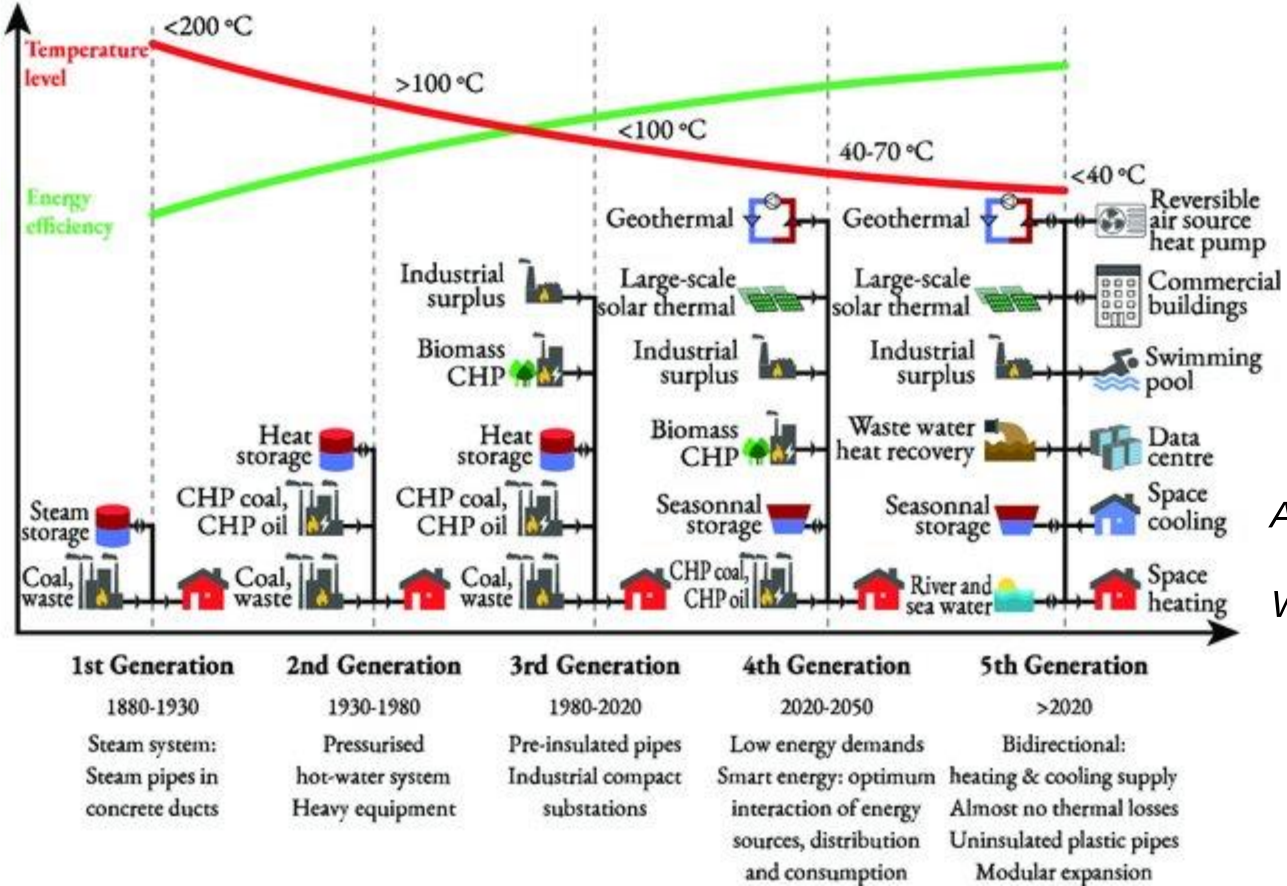
SUSTAINABLE PLACES 2023

District Heating & Cooling in the future energy system

15th June, 2023 - Madrid, Spain

sustainableplaces.eu

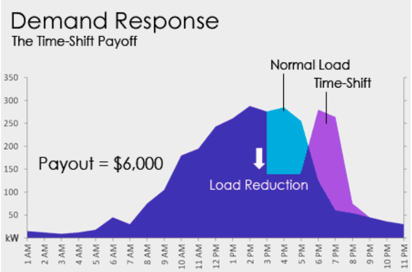
Framing DHC

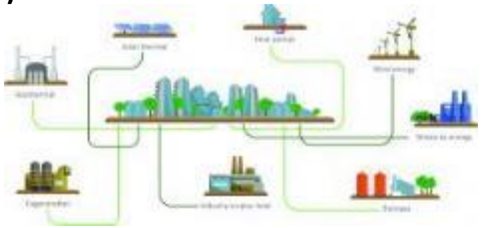


Adopted from Lund et al. (2018) and Wirtz et al. (2020b)

Challenges

- European and local regulations require **efficiency/RES increase**
- **Large fossil fuels-fired CHPs** are no more operating like in the past
- **Feed-in** from data centers, HP, ST, bio-chps
- Need to **shave peaks** in demand
- Manage of **non-programmable RES** (mainly solar thermal)
- Manage **different temperatures** from decentralised sources
- Ensure correct **return temperature**
- Connect to existing **high temperature buildings**
- Interact with the **electricity grid** (flexibility, demand response)
- Find the **proper business models** for decentralised sources
- **Connect different DHC grids** together





SUSTAINABLE PLACES 2023

Our projects

Bio-FlexGen

REWARDHeat

SENERGY NETS

European Commission

HYPERGRYD

W.E. DISTRICT

ConnectHeat
Community engagement for clean heat

SUSTAINABLE PLACES 2023

The Workshop

- Presentation of each project

- How will DHC technically change in the future?

- Which will be the role of DHC in the future EU energy system?

- How will end users be involved in each project and which are the challenges in doing so?

Bio-FlexGen

SUSTAINABLE PLACES 2023

Workshop: District Heating and Cooling in the Future Energy System

Juan Francisco Gutiérrez Guerra June 15, 2023, Madrid

Bio-FlexGen

Bio-FlexGen in a nutshell

•**Multidisciplinary team** of 14 partners and 5 EU- countries (Spain, Finland, Sweden, Germany, Hungary).

•**Multi-stakeholder approach**: Research Centres and universities, technology providers (SMEs or large companies), case studies and stakeholders (chemical industry players, cement companies), experts in impact assessment, dissemination and policies (consultancies).

•**Project duration**: 36 months Sep. 2021 – August 2024

•**Overall budget**: ca. 6 million Euros

•**Pilot/demo sites**: Development rigs in Stockholm and Piteå, Sweden and Berlin

•**Animated film: https://bioflexg**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037085.

Bio-FlexGen – Highlights

- Develops **cutting-edge Biomass-fired Top Cycle (BTC)** plant technology for energy independence
- Applies **patented** gasification, combustion and gas turbine technology
- Produces **green H2** or renewable, plannable electricity from biomass
- When producing green H2 from biomass, biogenic **CO2 is captured**
- When generating electricity from biomass, **2-3 times more electricity** is produced
- Can **flexibly utilise** green H2 for fast-response electricity production
- 25 MW plant **saves 90.000 tons of CO2 emissions** per year

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037085.

The Biomass-fired Top Cycle (BTC)

- **The BTC technology produces power from biomass twice as efficiently as traditional steam cycle technologies**

➢ by gasifying biomass with a high-pressure gas turbine process and massive steam injection. The goal: 50% electrical efficiency from biomass by the year 2030.

➢ Operating costs are cut almost by half. This results in a profitable plant that generates renewable power and heat on-demand for industry and district heating

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 101037085.

How will DHC technically change in the future?

•Highly flexible technical components in DHC enabling smooth green transition.

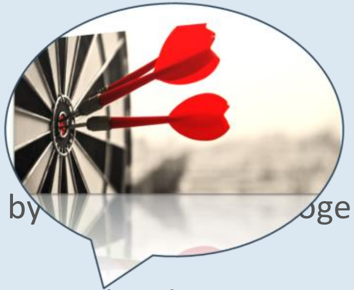
➢ **Example: The Biomass-fired Top Cycle (BTC) CHP** https://bioflexgen.eu/project/

- Highly flexible energy supply: Hourly, daily and seasonal flexibility of electricity or hydrogen production from biomass
- Flexible switch from producing electricity to producing hydrogen when there are long periods of excess electricity
- Also allows for carbon removal – critical to meet climate goals (IPCC)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037085.

What will be the role of DHC in the future EU energy system?

•DHC can play a key role in meeting the challenges of the energy transition



- The heating sector provides flexibility by ogeneration or combined heat and power (CHP) through heat storage:

➢ for the case of access energy in the system, the electricity production can be decreased while the heating demand can be satisfied

➢ during a period when there is a higher heat production than demand, heat can be stored. For the case of deficit of energy, the electricity production can be increased in CHP units while the heat demand can be met from the stored heat.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037085.

What will be the role of DHC in the future EU energy system?

- **DHC can play a key role in meeting the challenges of the energy transition**
- **It will:**

➢ boost decarbonisation and green, properly sourced electricity

➢ provide local electricity

➢ strongly promote energy independence from third countries

➢ increase local economy (well-paid jobs in the green energy field)

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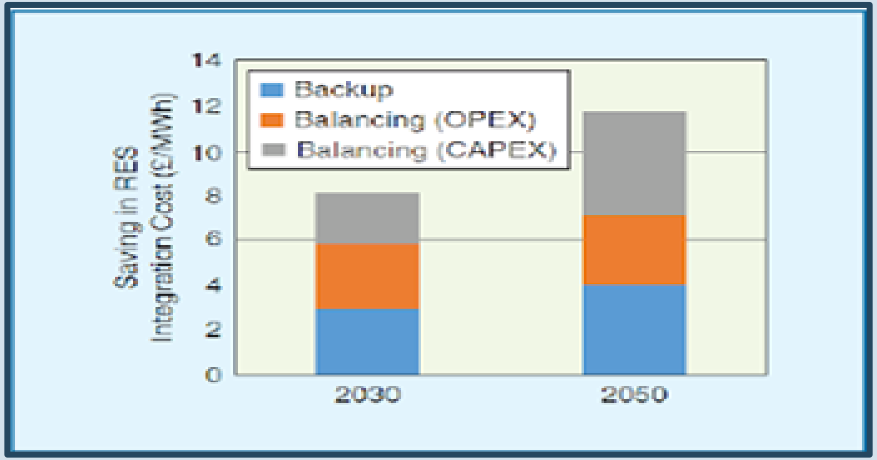
What will be the role of DHC in the future EU energy system?

