONCLUSION

As a conclusion, during the next steps, the shifting from coal to biomass, or the reduction of excess in capacity will be evaluated. The evaluation of potential cooling demand will be done to check the viability of district cooling in the area, especially for non-residential buildings. The analysis will check the impact of adding additional WEDISTRICT technologies as:

- Biomass: to provide additional thermal capacity, or for renewing/retrofitting heat capacity.
- Cooling services: adding cooling capabilities, thermal energy will be demanded in summer, requiring the utilization of gas boilers and additional thermal energy based on solar technologies, if a viability checking is positive.
- Evaluation of energy storage needs, and implementation based on WEDISTRICT technologies, in case of solar technologies implementation.

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3 Conclusion and next steps

The WEDISTRICT Simulation Working Group has selected virtual demos that will join the project as demo-followers. Different technological scenarios will be tested for each project. Each virtual demo will integrate the most suitable technologies and operation strategies for improving the energy efficiency and lowering the emissions.

The aim is to improve their current system by integrating renewable energy technologies and demonstrate WEDISTRICT replicability. Besides, the Simulation Working Group aims at proposing the most cost-effective system for each particular demo follower. The different selected demo-followers have been categorized in two sections: first, the new DH/C systems, second the retrofited DH/C where, currently, is already operating a DH/C system. The demo-followers are located in different location, experiencing different weather, allowing exploring a wide range of boundary conditions.

The different demo-followers are listed below:

NEW DH/C SYSTEM		
Demo-follower	**Location**	**Description**
SeiMilano	Milan (Italy)	New modern urban and landscape re-development project that transforms the area by generating a new landscape.
Montegancedo Campus	Madrid (Spain)	School of software engineering and research pole with multiple research institutions currently supplied by individual gas boilers and compression chillers.
Playa del Inglés	Gran Canaria (Spain)	New DHC network in potential Canary Islands area.
Tecnoalcalá	Alcalá de Henares (Spain)	Scientific and Technological Park with individual heating and cooling supply in more than 40 companies located in the Park.
Independencia	Santiago de Chile (Chile)	10 clients (4 health clients, 2 residential apartments, 1 university, 1 mall and 2 offices and public clients), with 18 buildings for a new DHC proposal.
RETROFITTING OF EXISTING DH/C SYSTEMS		
Demo-follower	**Location**	**Description**
Parc de l'Alba	Barcelona (Spain)	New urban development with a high efficiency energy system and DHC partially implemented. 2 new production plants are planned.
Cyprus University	Nicosia (Cyprus)	DHC initially developed in 1999, expanded twice (in 2007 and 2010) and new expansion planned for year 2022. Currently operating with oil boilers and air-cooled chillers.
Żyrardów	Żyrardów (Poland)	Existing DH with around 500 heat centres coal-fired based (35-year old)
Valladolid	Valladolid (Spain)	6 buildings covered by a recent (2018) DH installation biomass-based with extension perspective.
Focsani	Focsani (Romania)	Old DH network retrofitted in 2018 with new CHP and gas boiler facilities.
Mrągowo	Mrągowo (Poland)	Old DH network (247 buildings connected) which has started a retrofitting action replacing coal by biomass.

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This document aims to make an introduction to the WEDISTRICT demo-followers showing the main information of the current status and WEDISTRICT technologies implementation potential. Each demo-follower description has been structured following the next three sections:

(1) **GENERAL DESCRIPTION:** presenting a short description as introduction, with main features of the location, RES potential and current DHC development in the site.
(2) PRELIMINARY ASSESSMENT: performing an energy baseline description, identification of possible suitable solutions and main impacts expected according to this very preliminary assessment.
(3) CONCLUSION: finalizing with a short conclusion about the demo-follower at the present stage.

At this initial phase, not all the demo-followers show the same detailed information since each particular demo-follower is at different status and it has been up to the representative people to share more or less data. In general, a very good cooperation has been started with all the demo-followers and there is a clear interest in WEDISTRICT interaction with them and how the project can improve their particular systems. In fact, after this very preliminary analysis, many interesting ideas have arisen, and first discussions and ideas exchange have started with the demo-followers.

The simulation working group has obtained a first picture of each demo-follower and more deep analysis will be carried out hereinafter.

During the full activity (Task 2.5 + Task 5.4) two workshops will take place with representative people from each demo-follower in order to show them the work performed and results obtained by means of the Trnsys simulations performed, generating debate and receiving their feedback regarding the work accomplished. The first workshop is foreseen in Madrid (Nov-Dec 2021) and the second workshop in Bucharest (Sept-Oct 2022).

