



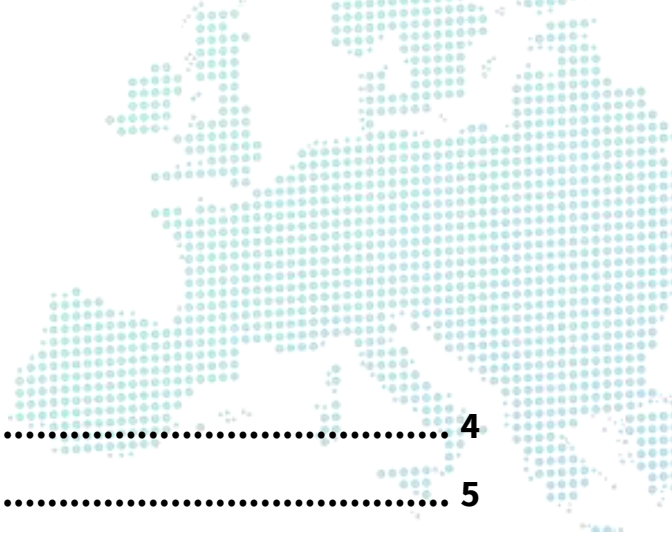
Guidance for group support

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1 Introduction

This document outlines the content of the nine webinars conducted as part of the Act!onHeat project within Support Facility 1 (SF1). Detailed notes for each webinar are provided below the respective presentation slides, offering explanations and context for the material presented.

The group support webinars offered valuable insights and fostered peer learning among Act!onHeat project participants, helping municipalities and regions enhance their heating and cooling planning. The table below provides an overview of the nine webinars, including topics, participant numbers, dates, durations, and links to each session's guideline document.

Table 1 Overview of the webinars

#	Topic and content	Nr. participants	Date and duration
W1	<u>Data for municipal heating and cooling planning</u> W1 explored data accessibility challenges in H&C planning, emphasizing data handling and the use of the Hotmaps platform to support strategic policy development and implementation.	7 – 10	03.11.2022 09:00 – 11:00
W2	<u>Development of a data inventory for heat planning</u> W2 covered dynamic data inventories and heat atlases for H&C planning, highlighting data resolution, geospatial visualization, validation, and strategies to address data gaps and prioritize planning zones for implementation.	7 - 10	17.11.2022 13:00 – 15:00
W3	<u>The use of Hotmaps for strategic heat planning</u> W3 presented the Hotmaps platform, a free tool for H&C strategy development, showcasing its features, use cases, and limitations for energy and climate planning.	4 - 7	06.12.2022 13:00 – 15:00
W4	<u>Use of Industrial Excess Heat (EH) for district heating</u> W4 explored reusing industrial excess heat for district H&C, covering industry types, mapping projects, planning tools, and applications like Hotmaps for cost and infrastructure planning.	6 - 13	05.06.2023 12:00 – 13:30
W5	<u>Using EH from data centers for heating buildings</u> W5 examined data centers as EH sources for district heating, emphasizing urban locations to reduce recovery costs and the use of heat pumps with European heating networks.	8 - 14	13.06.2023 12:00 – 13:30
W6	<u>The use of excess heat from wastewater treatment plant</u> W6 The webinar highlighted low-temperature wastewater, boosted by heat pumps, as a sustainable and cost-effective solution for district H&C, benefiting municipalities environmentally and economically.	3 - 10	27.06.2023 12:00 – 13:30
W7	<u>Geothermal in District heating</u> W7 highlighted geothermal energy as a low-emission, flexible, and region-specific solution for sustainable DHC systems.	5-13	13.03.24 10:00–12:00
W8	<u>Space Cooling– demands, potential reduction, and sustainable supply opportunities</u> W8 examined Europe's rising cooling demand, highlighting energy reduction measures, system efficiency, and EU policies driving sustainable cooling for decarbonization.	8-10	17.06.2023 11:00 – 12:00
W9	<u>Existing heat planning policies in Europe-overview and selected examples</u> W9 detailed Europe's EED heat planning policies, emphasizing efficient systems, strategic zoning, public engagement, and alignment with decarbonization goals.	8-15	11.10.2024 11:00 – 12:00

2 Documentation of the Webinars



Webinar 1: Data for municipal heating and cooling planning

Act!onHeat SF1

Time: 150 min

- Serial 1:
 - Webinar 1
 - Strategical Heating & Cooling planning
 - Group support for municipalities and stakeholders

Presented by:

- TU Wien / Austria
- e-think / Austria

Agenda

Part I: Policy challenges, policy questions and related data needs

- Input presentation (15 min) – Different cases, practice examples
- Interactive part (35 min)
 - Online questions (5 min) – Which cases are relevant for you?
 - Discussion in break-out rooms (20 min) – Data needs for setting priority zones
 - Summary in the main room (10 min)

Part II: Open data in the Hotmaps platform

- Input presentation (10 min) – Overview of available data
- Interactive part (35 min)
 - Online questions (5 min) – Which data is most interesting for you?
 - Discussion in break-out rooms (20 min) – How to potentially make use of the available data in your case?
 - Summary and finish in the main room (10 min)

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The quality of data available largely defines the depth in which a strategic heating plan can be developed. The webinar focuses on the data needed for developing a heating and cooling plan, what is already available with the municipalities, and what proxy data can be used in case of unavailability.