- **Integrated heat and electricity systems**



➢ The reduction in integration costs of renewable generation (electricity sector only) enabled by the integrated operation of heat and electricity sectors.

Ref: J. Kiviluoma et al, 'Harnessing Flexibility from Hot and Cold', IEEE power &energy magazine, 2017.

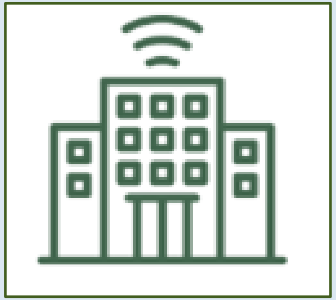
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037085.

How are end users involved and what are the challenges?

- **The end users have great potential to perform demand response and provide flexibility, however the challenges must be addressed properly:**

➢ By increasing awareness

➢ By developing incentivising techniques for the end users to provide flexibility



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037085.

Future common activities

- Seminar on pros and cons of biomass
- Seminar on pros and cons of green hydrogen
- Policy Workshops

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037085.


Bio-FlexGen

W.E. DISTRICT

Smart and local reneWable Energy **DISTRICT heating and cooling solutions for sustainable living**

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

WEDISTRICT
Main data

EU Funding:

14.972.852,64 €

Start:

Oct. 2019

End:

Sept. 2024

20
Partners

9
Countries

3
Demosites

10
Technologies developed

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

Our Partners

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

Heating and cooling buildings in EU accounts for

42%

Of total energy consumption in EU

77%

Of this energy is generated from fossil fuels

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

WEDISTRICT goal is

To demonstrate innovative 100% fossil free heating and cooling solutions for new and existing district heating & cooling systems.

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

WEDISTRICT solutions will integrate

Solar Thermal Technologies
- Parabolic Trough Collector
- Fresnel
- Tracking concentrator for fixed tilt collector

Biomass Technologies
- Low emission biomass boiler

PV-Geothermal System
- Hybrid solar geothermal district heating system

Cooling from Renewable Energy Sources
- Renewable air cooling unit (RACU)
- Advanced absorption chiller

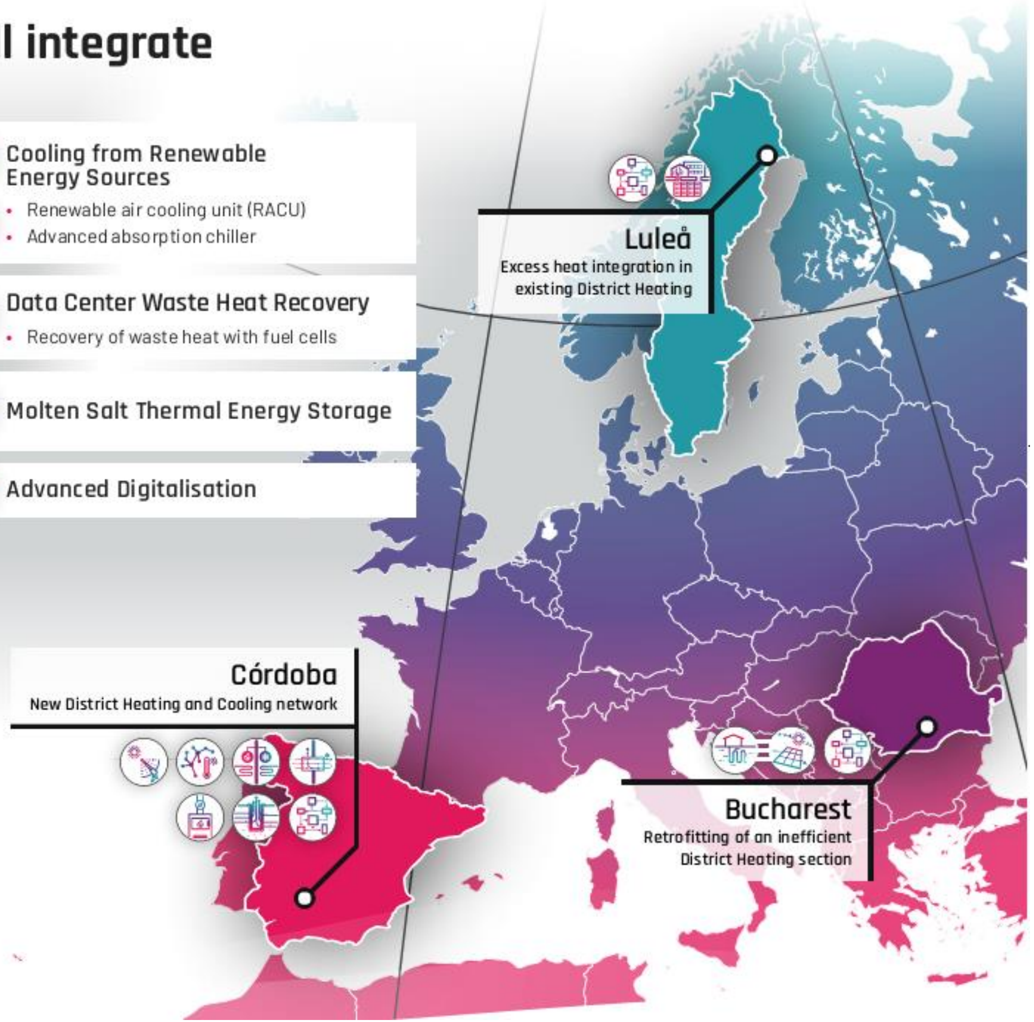
Data Center Waste Heat Recovery
- Recovery of waste heat with fuel cells

Molten Salt Thermal Energy Storage

Advanced Digitalisation

3 demo sites

WEDISTRICT technologies will be implemented in **3 real-scale projects** in Spain, Romania and Sweden.



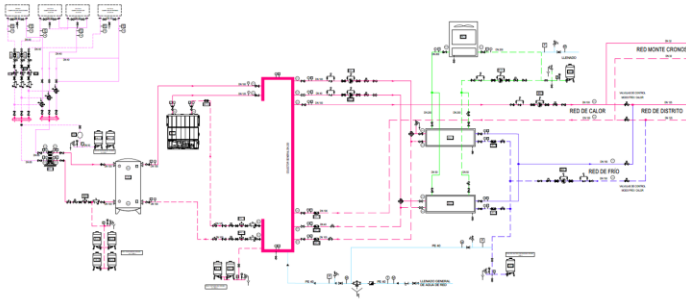
Demonstration site

Córdoba (Spain)

New district heating and cooling network

TECHNOLOGIES PLANNED:

- **Concentration Solar Collectors:** 3 fields with 3 different technologies: CSP, Fresnel and Concentrated Flat Plate
- **Solar cooling:** 1 advanced absorption chiller for district cooling supply coupled with a conventional absorption chiller + 1 R-ACU
- **Thermal storage:** Molten salts storage (at CIEMAT) and 1 water tank
- **High efficiency low emissions biomass boiler**



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

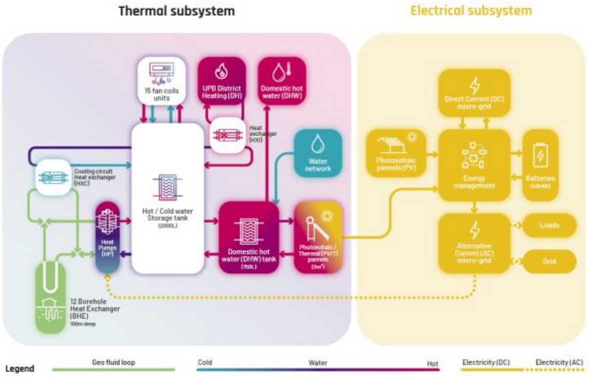
Demonstration site

Bucharest (Romania)

Retrofitting of an inefficient district heating section

TECHNOLOGIES PLANNED:

- **Photovoltaic panels** installed on the building roof
- **Solar thermal panels** for domestic hot water production, connected to the buffer tank
- **Geothermal heat pump** to provide the heating of the building.
- The cooling demand will be assured by a **passive cooling system** using the borehole heat exchangers.



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

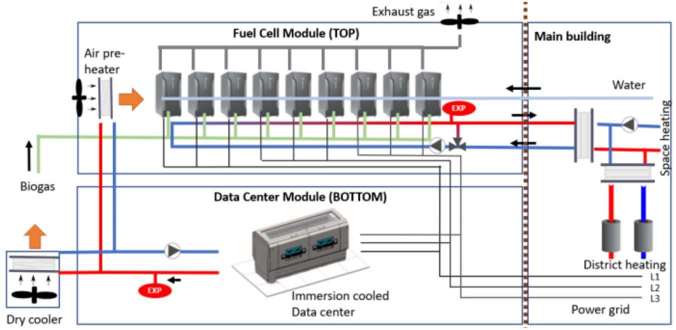
Demonstration site

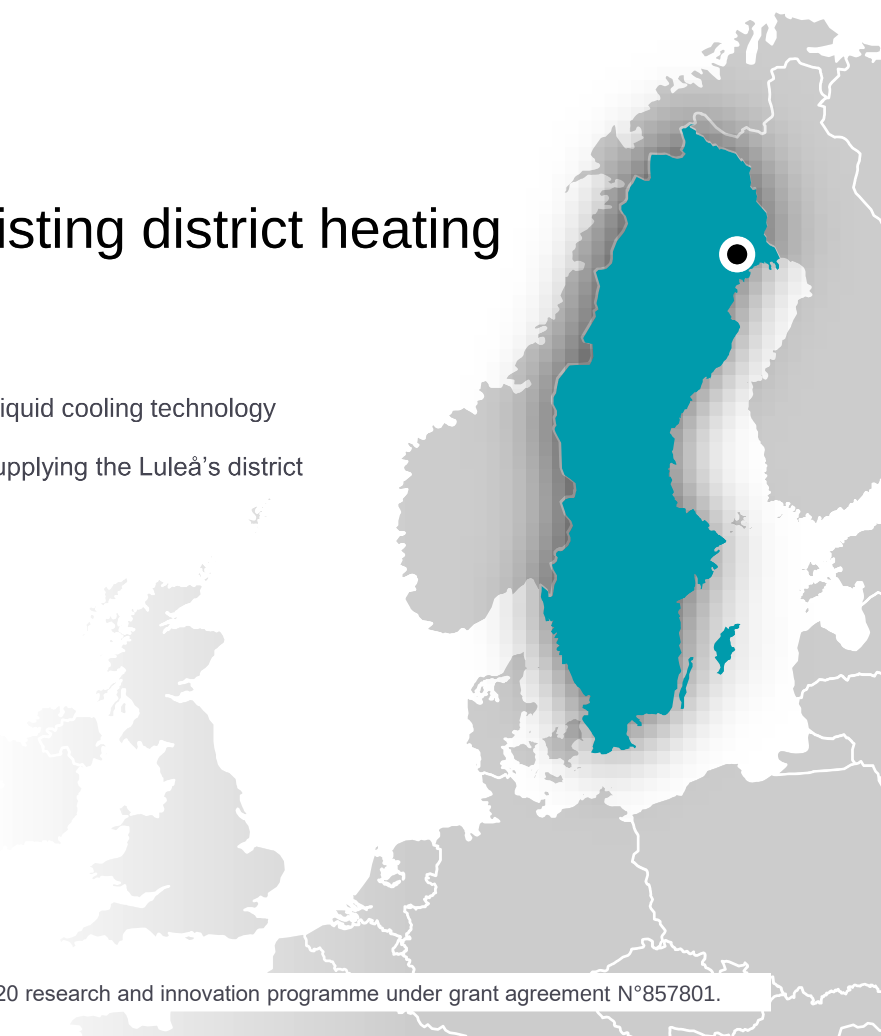
LULEÅ (Sweden)

Excess heat integration in existing district heating

TECHNOLOGIES PLANNED:

- The **excess heat from the data centres** will be recovered by liquid cooling technology
- The excess heat will be boosted to temperatures suitable for supplying the Luleå's district heating by **fuel cell technology**.