The activity will end with the submission of a final public deliverable in September 2022 (D5.8 Virtual demo designs).

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4 Annex 1: Basic info tables

Table 4-1 Basic info SeiMilano demo-follower

SEIMILANO		
General data		
Location		Milan, Italy
The district to be analysed in the Italian WEDISTRCT case study is named SEIMILANO (https://seimilano.com/) located in the city of Milan, Italy's second largest town. SEIMILANO will receive its district heating from the multi-utility, A2A (https://www.a2aenergia.eu/). Currently, the city of Milan has a limited district heating network (11%). Historically, it had several smaller DH networks supplying parts of the city. In recent years, A2A has started connecting those separated networks to build a large network at municipal level. Milan also has several small district-cooling systems, mainly supplying what is referred to as "tertiary districts". WEDISTRICT will support A2A in choosing the best suitable heating and cooling generation technologies.		
Area covered by District Heating and/or Cooling (DHC)	**m^2**	Residential sec. 80,985 m^2, Commercial section 8,000 m^2, Tertiary section 26,500 m^2
Number of buildings connected	**-**	Not yet defined. All in all, approximately 1,020 flats.
Current thermal station data		
DHC age	**-**	SeiMilano is a new project.
Has it been retrofitted?	**Y/N**	No.
Heating: District Heating from the existing western system (Milano Ovest). Cooling: 2 x 1.5 MWc chillers (vapour compression) + 1 MWc chiller (absorption).		
Energy demand		
Total heating power:	3.8 MWt	
Total cooling power:	from 4-7 MWc	
Heating energy needs:	10 GWh/y	
Cooling energy needs:	~5 GWh/y	
Any other information		
-		

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Table 4-2 Basic info Montengancedo Campus demo-follower

MONTEGANCEDO CAMPUS		
General data		
Location		Pozuelo de Alarcón, Madrid (Spain)
The Montegancedo Campus from the "Universidad Politécnica de Madrid" (UPM) is located in Pozuelo de Alarcón. It includes the school of software engineering and a research pole with multiple research institutions, among which the super-computation and visualization centre of Madrid (CESVIMA) and the centre of research on biotechnology and genomic of plants, two building of special interest for its high heating, cooling, and electricity demands related to their activity.		
Area	**m^2**	480,000 m^2
Existing buildings	**-**	6
Current energy supply situation		
DHC	**-**	No current DHC exists, neither a project is planned.
Building are supplied by individual gas boilers for heating and domestic hot water, as well as compression chillers for cooling		

Table 4-3 Basic info Playa del Inglés demo-follower

PLAYA DEL INGLÉS		
General data		
Location		Gran Canaria (Spain)
The Canary Islands is a Spanish archipelago in the Atlantic Ocean, in a region known as Macaronesia. At their closest point to the African mainland, they are 100 kilometres west of Morocco. They are the southernmost of the autonomous communities of Spain and are located in the African Tectonic Plate. The archipelago is economically and politically European and is part of the European Union.  Gran Canaria island is called a "miniature continent" due to the different climates and variety of landscapes found, with long beaches and dunes of white sand, contrasting with green ravines and picturesque villages. A huge number of hotels and touristic services are located in few kilometers in the south-east part of the Gran Canaria island, in the area around the site known as "Playa del Inglés"		
Area covered by District Heating and/or Cooling (DHC)	**m^2**	To be defined

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Number of buildings connected	**-**	To be defined
Current thermal station data		
DHC age	**-**	New Project
Has it been retrofitted?	**Y/N**	N
New DHC		
Energy demand		
To be defined		

Table 4-4 Basic info Tecnoalcalá demo-follower

TECNOALCALÁ		
General data		
Location		Alcalá de Henares (Spain)
In April 2003, at the hands of the Community of Madrid, the TECNOALCALÁ Scientific and Technological Park was established. Its main mission is to create a space where the priority is to support innovation and the transfer of technology and knowledge, offering quality flooring for the installation of innovative companies. The Park is developed on a 370,705m^2 plot, located on the campus of the University of Alcalá.		
Area covered by District Heating and/or Cooling (DHC)	**m^2**	370,705m^2
Number of buildings connected	**-**	Currently the Park has more than 40 companies installed
Current thermal station data		
DHC age	**-**	No DHC up to now
Has it been retrofitted?	**Y/N**	-
No central station		
Energy demand		
Madrid Activa does not have the individual energy consumption data of the different companies in the park, since the contracting and payment of the same correspond directly to the companies. To point out that there is a huge Data Center within the Park (useful area: 15,000 m^2).		
Any other information		
TecnoAlcalá belongs to the Association of Science and Technology Parks of Spain (APTE) which is a non-profit Association whose main objective is to collaborate, through the promotion and dissemination of science and technology parks, to the renewal and diversification of productive activity, technological progress and economic development.		