Part I:

- Discussion on defining the different policy-level questions to be answered for the development of the heating and cooling plan and the respective data requirements.

Part II:

- Overview of the open-source data available in the Hotmaps database and discussion on its potential application for the development of strategic heating and cooling plans.

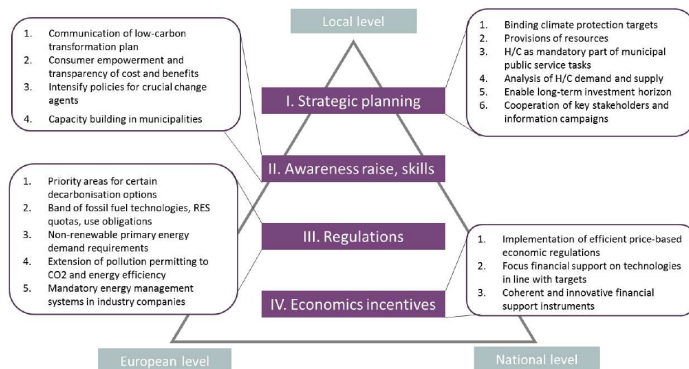
PART I

Policy challenges, questions and data needs

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Overview of Policy Recommendations for H/C



• H/C aspects that need to be addressed:

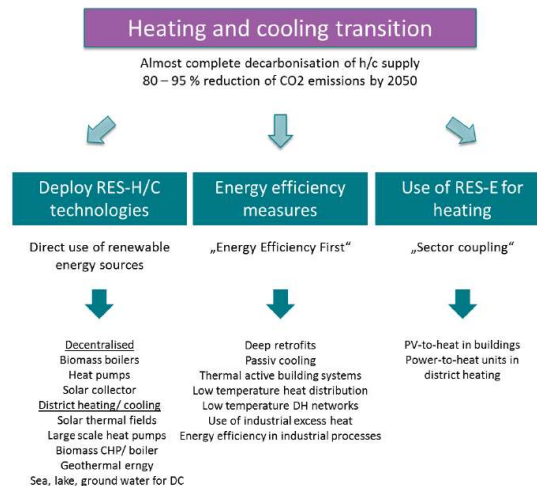
1. Overall heating and cooling demand
2. Heating and cooling demand in buildings
3. Process heating and cooling demand
4. Electricity supply



- To provide policy recommendations to support policymakers to develop and implement an appropriate technology at the local and regional level
- Policy recommendations can be set up on three geographic levels covering the four aspects
- Local-level data is also important for national-level planning. Therefore, iterative planning on a local level is needed. However, national planning needs to have a more global perspective, and local planning considers these aspects [3. pg.53].

Recent trends in the heating and cooling sector

- Target Framework: Regulatory emissions towards low carbon systems on local/regional and national levels [2]
- Demand
 - Retrofitting options
- Supply
 - Solar thermal combined heating and cooling systems
 - On-site bioenergy technologies
 - Heat pumps
 - RE powered district heating and cooling. Tapping locally available resources
 - Heat Recovery



Source: progRESsHEAT, 2017

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- Recent trends in the heating and cooling sector are directed towards the three aspects of target framework, demand reduction, and diversifying the supply portfolio with improved integration of renewable energy.
- The main aspects of the heating and cooling planning process include the following steps:
 - Preparation and orientation
 - Collection of Data
 - Quantitative Analysis
 - Prioritization and decision
 - Implementation and Monitoring

Common Policy Questions and Challenges

How can GHG emissions in buildings be reduced to match the EU/national targets?

How can the heating/cooling demands in the buildings be reduced? (promoting building renovations)

How can the share of renewable energy be increased in the heating and cooling sector?

How can district heating coverage be increased? (reducing the costs of DHC, benchmarking efficiency of district heating grids)

How to transform the existing heat network towards 4th generation?

How can individual heat pumps be implemented on a large scale in the region?

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The Process of Defining the Policy Questions

- Questions need to be practical

What is a policy question?

- Policy questions focus on the actions rather than the acquisition of knowledge
- Practical questions
- The answer is a statement that says what needs to be done... (should answer the “how” question)
- Many underlying research questions need to be answered to address the policy question in an informed manner.