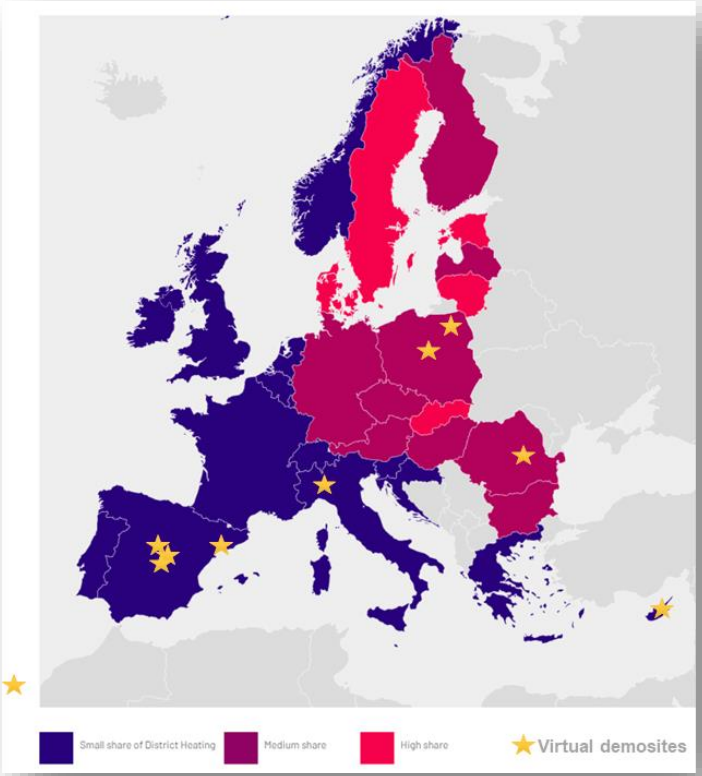


This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°857801.

Virtual demos

A set of virtual demos selected from the identification of potential **demo-followers** have been simulated considering different scenarios with technologies developed within the project in order to evaluate the **most cost-effective system** for each individual demo case.

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.



WEDISTRICTool

INPUTS

- Location
- Energy consumption
- Heat Price
- Electricity Price
- Subsidies
- Free area
- Other…

INTERNAL ENGINE

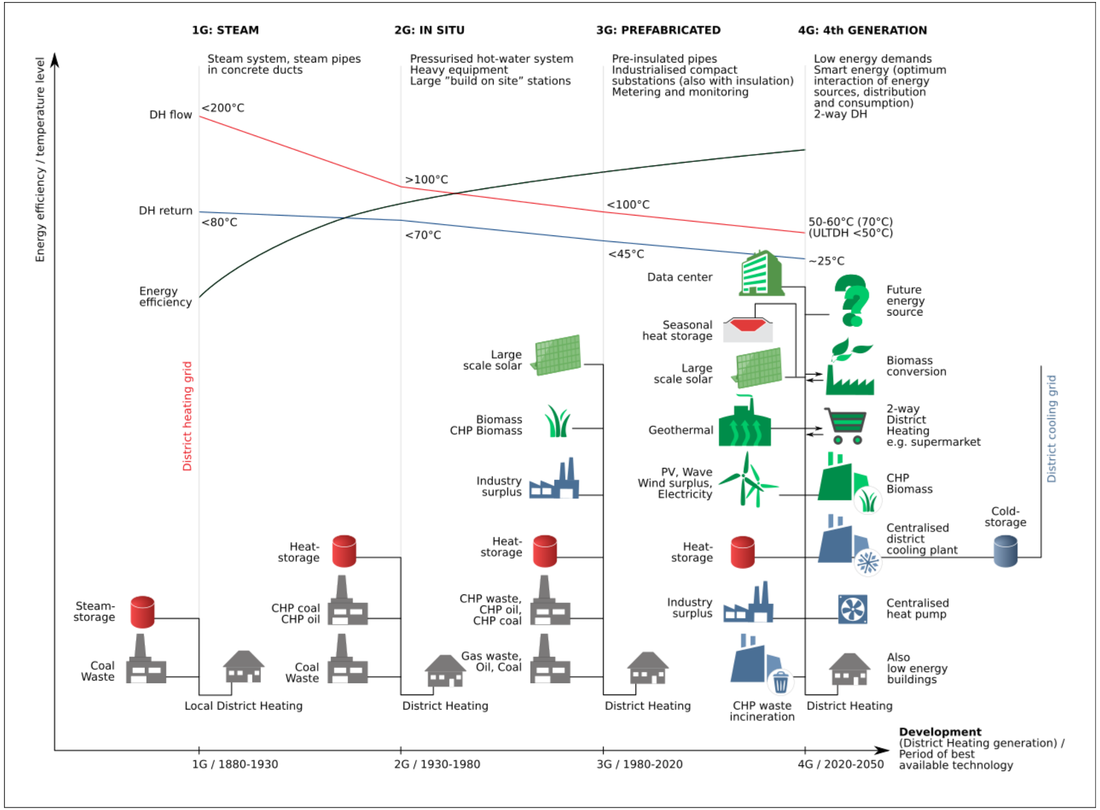
- Database of simulations
- Or Meta models procedure

OUTPUTS

- CAPEX
- OPEX
- % emissions
- Other KPIs
- Summary report

Generation of optimized scenarios categorized according preferences (cost, emissions,…)

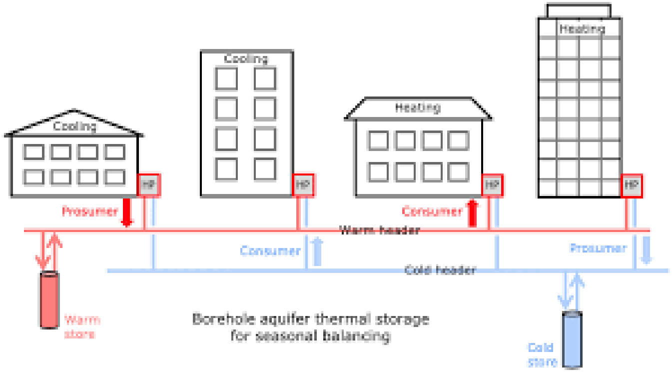
Evolution of DHC: 4th Generation

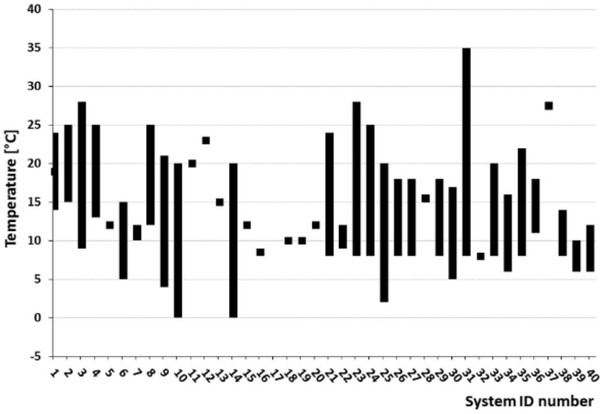


- Integration of high shares of renewable energy
- Providing high flexibility to the electricity system
- Key characteristics of 4th generation DHC

Question 2: Which will be the role of DHC in the future EU energy system?

Role of DHC in Future EU Energy System



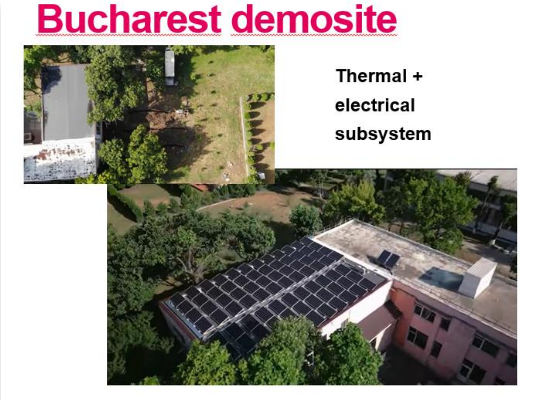


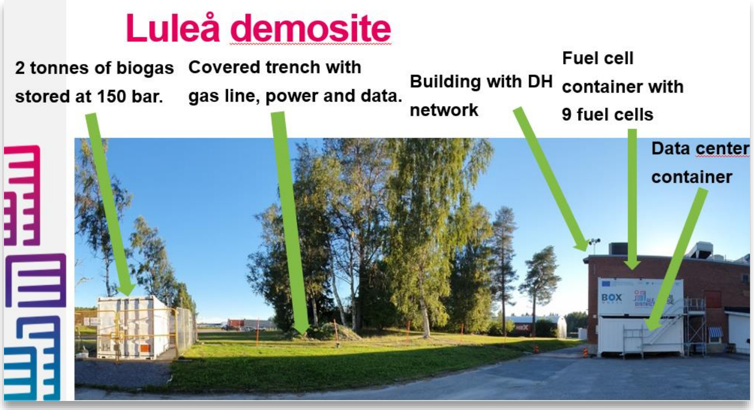
- Improved energy efficiency
- Integration of low temperature heat sources
- Implementation in residential and industrial areas
- Introduction of 5th Generation DHC network

Question 3: How will end users be involved in your project and which are the challenges in doing so?