Table 4-5 Basic info Independencia demo-follower

INDEPENDENCIA		
General data		
Location		Independencia (Santiago, Chile)
Independencia is a borough located in Chile's capital Santiago. It has a population around 100,000 people. The borough concentrates many key buildings like hospitals, schools, malls in small areas close to residential areas. The population consists of mostly young people in the 20 to 34 years old range due to the accessibility of the area which facilitates the arrival of new inhabitants.		

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Area covered by District Heating and/or Cooling (DHC)	**m^2**	300,650m^2
Number of buildings connected	**-**	10 clients (4 health clients, 2 residential apartments, 1 university, 1 mall and 2 office and public clients), with 18 buildings.
Current thermal station data		
DHC age	**-**	New Project
Has it been retrofitted?	**Y/N**	N
-		
Energy demand		
Preliminary studies have shown that the annual heating demand can reach up to 8,000 MWh, excluding DHW energy demand and 18,700 for annual cooling demand.		

Table 4-6 Basic info Parc de l'Alba demo-follower

PARC DE L' ALBA		
General data		
Location		Cerdanyola del Valles (Barcelona), Spain
The "Parc de l'Alba" (also known as Directional Centre) is a new urban development with the aim to become a model of sustainable growth, located in Cerdanyola del Vallès, a city of 57.000 inhabitants in the area of Barcelona. The park has partially implemented a high efficiency energy system that produces electricity, heat and cold with a DH&C network.		
Area covered by District Heating and/or Cooling (DHC)	**m^2**	currently: 710,000 m^2 / forecasted: 1,500,000 m^2
Number of buildings connected	**-**	6
Current thermal station data		
DHC age	**-**	Operation started in September 2010
Has it been retrofitted?	**Y/N**	No
The first plant, called ST4, started operation in September 2010. The plant currently includes 3 natural gas co-generation engines, with a power output of 3.35 MW each. It also hosts a 3 MW single effect absorption chiller, driven by hot water from the co-generation engines' cooling system, and a 5 MW double effect absorption chiller directly powered by co-generation exhaust gases. The plant has an underground chilled water storage tank of 4,000 m3, that acts as a buffer to meet higher cooling demands during peak loads. This plant is ready to increase its capacity when the energy demand grows: it can house 2 additional CHP engines as well as additional single-effect and double-effect absorption chillers.		
Energy demand		
So far, the ESCo that exploits Parc de l'Alba DH&C network supplies energy to 6 customers (out of 7 existing buildings within the park): Alba Synchrotron (heating, cooling and electricity), 3 office buildings (heating & cooling) and 2 data centres (cooling). The thermal energy sold during 2019 was 25,118 MWh of cooling and 4,044 MWh of heating. The electricity produced was either sold to the Synchrotron (23,500 MWh) or exported to the grid (29,100 MWh).		
Any other information		
The Parc de l'Alba energy system will include 2 other production plants, that will be implemented according to the pace of the urban development, which may include renewable energy sources.		

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Table 4-7 Basic info Cyprus University demo-follower