Formulating a policy question:

- Problem Setting
- Policy Formulation
- Scenario Analysis
- Decision Making

Better collection of public data under GDPR constraints. Tracking the consumption patterns

Link policy questions to energy efficiency obligations (EEO) according to the EED

Answering the policy questions and Challenges

Pathways...

- Quantify heat demand
- Assess and quantify the availability of resource in the area
- Assess and quantify the potential of heat savings in the area
- Identify balance between investments in heat supply and savings
- Align national, regional and local energy plans
- Develop technical alternatives and scenarios

Strategies ..

- R&D & demonstration policies
- Fiscal policies such as tax exemption and reductions and carbon tax
- Pricing policies such as Feed-in tariffs
- CHP feed-in premiums and quantitative policies such as obligations
- Certification schemes with minimum quotas and building procurements

Bottleneck

- Lack of resources (funding, human resource)
- **Data Gaps**
- Lower acceptance of change
- Restricted authority (building renovation cannot be enforced)

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Answering the policy questions requires the definition of concrete pathways and a detailed definition of strategies to achieve the targets.

Obstacles for strategies of decarbonization:

- Economic barriers [technology costs, fuel prices, sensitivity, lack of economizing of scale)
- Structural barriers (slit incentives, lack of supply change)
- Technical barriers (suitability of building stock and lack of supply technologies)
- Psychological barriers (lack of awareness, hassle factor)
- Lack of data
- Need for policy mix including regulatory, economic, and other complementary policies [3]

The availability of data is a significant bottleneck that has been identified for this step based on experience and discussions with the relevant local authorities.

This presentation aims to discuss and highlight measures to overcome these bottlenecks.

Overcoming the data gap (pushing for data collection-examples)

- **The Netherlands** for example, the **legislation forces all the energy utility companies** to publish the effective consumption of small clusters of buildings, which are usually composed of 15-20 delivery points. This measure facilitates urban planning at district level by cities
- **UK:** Local governments can receive **grants from Heat Network delivery Unit perform feasibility studies** and related early stages of infrastructure development.
- **Denmark zoning** by local authorities^[3]
- **Dublin, Ireland** uses **archetype based categorization** for modeling demand and also estimating the renovation potential based for residential. For non-residential, crude demand estimation based on the floor area.
- **Munich, Germany** building **volumes** measurements (using laser) especially for non-public buildings are carried out to estimate the heat demand and a **3D map used for detailed DH planning**
- All non-sensitive building information and sensitive energy consumption data should be made available to municipal workers with heat planning and energy optimization. The respect to GDPR is therefore essential;^[3]

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Source : [1]



A collaborative effort is needed from national, regional, and local authorities to fill this gap in data.

[3] pg 53.

Local-level data is also essential for national-level planning. Therefore, iterative planning on a local level is needed. However, national planning needs a more global perspective, and regional planning considers these aspects.

Case 1: Strategic Decision Making

Area	Objective	Data Used
EU – all MS	Objective: Improve database on current and potential future demand and supply for H/C Activity: Mapping H/C current and future demand and scenario for supply until 2030 (Fraunhofer ISI et al. 2017)	<ul style="list-style-type: none"> heating demand on a national level split up to different building archetypes heating and cooling energy demand for different industries (national) National GDP, employment, investment costs, benefits- baseline) existing subsidies for H&C in place current national level energy mix solar thermal potential (national)
EU – selected MS	Objective: Develop efficient and effective policy instruments for driving implementation of nZEB standard, find replicable solutions for different countries in the EU Activity: Policy evaluation and optimisation for developing strategies to uptake nZEBs (TUW-EEG,2016)	<ul style="list-style-type: none"> information regarding market development and characteristics of nZEBs was collected renovation activities and quantity on national level national level building stock data
National level	Objective: Provide a scenario of full decarbonisation of EU heating and cooling until 2050 Activity: A scenario of an EU with net-zero greenhouse gas emissions and its implications (UBA 2019)	<ul style="list-style-type: none"> Baseline emission data Total residential GFA Specific heating and cooling demand for residential (average)
Regional / local level	Objective: Develop local and regional H&C strategies Activity: Hotmaps – Open-Source Tool for mapping and planning in Heating and Cooling	<ul style="list-style-type: none"> Hectare level data on heat and cold demand generated for all EU-27, updated with local data based on estimated demand in buildings for case studies Estimation of resource potentials based on EU studies and other local studies Costs and prices from national level discussed with stakeholders

Based on the type of policy questions being answered, the overall strategic heating and cooling planning process is categorized into the 4 cases discussed in the current and following slides.

Strategic policy decision requires a clear long-term vision. This vision can be developed/assessed based on technical scenarios, which in turn require reliable data.