WEDISTRICT Challenges

- Difficulty to obtain licenses & permits: 1 pilot withdraw + 1 pilot exchange
- Slow tender process: Pilot at University
- Participation in H2020 projects and Integration of R&D projects in Commercial environments
- Technical challenges (innovations)





Question 4: Share suggestions about future possible common activities

Suggestions to face DHC Challenges in Spain

- Lack of specific regulations and aligned with other EU Countries
- Reluctancy (fear) from Local Public Administrations
- Lack of political support for urban development based on DHC

Proposed activities

Policy workshops due to lack of specific DHC regulation in Spain
Capacity building activities to reduce risks and increase investment

W.E. DISTRICT
Heating & cooling solutions

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www.wedistrict.eu

Project Coordinator:

Jon Martinez Fontecha (jomartinezfo@acciona,com)

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

REWARDHeat

Renewable and Waste Heat Recovery
in Low-Temperature DHCN

Ismael Lozano-Gabarre, CARTIF Technology Centre

Roberto Fedrizzi, EURAC Research

Background

- 72% of the European population (EU28) lives in cities and towns
- A huge amount of low-grade waste heat is distributed within the urban texture, the largest amount being rejected by air-conditioners, cooling systems in industrial processes and tertiary buildings, chillers of refrigeration systems and service facilities, e.g. sewer pipes
- For historic reasons, cities and towns have born along rivers, lakes and seashores. All these sources make low-temperature renewable energy available, which utilisation is highly replicable because it is accessible right where it is needed

Source: Ricardo Gomez Angel on Unsplash

The vision – how we see future DHC

1. To use distributed, low-temperature RES as much as possible

1. To close the energy loop: to re-use waste energy as much as possible in a “circular energy” approach.

1. To avoid energy import/exchange as much as possible

1. To promote energy share and balance among multiple energy sources, through storage management and digitalization

1. To promote business models and financing based on opportunities offered by sector coupling.

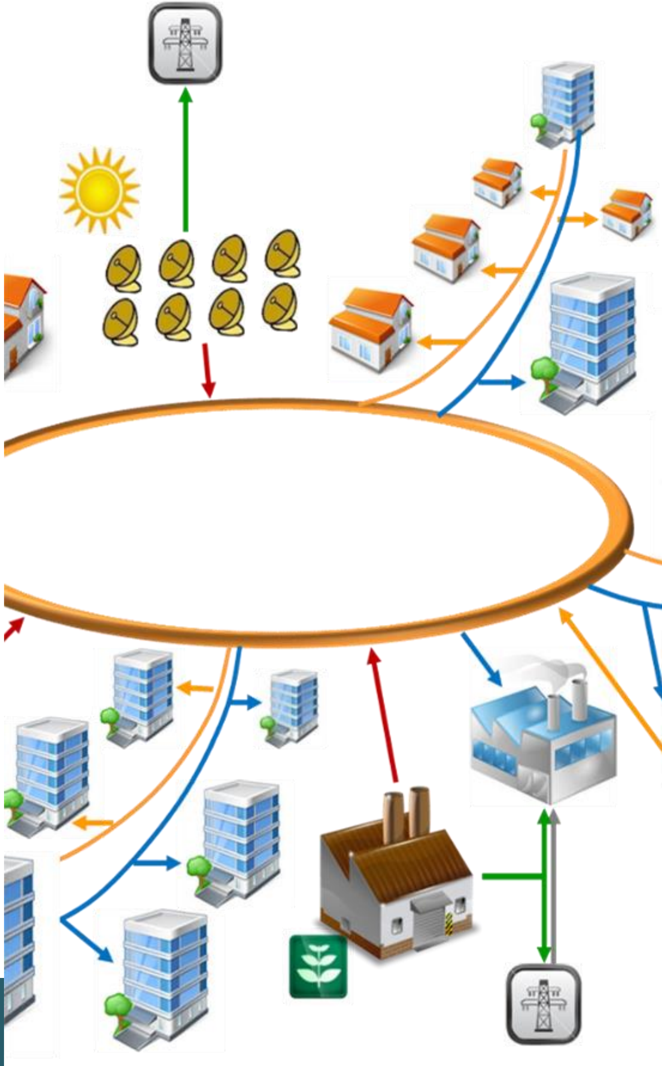
Source: Milind Kaduskar on Unsplash

How can DHC contribute to energy systems

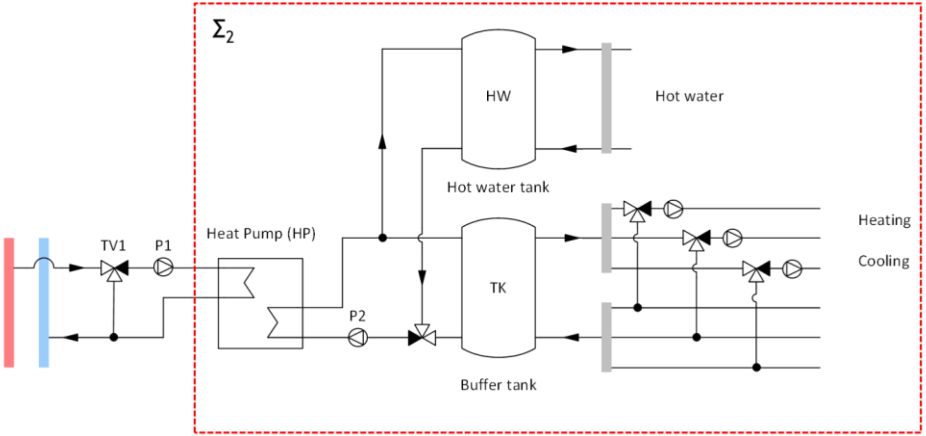
According to the vision represented, we see DHC networks as active nodes in the electricity grids, capable of aggregating thermal loads, and electric loads through HPs utilization, allowing to:

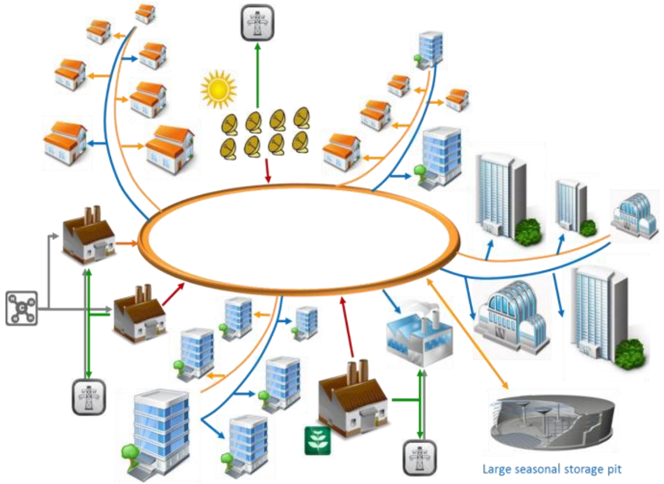
1. Accumulate electric power as thermal energy in TES distributed along the network
2. Shift significant, aggregated electric and thermal loads along the day

As such, we do not see a contraposition with the strategy towards the electrification of the heating sector, rather we see a synergic strain.



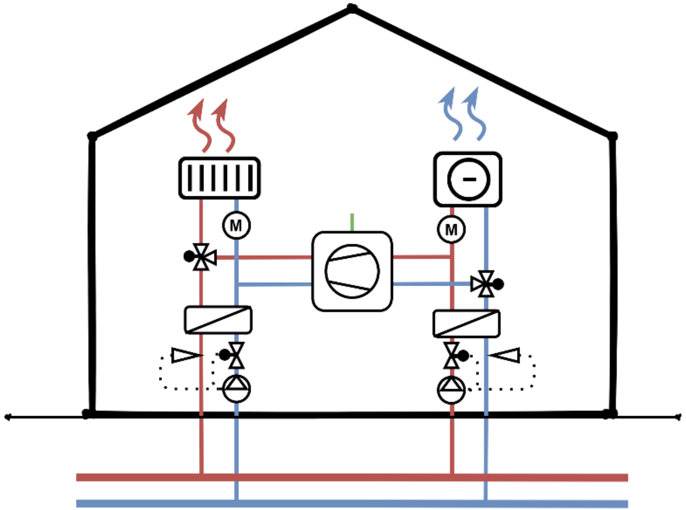
Industrialised and Prefabricated, bi-directional substations with heat pump and storages for installation in single buildings / processes





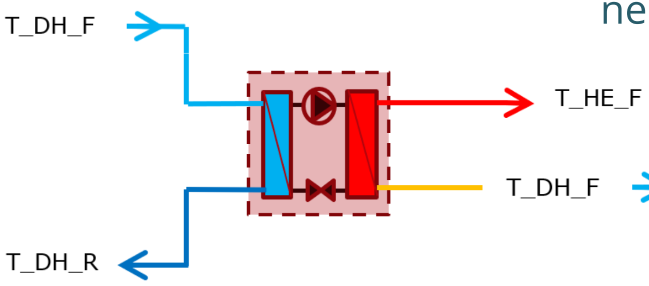
Innovative HP systems

- Both heating and cooling are covered at building level
- Standard heat pumps can be used. Multiple units are used to modulate thermal capacity and increase system reliability
- The management of the HPs is a challenge and needs to be optimized with a smart control and storage capacity installed

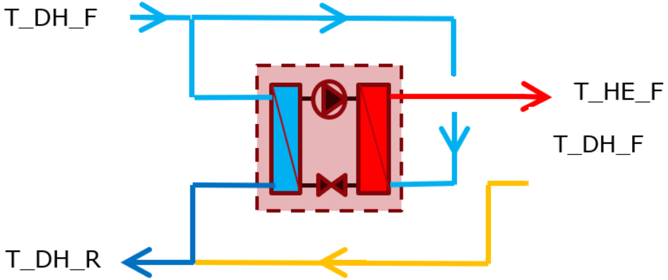


Source: e.on ectogrid

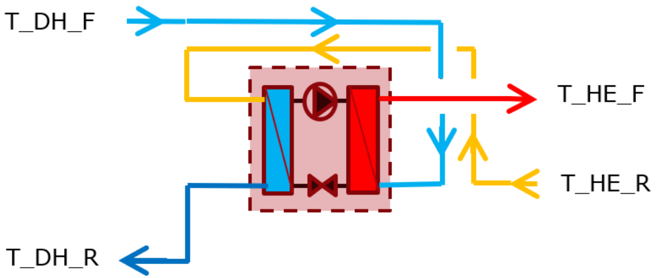
- Versatile configurations adapting to specific building needs and distribution systems operation
  - Adapted to variable network supply temperatures and needs