<table>
<tr><th colspan="4">CYPRUS UNIVERSITY</th></tr>
<tr><th colspan="4">General data</th></tr>
<tr><td colspan="2">Location</td><td></td><td>Nicosia, Cyprus</td></tr>
<tr><td colspan="4">The cooling, heating and domestic hot water needs of the campus of the University of Cyprus are served by district heating and cooling systems.
These systems are the only installations in the University of Cyprus, and they present a unique opportunity to study the performance of the systems in the context of Southern European climatic conditions.
The networks are expanding as the campus grows and more power is added to the plant, to serve the new load. This provides an opportunity to select the best possible plant configuration to serve the networks, when the need arises, without having to decommission existing plant.
Cyprus climate is particular in the European context and sports one of the highest solar radiation potential in Europe. This high potential can be enticing for technologies such as Solar Heating, Heat Pumps with PV, Energy Storage etc.
Additionally, next year the University of Cyprus, plans to develop a 5 MWp PV plant complete with electricity storage of 2.35 MWh capacity.
The generation of RES electricity in this particular case can justify the implementation of heating and cooling storage systems (along with the electricity storage) and this is situation that needs to be thoroughly studied, in order to derive the optimum mix of technologies that will serve the needs of the Campus.</td></tr>
<tr><td colspan="2">Area covered by District Heating and/or Cooling (DHC)</td><td>m^2</td><td>91,422 (Cooling),
98,520 (Heating)</td></tr>
<tr><td colspan="2">Number of buildings connected</td><td>-</td><td>17 (Cooling),
29 (Heating)</td></tr>
<tr><th colspan="4">Current thermal station data</th></tr>
<tr><td>DHC age</td><td>3</td><td colspan="2">Initially developed in 1999. Plant has been expanded twice (in 2007 and 2010). A new expansion is planned for year 2022.</td></tr>
<tr><td>Has it been retrofitted?</td><td>Y/N</td><td colspan="2">No. Both systems are modular, and more plant was installed as needed, but the system has never been retrofitted.</td></tr>
<tr><td colspan="4">District heating system is served by four oil boilers.
Each boiler has nominal heating power of 1,750 kW and the fuel is heating oil.
The nominal efficiency of the burners is 88%.
District cooling system is served by eight air-cooled chillers each of 1,000 kW cooling capacity.
The chillers have an ESEER of 4.2.</td></tr>
<tr><th colspan="4">Energy demand</th></tr>
<tr><td colspan="4">Provided in excel file</td></tr>
<tr><th colspan="4">Any other information</th></tr>
<tr><td colspan="4">UCY is a relatively young University and its campus is growing constantly.
New buildings are being developed and as the campus grows, the heating and cooling networks need to be upgraded to supply the necessary heating and cooling.
Currently, three building complexes are under construction: The School of Engineering, the Cancer Research Institute, and the Department of Biological Sciences / Common Teaching</td></tr>
</table>

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Facilities 3. To facilitate the new construction, a new energy Center is planned to be developed in the near future. The technologies that have been considered for the new energy Center are air-cooled chillers, ice storage, tri-generation, oil-fired boilers*, and solar heating. However more detailed studies are necessary to obtain the optimum mix.

Table 4-8 Basic info Żyrardów demo-follower

ŻYRARDÓW		
General data		
Location		City (Country), Żyrardów, POLAND
Żyrardów has almost 200 years of history. The town developed during the 19th century into a significant textile mill town in Poland. Currently most of textile industry is not working anymore however a lot of buildings and infrastructure created unique feature that city can still develop as a touristic city. However, a lot of old buildings which are historical buildings, big 70-80's residential area and currently built buildings created quite sophisticated heating system, also as a result of decreasing so called "low emission" from old residential buildings. The district heating system covers around half of the city and is still developing. However, 35 years old coal fired heat plant needs urgently to be changed in next 5-10 years for more environmentally friendly sources of energy, and cheaper as well. Next 2-3 years will be vital for correct decision which direction should be chosen.		
Area covered by District Heating and/or Cooling (DHC)	**m^2**	Around 4,000,000.
Number of buildings connected	**-**	Around 500 heat centres.
Current thermal station data		
DHC age	**-**	40 years
Has it been retrofitted?	**Y/N**	Yes, mainly in 2013-2016.
There are two thermal plants in Żyrardów. One hard coal fired with water boilers (around 63 MW in fuel) which belongs to PEC "Żyrardów" company and one 9 MW gas fired boiler which belongs to other private company located around 2 km from main heat plant. The are no renewables in district heating system. Biomass and gas are mainly considered to be used in future adaptation of sources of energy, including cogeneration. Also, geothermal source is considered in the location of main heat plant. Cooling is not considered since there are no available market for cooling rather. The parameters of water are around 120/75 C deg. for day with -20 C deg and around 75/50 in the summer.		
Energy demand		
Ordered power in 2020 is around 66 MW in heat. This is still growing, and it is expected to reach around 74-75 MW in next 3-4 years. Recently yearly production of heat does not exceed 400,000 GJ rather (coal and gas heat plants together). Last year maximum input for heating system was around 45 MW. If cogeneration is considered it should have around 4 MW in electricity and heat since thermal real demand for heat water in summer is around 3-4 MW (around 8-9 MW of ordered power).		
Any other information		
We generally consider each source of energy. However, since Żyrardów is rather urbanistic area we can not consider rather sun and wind as a potencial source of energy. We focuse more on biomass and gas with cogeneration as well however we do not have natural gas yet (we consider LNG as well). It is also important, due to ETS, create e.g. three sources of energy. The future price for heat is one of the key parameters. Currently the average price for heat is around 74 PLN/GJ (production + distribution). The heat from coal fired thermal plant is still cheaper than from gas one (almost twice), even there is no ETS for gas heat plant.		