Preparation of Municipal Energy Plan

- Step 1: Political willingness
- Step2: Stakeholder engagement at an early stage
- Step3: Defining the policy questions
- Step 4: Define long-term goals to be achieved
- Step 5: Mapping à data on municipality consumption to develop a reference scenario; Data on the demand, potential resource mapping, building energy performance, energy performance in buildings
- Step 6: Analysis step Reanalyzes the initial steps to re-confirm decarbonization goals and visions and prioritize the decarbonization opportunities[**technology costs**] for developing the vision and goals based on which scenarios are developed
- Step 7: Analyze the extent of the national framework and address the discrepancies with the national framework; Respect GDPR [3]

Input data comprise the main drivers, policy parameters, structural information, and a massive set of technology parameters, including behavioral assumptions [4]

Case 2: Specific Decisions on Priority Zones

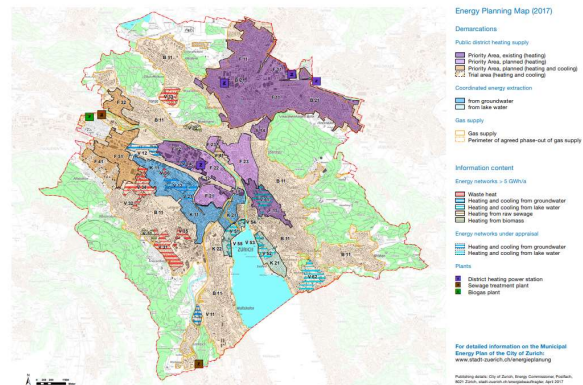
Objective

- Identify District Heating Zones
- Identify areas for retrofitting focus
- Local RE utilization (geothermal, solar)

Data Inputs—geospatial data

- Public district heating supply
- Gas Supply
- Resource potentials in the region
 - Ground water
 - Raw Sewage
 - Lake Water
 - Industrial waste heat
 - Biomass

Examples: **Zurich** identification of priority zones, **Denmark** to achieve low cost heating resulting from a high connection rate.



Source: [6]

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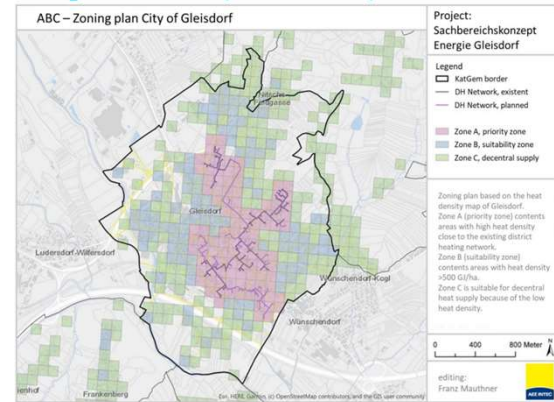
- Data reliability at a level that allows not only informed policy decisions but also ensures that the decision holds in case a party decides to challenge the district heating zone in court.
- Ideally, compare calculated/estimated data with (normalized) measured consumption data.

Case 2: Specific Decisions on Priority Zones (contd..)

- Combining urban planning and energy planning- Spatial Energy Planning an innovative tool
- Data collection included:
 - Geoinformation systems
 - Spatial datasets
 - Local energy requirements

Results provided overview on

- State of renovation in buildings
- Distribution and type of heating systems
- Energy source used
- Demand and emissions in the area
- suitability and priority areas for district heating supply
- potentials for the expansion and integration of biomass, heat pumps, solar thermal and PV systems, waste heat utilization



Source [8]

The results provide an overview of the optimal level of measures to be implemented based on the geographical location

Case 3: Detailed technical design of network

City	Jelgava	Berlin	Alba Iulia
Scale	Entire City	16 buildings	Few neighboring buildings
Objectives	Reduce CO2 emissions and increase energy efficiency and RE supply.	Phase out coal powered district heating by 2030	Reduce building Energy demand
Data used (Source; Type)	<ul style="list-style-type: none"> • Building footprint (OSM; Public) • Network Path (OSM; Public) • LIDAR (Municipality; Private) • Building demand (Thermos Default) • Heating Tariff (Heating Service Provider; Public) • Pipe costs (Fortum and external experts; Private) 	<ul style="list-style-type: none"> • Building footprint (Data from district heating provider; Private) • Network Path (OSM; Public) • LIDAR (Berlin Lidar Data) • Building demand (Calculation based on VDI 2067; Private) • Heating Tariff (Heating Service Provider; Private) • Pipe costs (Thermos Default Data) 	<ul style="list-style-type: none"> • Building footprint (OSM; Public) • Network Path (OSM; Public) • Building demand (Thermos Default) • Heating Tariff (Real data; Private) • Pipe costs (Thermos data; Public)

Source: [5]

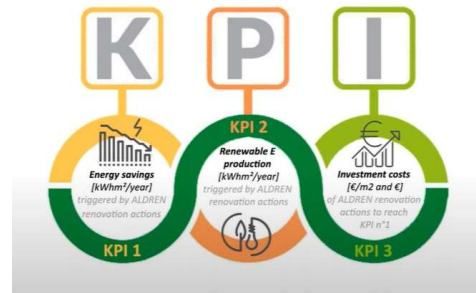
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Three distinct case studies demonstrate how varying levels of data availability and quality can significantly influence the final analysis and outcomes. Each case underscores the importance of tailoring the approach based on the data at hand.