Direct flow configuration



Split flow configuration



Reverse flow configuration

Source: Danfoss

Innovative storage solutions

- Local, intra-day storages at customer substations

- Central, intra-day storages to balance the network and store energy during off-peak periods <u>the thermal capacity associated to the network's water content can be relevant</u>

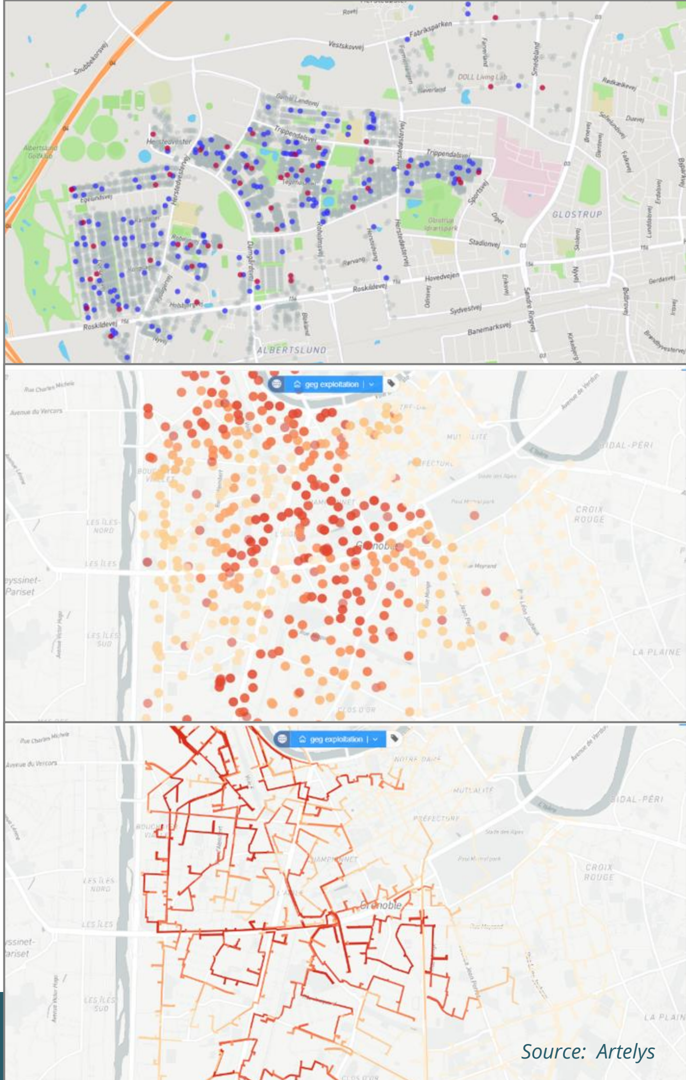
- Seasonal storage <u> boreholes and mine wells under investigation</u>

Source: e.on – Medicon Village

Digitalisation solutions allowing to optimise the management of the substations and of the network

In REWARDHeat, storage capacity and control are used synergically to manage the system.

- Smart metering communicating real-time for assets monitoring
- Data-mining platforms for performance analysis and KPIs calculation for wise management of the network
- Fault detection and expert control strategies elaboration for optimisation and electricity grid coupling

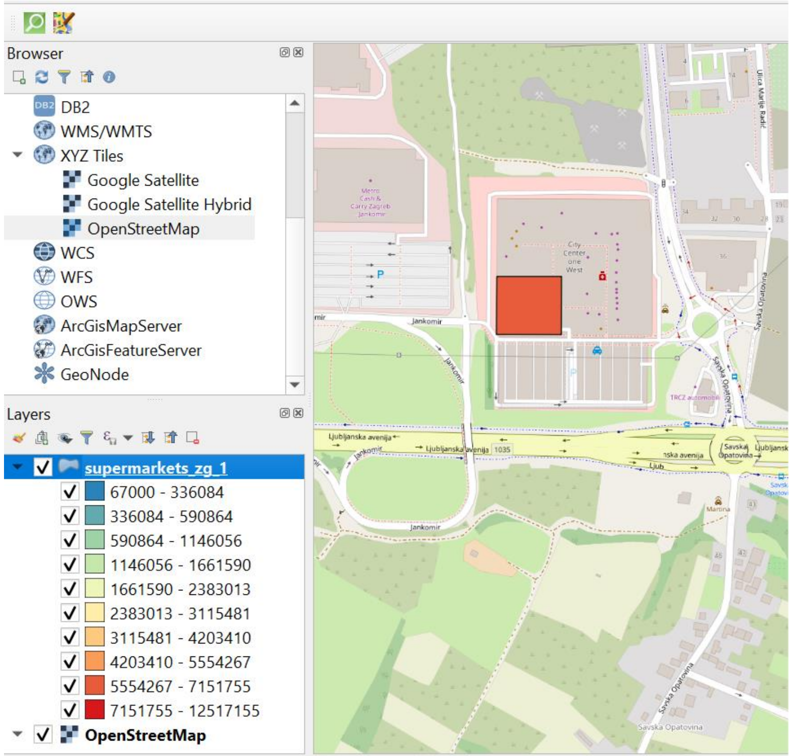


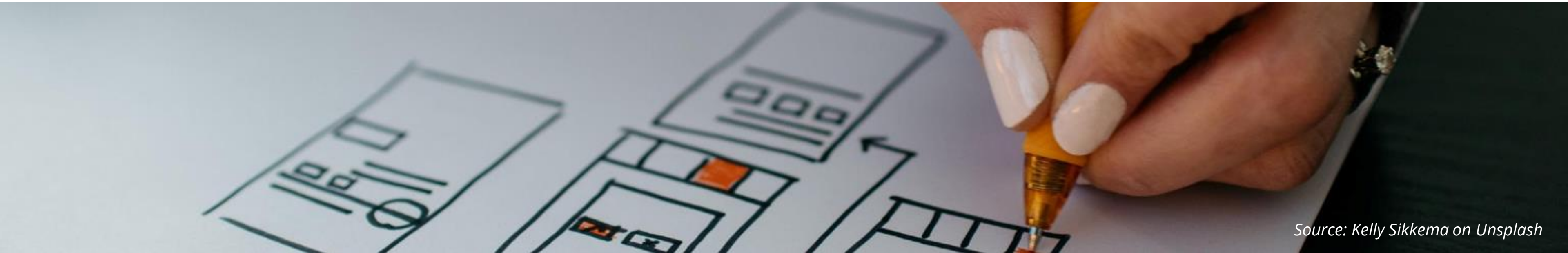
Source: Artelys

Integration of multiple RES and WH sources

REWARDHeat explores configurations of a DHC network, providing tools and recommendations for the integration of multiple renewable and waste heat sources

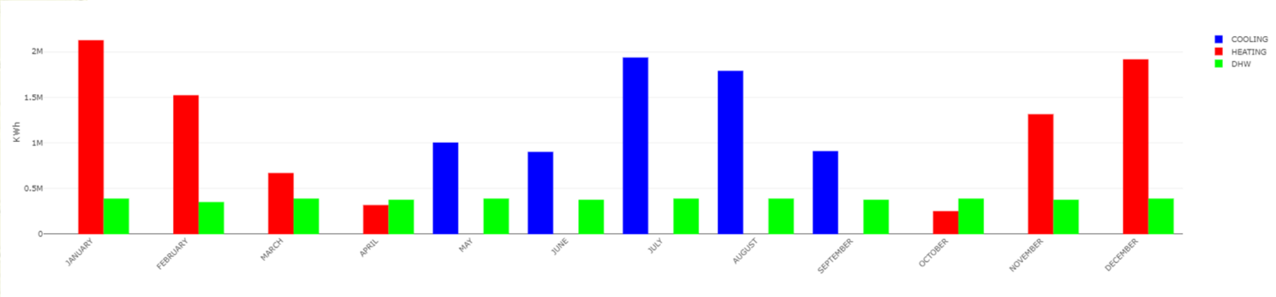
- Planning schemes and performance database
- Pre-design tool coupling Open Street Maps and deemed WH availability from industrial and tertiary sources
- Guidebook for planners





Source: Kelly Sikkema on Unsplash

DHCN Pre-design tool



Source: Kelly Sikkema on Unsplash

DHCN Pre-design tool

Source: Kelly Sikkema on Unsplash

Communication and Dissemination activities

Dedicated REWARDHeat session at SDEWES

24-29 September ‘23 in Dubrovnik

Dedicated REWARDHeat session at SES

in 2024 in Copenhagen

Policy paper to be reviewed in 2024

Training material as a wiki page to be populated

REWARDHeat

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Thank you

www.rewardheat.eu

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Introduction to

SENERGY NETS

increase the Synergy among different ENERGY NETworkS

Claudia Vannucchi

SENERGY NETS Project WP2 leader

R&D Engineer, European Institute for Energy Research (EIFER)

Sustainable Places 2023
15 June 2023, Madrid

Funded by the European Union

The story of a team…

(many researchers, developers, experts!)

Consortium

19 partners from 8 EU countries

6 - Research and Academia

(EIFER, RSE, TECNALIA, Mälardalen university, Universität Kassel, University of Ljubljana)

6 - Energy supply and services

(EDF, DALKIA, VEOLIA, A2A life company, A2A Calore e servizi, ENERGETIKA Ljubljana)