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Table 4-9 Basic info Valladolid demo-follower

VALLADOLID		
General data		
Location		Valladolid (Spain)
Valladolid is a city in Spain and the capital of the autonomous community of Castile and León. It has a population around 300000 people making it Spain's 13th most populous municipality and northwestern Spain's biggest city. The city is situated at the confluence of the Pisuerga and Esgueva rivers before they join the Duero. The old town is made up of a variety of historic houses, palaces, churches, squares, avenues and parks, and includes the National Museum of Sculpture, the Museum of Contemporary Art Patio Herreriano or the Oriental Museum, as well as the houses of Zorrilla and Cervantes which are open as museums. Among the events that are held each year in the city are the famous Holy Week, Valladolid International Film Festival (Seminci), and the Festival of Theatre and Street Arts (TAC).		
Area covered by District Heating and/or Cooling (DHC)	**m^2**	53,400m^2
Number of buildings connected	**-**	8 (6 publics and 2 apartment buildings) and now we are installing about 2,5km of pipes to connect more buildings
Current thermal station data		
DHC age		4
Has it been retrofitted?	**Y/N**	NO, BUT EXTENDED
The projected building has two biomass (wood chip) boilers with a nominal power of 6,960 thermal kW (3,480 kW each), each boiler includes the multi-cyclonic filtering system and a bag filter system. The minimum efficiency is 86%.		
Energy demand		
The consumers only demand heat from the district heating. Currently, there are eight buildings connected (6 publics and 2 apartment buildings) and now we are installing about 2.5km of pipes to connect more buildings.		

Table 4-10 Basic info Focsani demo-follower

FOCSANI		
General data		
Location		Focsani (Romania)
Focşani is the capital city of Vrancea County in Romania on the shores the Milcov River with around 98 000 inhabitants. The Municipality of Focşani is the legal owners of the DH Company ENET SA, which is the operator of the cogeneration and heating plants, the transmission (23.21 trench km) and distribution network (60.93 trench km) and the DHW (6.093 km trench including recirculation) systemin Focsani since 2001.		
Area covered by District Heating and/or Cooling (DHC)	**m^2**	579,000
Number of buildings connected	**-**	11,575
Current thermal station data		
DHC age	**years**	3 (from 2018)

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Has it been retrofitted?	**Y/N**	Y
The modernization and rehabilitation of the heating networks and heating substations was started. Based on the Master Plan developed in 2009 the municipality succeeded in deeper rehabilitations of the DH system including substations and also rehabilitation of the CHP/HoBs facilities with the installation of 2 x 6.8 MWe gas engines and a 50 Gcal/h gas boiler. From 2025 is expected the installation of heat pumps to operate in summer, increasing external electricity consumption for district heating water (DHW) water.		
Energy demand		
Energy demand in 2018 was of the order of 136 GWh/y in form of heat for district heating resulting in a demand of 105 GWh/y discounting the transmission and distribution losses, with an end-user invoiced heat of 86 GWh/y, and 84,000 GWh/y of electricity production for the grid. Strong differences between winter and summer. Heating demand in summer months are absent, keeping an electricity output of 25 GWh to the grid.		

Table 4-11 Basic info Mrągowo demo-follower

MRĄGOWO		
General data		
Location		Mrągowo (Poland)
Mrągowo is a resort town in the Warmian-Masurian Voivodeship of northeastern Poland, with 21,889 inhabitants (2019). It is the capital of Mrągowo County and the seat (though not part of) the Gmina Mrągowo. The town is located in the historical region of Masuria, within the Masurian Lake District, about 60 km (37 mi) east of Olsztyn. The heating demand of the Mrągowo municipality is covered in a 70% by district heating by the company Miejska Energetyka Cieplna Spółka zoo.		
Area covered by District Heating and/or Cooling (DHC)	**m^2**	416,000 m^2
Number of buildings connected	**-**	247
Current thermal station data		
DHC age	**-**	80's
Has it been retrofitted?	**Y/N**	Old system, they have started retrofitting actions (biomass)
3 x WR -10 construction years 1984-1987 1 x WR – 5 construction years 1979 (water-tube, stoker coal-fired boilers). As the power exceeds 20 MW it is included in EU-ETS mechanism.		
Energy demand		
The energy supply is about 160 thousand GJ per year although last few winters have been pretty mild and varies depending on the conditions.		
Any other information		
-		

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