The technical design process involves developing a customized layout and determining appropriate pipe sizes for the network. This step is highly case-specific, as it depends on the unique requirements and constraints of each scenario. Comprehensive guidance is provided in **SF2** within the **Act!on Heat** project.

Case 4: Deploy Building Renovation Passports

- The ALDREN BRP as a tool:
 - To inform and motivate building owners/investors to undertake renovation
 - By which the government can bring tangible support to customers
 - Common European Solution
- Components of the BRP
 - LogBook: collection of data to better inform owners about current technical energy
 - RenoMap: Tailored renovation roadmap to reach desired energy performance levels
- B-log is a digital repository that includes building's (ownership, building design, materials used, structures, installations, systems, adaptations, investment, operational and maintenance costs, health and safety, performance indicators, certifications, etc.) → provides accessible comparative analysis



Source: [7]

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The development of the building renovation passport enables the tracking of the existing status of the buildings and allows better planning and investment in the renovation strategies.

One such example of successful implementation of the building renovation passport: The ALDREN BRP core concept consists in the dual element of the passport: the ALDREN BuildLog and the ALDREN RenoMap, which make the passport a complementary tool to the EPC with the aim to increase owners' awareness about the current technical energy performance status of their building and support them for its regular daily operation, coupled with a tailored made renovation roadmap which provides an assessment of three main KPIs represented in Figure above.

PART I – Interactive Session

- Online questions (5 min) – Which cases are relevant for you?
- Discussion in break-out rooms (20 min) – Data needs for setting priority zones
- Summary in the main room (10 min)

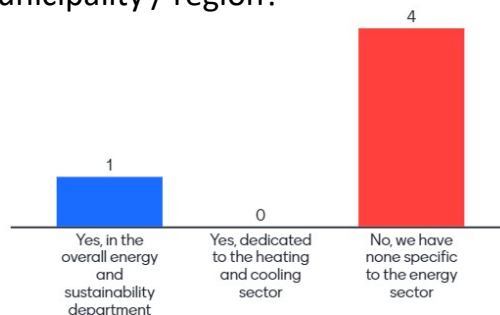
4 rooms
~2 regions per room

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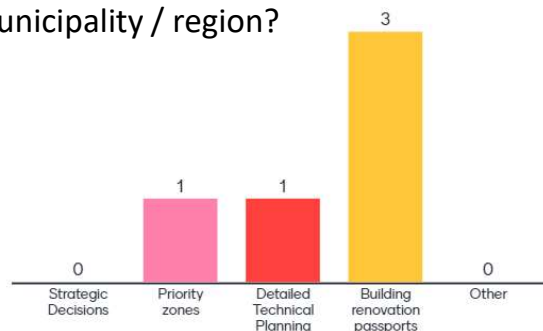



A mention-meter poll was presented to see which of the cases were of most interest to the applicants.

Are there dedicated human resources / departments for data collection and processing in your municipality / region?




Which policy question category do you see as the most fitting area for immediate intervention in your municipality / region?





	Case 1: Strategic decisions	Case 2: Setting priority zones	Case 3: DH technical planning	Case 4: building renovation passports
Data on existing heat / cold demand	<ul style="list-style-type: none"> Regional energy balance (aggregated) Hectare level data for assessing district heating potentials (Calculated / measured demand data on single building level) 	<ul style="list-style-type: none"> Calculated demand data on single building level Calculated demand data validated with measured consumption data 		
Costs of heat distribution / DH vs. individual supply	<ul style="list-style-type: none"> Estimation on hectare level based in heat demand density, gross floor area Comparison of DH supply costs with individual supply costs 	<ul style="list-style-type: none"> Estimation of heat distribution costs: <ul style="list-style-type: none"> Estimation based on type of district Estimation on hectare level based in heat demand density, gross floor area Estimation based on street level Account for location of currently existing network Comparison of DH supply costs with individual supply costs <ul style="list-style-type: none"> for a single area vs. for entire city Using estimations of future prices vs. current prices ... 		
Data on resource potentials (renewable energy [RE] and heat sources)	<ul style="list-style-type: none"> Total RE potential in the region available Profiles for solar irradiance, temperatures of heat sources, ... 	<ul style="list-style-type: none"> Location of potential resources and estimation based on literature study Potential estimation based on measurements and (pre-feasibility studies) Mix of both 		
Data on demand reduction potentials	<ul style="list-style-type: none"> Costs and potentials for heat demand savings in different building archetypes 	<ul style="list-style-type: none"> Costs and potentials for heat demand savings in different building archetypes allocated over the city area ... 		