2 - DSO

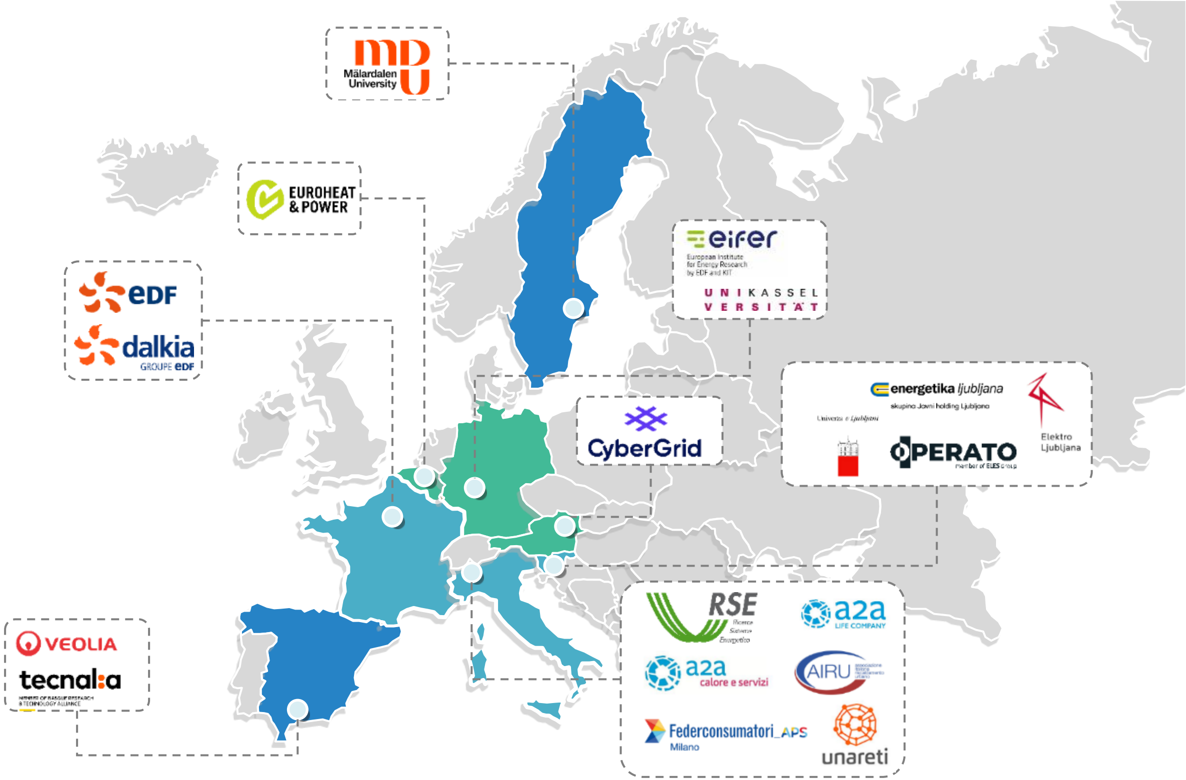
(Elektro Ljubljana, Unareti)

2 - Software provider

(CyberGrid, OPERATO)

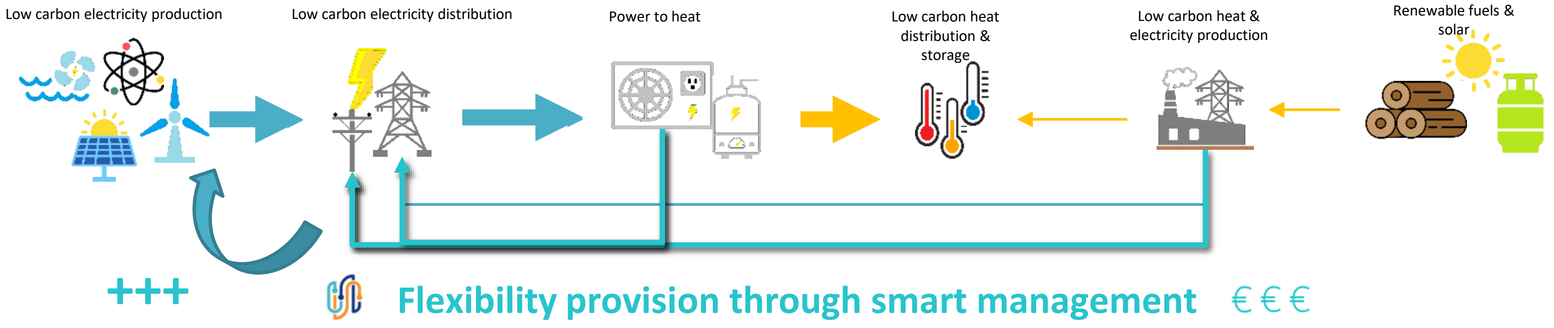
3 - Association and networks

(AIRU, Federconsumatori APS, Euroheat & Power)



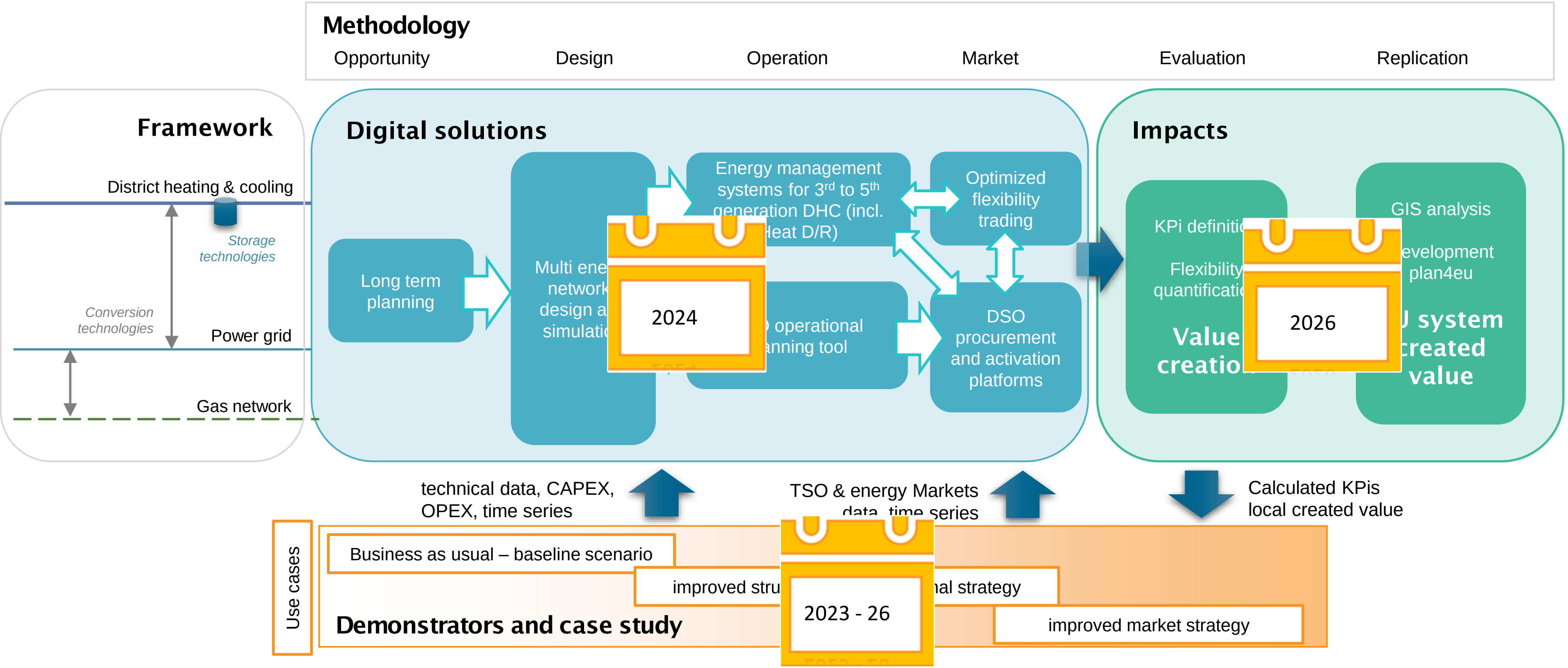
With a plan to decarbonize the energy sectors…

(At least to participate)



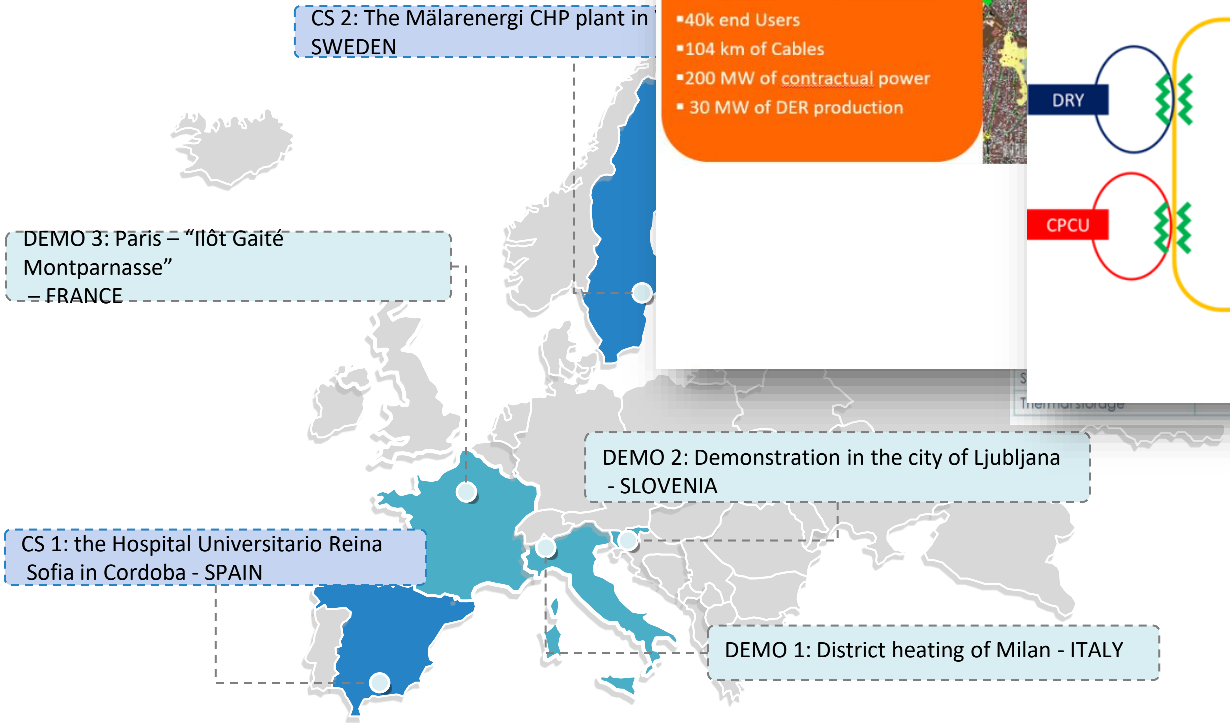
The concept

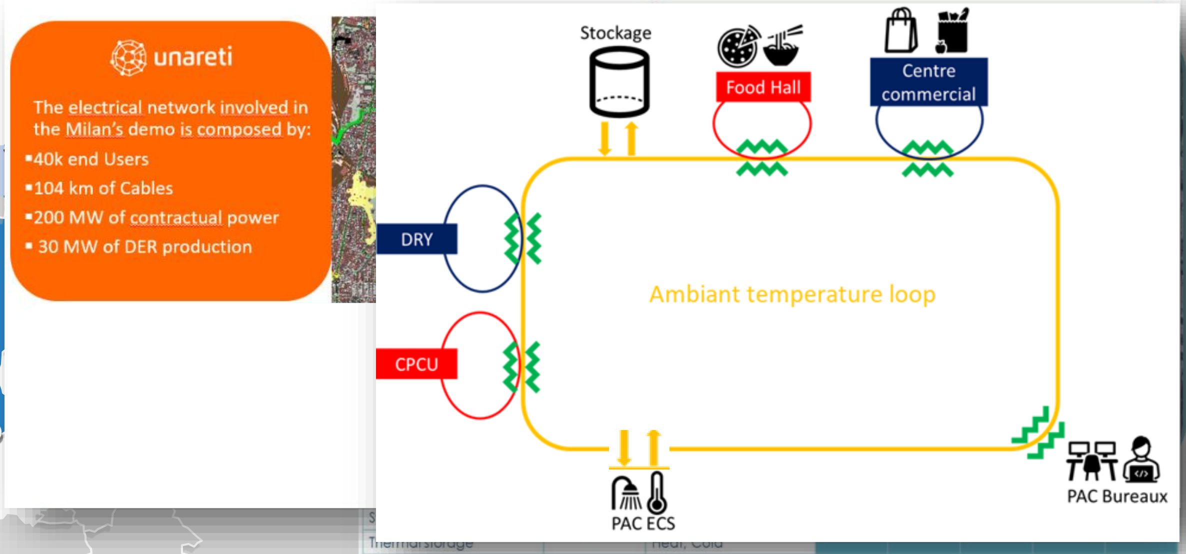
MAXIMIZE the impact by developing and applying a consolidated method to evaluate the overall created value by sector integration, and evaluating the effects of a strong replication to the EU power system and market