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The table was filled with the inputs from the participants. The columns show the 4 cases, the rows represent the categories of data required. Efforts were made to identify the specific data required for each case, leveraging the expertise and experience of the participants.

PART II

Open data in the Hotmaps platform

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	Case1: Strategic Planning	Case 2: Setting Priority Zones	Case 3: DH Technical Planning	Case 4: Building Passports
Data on existing heat cold demand	<ul style="list-style-type: none"> Heat demand and gross floor area density maps (default) database on existing building stock in EU countries (spec. energy demand, construction, ...) hourly heat load profiles for NUTS2 regions (residential, tertiary, industrial) 	<ul style="list-style-type: none"> database on existing building stock in EU countries (spec. energy demand, construction, ...) (hourly heat load profiles for NUTS2 regions (residential, tertiary, industrial)) 	<ul style="list-style-type: none"> database on existing building stock in EU countries (spec. energy demand, construction, ...) (hourly heat load profiles for NUTS2 regions (residential, tertiary, industrial)) 	
Costs of heat distribution / DH vs. individual supply	<ul style="list-style-type: none"> Heating technology data (costs, efficiencies, lifetime, ...) Hourly electricity prices for 2040, 2050 for full decarbonisation pathways (different scenarios, at NUTS0 level) 	<ul style="list-style-type: none"> Heating technology data (costs, efficiencies, lifetime, ...) Hourly electricity prices for 2040, 2050 for full decarbonisation pathways (different scenarios, at NUTS0 level) 	<ul style="list-style-type: none"> Hourly electricity prices for 2040, 2050 for full decarbonisation pathways (different scenarios, at NUTS0 level) 	
Data on resource potentials	<ul style="list-style-type: none"> wastewater treatment plants biomass residues (industrial excess heat locations) benchmark data industry (demand and excess heat) shallow geothermal potential solar thermal and PV on rooftop or standalone 	<ul style="list-style-type: none"> wastewater treatment plants biomass residues benchmark data industry (demand and excess heat) (shallow geothermal potential) (solar thermal and PV on rooftop or standalone) 		
Data on demand reduction potentials	<ul style="list-style-type: none"> scenarios for heat demand reduction at local level based on national level scenarios 			

Here the same table is shown but the cells are filled with data that is available within the Hotmaps dataset. These can be used as proxy data for the planning process, but the use of locally available data is highly recommended wherever possible for higher accuracy and reliable results.

PART II – Interactive Session

- Online questions (5 min) – Which data are most interesting for you?
- Discussion in break-out rooms (20 min) – How to potentially make use of the available data in your case?
- Summary in the main room (10 min)

4 rooms
~2 regions per room

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Based on the inputs of the participants, no concrete structure, regulation or granularity on the data needs for the different cases could be identified. Thus, to conclude, the implementation of the energy plan is largely influenced by the local political structure. If favorable political environment is set in place the implementation of plans can be carried out with minimal data availability.



Thank you.



This project has received funding from the EU's Horizon 2020 programme under grant agreement no 101033706.



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Sources

- [1] <https://decarbcitypipes2050.eu/2021/07/22/the-data-driven-future-of-heat-planning/>
- [2] <https://www.odyssee-mure.eu/events/workshops/vienna/heating-policies-policy-brief.pdf>
- [3] literature-Policy support for heating and cooling decarbonization
- [4] Renewable space heating under the revised renewable energy directive
- [5] https://www.thermos-project.eu/fileadmin/user_upload/THERMOS_City_Case_Studies_Oct2020.pdf
- [6] Energy Planning Map, City Zurich, 2017
- [7] <https://aldren.eu/building-renovation-passport/>
- [8] https://www.researchgate.net/publication/337758104_Urban_energy_modelling_as_a_basis_for_futur_e-oriented_city_planning





Webinar 2: Development of a data inventory for heat planning

ActlonHeat SF1

Time: 154 min

- Serial 1:
 - Webinar 2
 - Strategical Heating & Cooling planning
 - Group support for municipalities and stakeholders
- Presented by:
 - e-think / Austria
 - TU-Wien / Austria

Agenda

Part I: Policy challenges, policy questions and related data needs

- Very short recap of the first webinar

Part II: Development of a data inventory at regional level for Austria (GEL/SEP)

- Input presentation:
 - Slideshow (overview, data model, validation, harmonization, module development, GDPR issues, validation, visualization, automatic reports)
 - Examples of results (Plausibility notebook, heat atlas, district report)
- Questions & Discussion:
 - Questions always possible, chat or orally
 - Focus of oral discussion potentially after specific blocks have been presented
 - Open discussion at the end

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Part 1

- Recapitulation of Webinar 1:
 - Heating & Cooling policy parameters for strategical planning.