Using some assets…
(mainly related to DHC)

The demonstrators





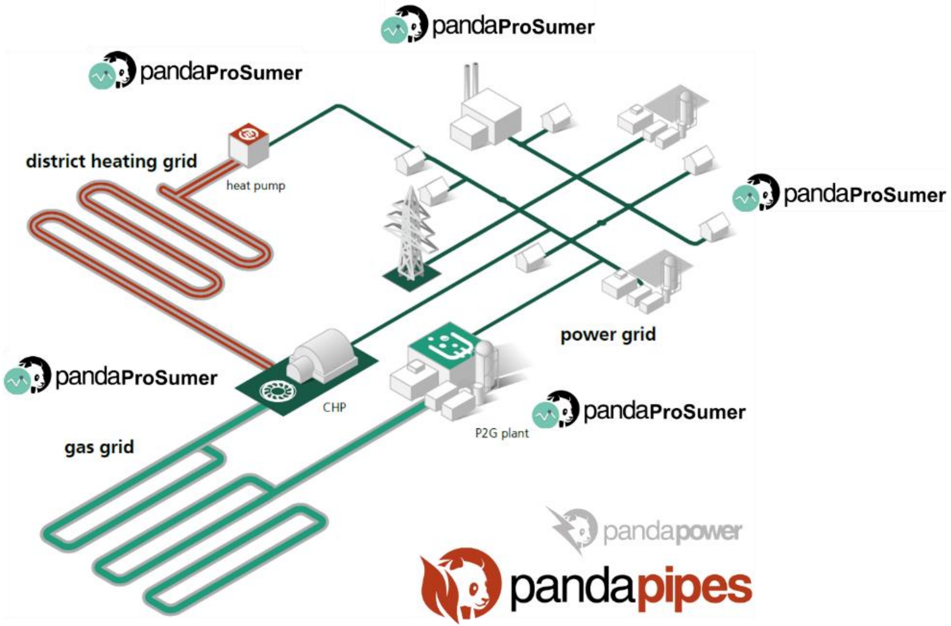
Conversion, distribution and storage technologies from the demonstrators and follow-up case studies (In light blue, technologies not part of the core test during SENERGY NETS but installed on the site or envisaged as part of simulation for medium-long term evolution)

Happy to share…

Our coming open-source model library (2024) + 15 public deliverables

Open-source library for Multi energy networks design (2024)

Technologies	Type	Energy carrier	Milano	UNILJ	Paris	Västerås	Cordoba
EV charging stations	Consumption	Elec					
CNG compressor		Elec, Gas					
Compression chiller	Conversion	Elec → Cold					
Electric boiler		Elec → Heat					
Absorption chiller		Elec, Heat → Heat, Cold					
Gas CHP		Gas → Elec, Heat					
Gas boiler		Gas → Heat					
Biogas steam reformer		Heat, Gas → Gas					
PV		RES → Elec					
Biomass CHP		RES → Elec, Heat					
Waste CHP		RES → Elec, Heat					
Geothermal		RES → Heat					
Solar thermal		RES → Heat					
Heat pump		RES, Elec → Heat, Cold					
District cooling	Distribution	Cold					
Distribution grid		Elec					
3G District heating		Heat					
5G DHC		Heat, Cold					
Stationary Batteries	Storage	Elec					
Thermal storage		Heat, Cold					



- Pandapipes et pandapower jointly developed by University of Kassel and Fraunhofer IEE
- Well diffuse language : Python
- Data analysis libraries pandas
- License BSD 3-clause (fully reusable)
- pandapower : power grids
- pandapipes : gas and thermal networks
- **Coming pandaProSumer** : conversion and storage technologies with the support of SENERGY NETS partners

R. Bolgaryn *et al.*, "Recent Developments in Open Source Simulation Software pandapower and pandapipes," *2022 Open Source Modelling and Simulation of Energy Systems (OSMSES)*, Aachen, Germany, 2022, pp. 1-7, doi: 10.1109/OSMSES54027.2022.9769084. https://ieeexplore.ieee.org/document/9769084

What role for DHC in the decarbonization of the energy system as a whole?

DHC in the future

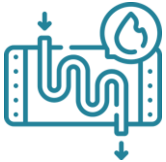
Higher integration among the energy sectors

Transition to newer DHC generation

Lower share of fossil fuel-based heating and cooling production

Role of DHC in the energy system decarbonization

Increase the energy
system flexibility



Waste heat valorization

Local renewables integration

How will end users be involved?

Smart metering and Surveys

Workshops

Surveys

Smart meters

Questions?

Thank you for your attention!

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Sustainable Places 2023

WORKSHOP – “District Heating and Cooling in the Future Energy System”

Thursday, June 15th 2023 - 9:00-12:30 - Madrid

This project has received funding from the H2020 programme under Grant Agreement No. 101036656

ABOUT THE PROJECT

HYPERGRYD

Hybrid Coupled Networks for Thermal-Electric Integrated Smart Energy Districts

Duration:
October 2021 – March 2025 (42 months)

Call: H2020-LC-GD-2-1-2020
(Research and Innovation action)

Total Cost: € 6M

Partners:
19 partners from 7 countries

TRL: 3-5

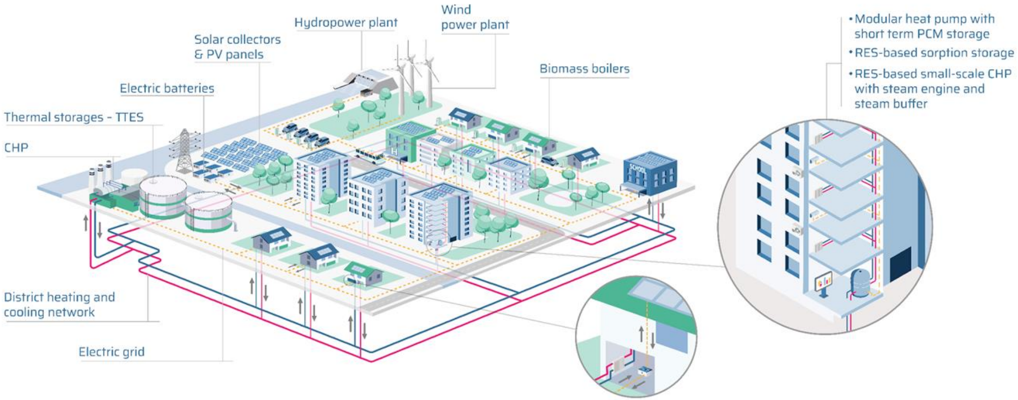
Coordinator: ARCbcn.
Francesco Milani (f.milani@arcbcn.cat)

Website:
https://hypergryd.eu/

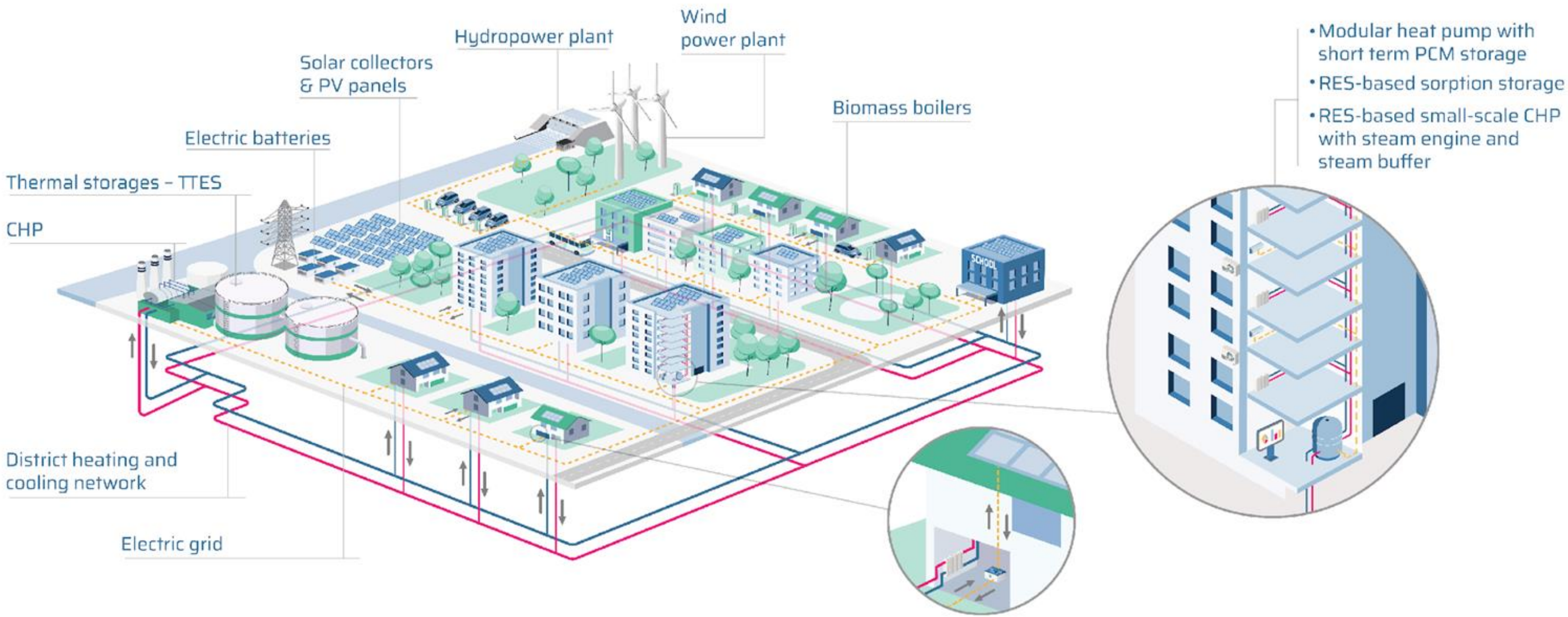
PROJECT OBJECTIVES

HYPERGRYD

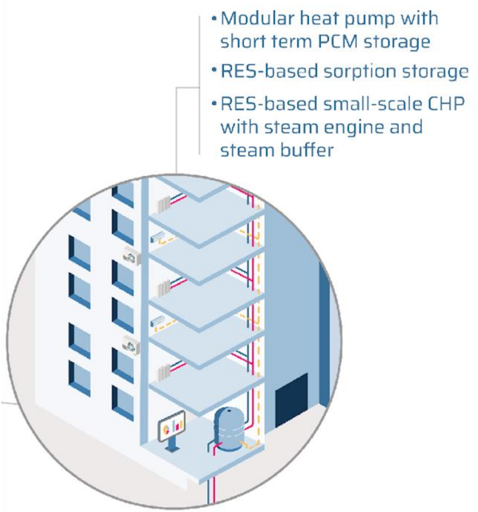
- Develop and integrate renewable-based solutions to empower the deployment of **smart hybrid energy networks**
- Optimize system design and operation
- Ensure flexibility and rapid deployment and guarantee robust and secure energy supply
- Enhance users' participation in the overall grid energy management
- Develop a single platform functioning as hub for hardware and tools testing

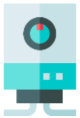


OVERALL CONCEPT



HARDWARE





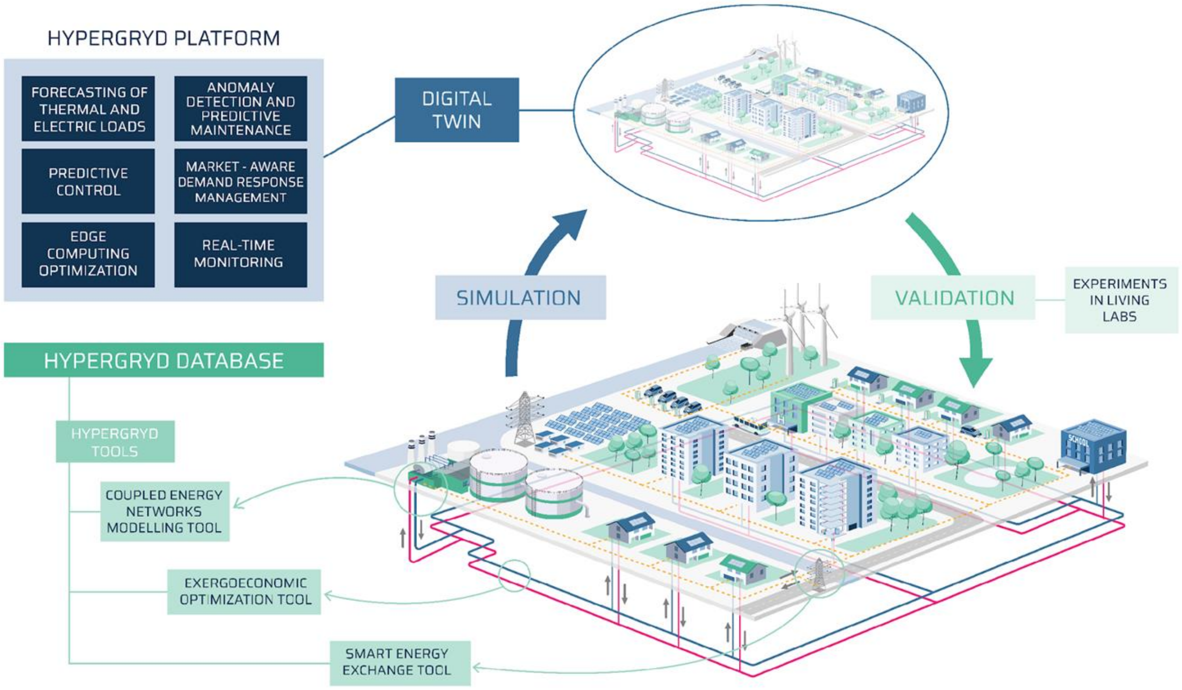
Modular Reversible
Heat Pump with short term PCM storage
- Bridge between electric and thermal worlds
- Heat and cool booster allowing lower temperature in the main DHC network
- Flexible operation: can be operated with surplus from renewables or external grid, following dynamic pricing model

Sorption Storage
- Monthly to seasonal storage applications
- Can provide heating and cooling at both high and low temperatures
- Can provide grid flexibility (ex. by storing cold during summer in combination with the heat pump)

Micro-CHP with steam engine and steam buffer
- Flexible operation
- Can be used in reversed mode

TOOLS AND SERVICES

HYPERGRYD



DEMONSTRATION

Turin (Italy) – ENVIPARK
LiL Type: Office District
Solution: ENCO dynamic simulation tool and Digital Twin

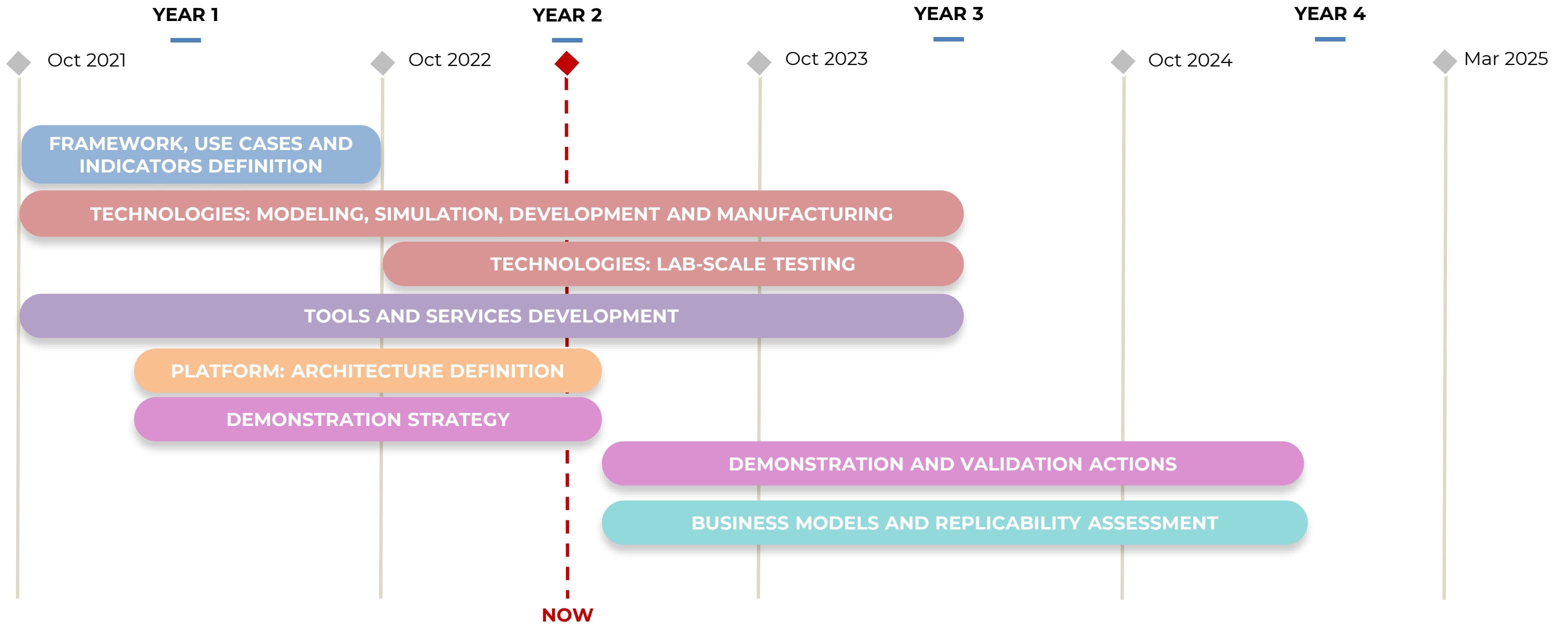
Großschönau (Austria) - SONNENPLATZ
LiL Type: Biomass-based District Heating System
Solution: GIS-BIM tool, exergoeconomic model, dynamic simulation tool and local energy marketplace

Jablonna (Poland) – KEZO Research Center
LiL Type: Laboratory and office buildings
Solution: HP with PCM storage, sorption storage, algorithms for heat pump and DHC management

Bozen (Italy) - EURAC
LiL Type: Research Lab
Solution: micro-CHP with steam engine and steam buffer

PROJECT STATUS

HYPERGRYD



FUTURE OF DHC

GENERATION: RES-based

GRID DISTRIBUTION: Low temperature, relatively close to the temperature of the ground (to use uninsulated pipes)

END-USER DISTRIBUTION: Combination of small individual heat pumps and large heat pumps to boost/decrease temperature from DHC

Tools orchestration: Exploit synergies with electric grid

Energy efficiency improvements in buildings should keep pace with DHC developments

The EU energy sector is moving towards electrification

DHC role in future EU energy sector

Solution: DHC

- Higher efficiency compared to individual H&C solutions
- Possibility to reuse waste heat-cool
- Sector coupling

End-users involvement and challenges

HYPERGRYD

- Facility managers, district and construction manager: define future investment for the transition to a 4^{th}–5^{th} generation DHC with high–RES share

- Building owners, tenants, occupants: looking at the project's developments and impact on daily life (thermal comfort, air quality etc).

Challenges:

- Interest
- Understanding of technologies, tools, policies
- Being open to a change of paradigm

Future possible common activities

HYPERGRYD

- **Policy workshop**: could address issues such as incentives and subsidies, grid integration, decarbonization targets, and building codes and standards.
- **Business Models and Financing Workshop**: An interactive workshop exploring innovative business models and financing mechanisms for district heating and cooling projects.
- Discussion on **technical challenges for feed-in** of local heat/cold into DHC networks (temperatures, pressures.)

This project has received funding from the H2020 programme under Grant Agreement No. 101036656

Thank you for your attention

HYPERGRYD