Part 2

- Presentation of Austria data inventory developed at the regional level.
 - Platform that joins together many data sources, with the idea to use it for Heating & Cooling planning at different levels for decision-making.

PART I

Policy challenges, questions and data needs

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Case 1: Strategic Decision Making

Area	Objective	Data Used
EU – all MS	Objective: Improve database on current and potential future demand and supply for H/C Activity: Mapping H/C current and future demand and scenario for supply until 2030 (Fraunhofer ISI et al. 2017)	<ul style="list-style-type: none"> heating demand on a national level split up to different building archetypes heating and cooling energy demand for different industries (national) National GDP, employment, investment costs, benefits- baseline) existing subsidies for H&C in place current national level energy mix solar thermal potential (national)
EU – selected MS	Objective: Develop efficient and effective policy instruments for driving implementation of nZEB standard, find replicable solutions for different countries in the EU Activity: Policy evaluation and optimisation for developing strategies to uptake nZEBs (TUW-EEG,2016)	<ul style="list-style-type: none"> information regarding market development and characteristics of nZEBs was collected renovation activities and quantity on national level national level building stock data
National level	Objective: Provide a scenario of full decarbonisation of EU heating and cooling until 2050 Activity: A scenario of an EU with net-zero greenhouse gas emissions and its implications (UBA 2019)	<ul style="list-style-type: none"> Baseline emission data Total residential GFA Specific heating and cooling demand for residential (average)
Regional / local level	Objective: Develop local and regional H&C strategies Activity: Hotmaps – Open-Source Tool for mapping and planning in Heating and Cooling	<ul style="list-style-type: none"> Hectare level data on heat and cold demand generated for all EU-27, updated with local data based on estimated demand in buildings for case studies Estimation of resource potentials based on EU studies and other local studies Costs and prices from national level discussed with stakeholders

Four different cases

Case 1

For solid policy decisions access to data is necessary:

- Strategic policy decision requires having a clear long-term vision.
- This vision can be developed/assessed based on technical scenarios, which in turn require data (reliable data..)

The strategic decision can be at different levels:

- European Union (EU)
- Member State (MS)
- National
- Regional

The levels determine the direction and extent of the decisions.

Case 2: Specific Decisions on Priority Zones

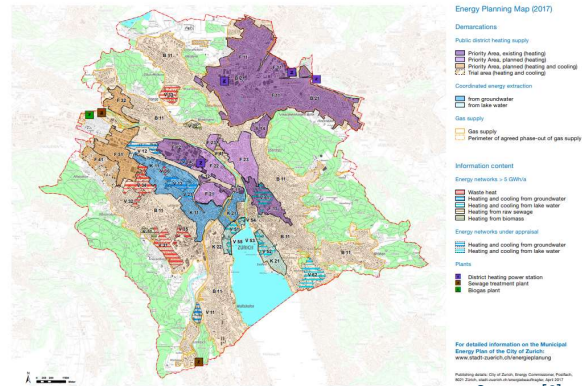
Objective

- Identify District Heating Zones
- Identify areas for retrofitting focus
- Local RE utilization (geothermal, solar)

Data Inputs—geospatial data

- Public district heating supply
- Gas Supply
- Resource potentials in the region
 - Ground water
 - Raw Sewage
 - Lake Water
 - Industrial waste heat
 - Biomass

Examples: **Zurich** identification of priority zones, **Denmark** to achieve low cost heating resulting from a high connection rate.



Source: [6]

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Case 2

Priority of zones is needed for policy.

- Different zones should be compared.
 - Data reliability on a level not only allows solid policy decisions, but also assures holding a decision in case district heating in a zone is challenged in a court.
 - Ideally, compare calculated/estimated data with (normalized) measured consumption data.

Case 3: Detailed technical design of network

City	Jelgava	Berlin	Alba Iulia
Scale	Entire City	16 buildings	Few neighboring buildings
Objectives	Reduce CO2 emissions and increase energy efficiency and RE supply.	Phase out coal powered district heating by 2030	Reduce building Energy demand
Data used (Source; Type)	<ul style="list-style-type: none"> • Building footprint (OSM; Public) • Network Path (OSM; Public) • LIDAR (Municipality; Private) • Building demand (Thermos Default) • Heating Tariff (Heating Service Provider; Public) • Pipe costs (Fortum and external experts; Private) 	<ul style="list-style-type: none"> • Building footprint (Data from district heating provider; Private) • Network Path (OSM; Public) • LIDAR (Berlin Lidar Data) • Building demand (Calculation based on VDI 2067; Private) • Heating Tariff (Heating Service Provider; Private) • Pipe costs (Thermos Default Data) 	<ul style="list-style-type: none"> • Building footprint (OSM; Public) • Network Path (OSM; Public) • Building demand (Thermos Default) • Heating Tariff (Real data; Private) • Pipe costs (Thermos data; Public)

Source: [5]

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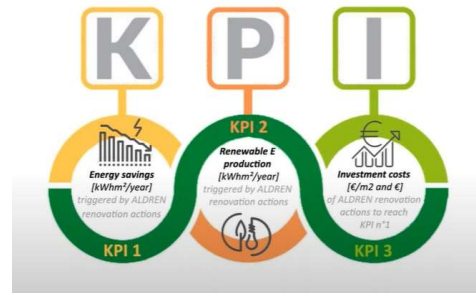
Case 3

Technical design is needed for policy.

- Comparison of design for different development projects
 - Scale:
 - Shows how a district heating network in a specific area looks like.
 - Objectives:
 - Depending on the time projection of the policy
 - Data:
 - Different levels of data affect the final analyses and results

Case 4: Deploy Building Renovation Passports

- The ALDREN BRP as a tool:
 - To inform and motivate building owners/investors to undertake renovation
 - By which the government can bring tangible support to customers
 - Common European Solution
- Components of the BRP
 - LogBook: collection of data to better inform owners about current technical energy
 - RenoMap: Tailored renovation roadmap to reach desired energy performance levels
- B-log is a digital repository that includes building's (ownership, building design, materials used, structures, installations, systems, adaptations, investment, operational and maintenance costs, health and safety, performance indicators, certifications, etc.) → provides accessible comparative analysis




Source: [7]

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Case 4


Specifications of (building-related) local conditions are needed for a policy.

- Single building level
 - Data collection of single buildings for policy development
- The ALDREN BRP:
 - The core concept consists of the building renovation passport (BRP): ALDREN LogBook and the ALDREN RenoMap, which make the BRP a sort of complementary tool to the EPC to increase owners' awareness about the technical energy performance of their building and support them for regular daily operations, coupled with a tailored made renovation roadmap which provides an assessment of three main KPIs as shown in the Figure.



	Case 1: Strategic decisions	Case 2: Setting priority zones	Case 3: DH technical planning	Case 4: building renovation passports
Data on existing heat / cold demand	<ul style="list-style-type: none"> Regional energy balance (aggregated) Hectare level data for assessing district heating potentials (Calculated / measured demand data on single building level) 	<ul style="list-style-type: none"> Calculated demand data on single building level Calculated demand data validated with measured consumption data 		
Costs of heat distribution / DH vs. individual supply	<ul style="list-style-type: none"> Estimation on hectare level based in heat demand density, gross floor area Comparison of DH supply costs with individual supply costs 	<ul style="list-style-type: none"> Estimation of heat distribution costs: <ul style="list-style-type: none"> Estimation based on type of district Estimation on hectare level based in heat demand density, gross floor area Estimation based on street level Account for location of currently existing network Comparison of DH supply costs with individual supply costs <ul style="list-style-type: none"> for a single area vs. for entire city Using estimations of future prices vs. current prices ... 		
Data on resource potentials (renewable energy [RE] and heat sources)	<ul style="list-style-type: none"> Total RE potential in the region available Profiles for solar irradiance, temperatures of heat sources, ... 	<ul style="list-style-type: none"> Location of potential resources and estimation based on literature study Potential estimation based on measurements and (pre-feasibility studies) Mix of both 		
Data on demand reduction potentials	<ul style="list-style-type: none"> Costs and potentials for heat demand savings in different building archetypes 	<ul style="list-style-type: none"> Costs and potentials for heat demand savings in different building archetypes allocated over the city area ... 		

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Hotmaps has default data sets that can be used to start Heating & Cooling planning.

- Data for existing Heating & Cooling demand.
- Data on the cost of heat distribution vs. individual supply
- Data on resource potential
- Demand reduction potential

And can be applied for:

- Case 1: Strategic decisions (explained in Webinar 1)
- Case 2: Priority zones (explained in Webinar 1)
- Case 3: Technical planning
- Case 4: Building renovation

PART II

Development of a data inventory at regional level for Austria (GEL/SEP)

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SPATIAL ENERGY PLANNING (SEP)

A Green Energy Lab (GEL) project

17 November 2022

Mostafa Fallahnejad


























Experiences from other projects

- Project: Spatial Energy Planning (SEP) – An Austrian flagship project in heating and cooling planning in three Federal States of Vienna, Styria and Salzburg
- Objective of the presentation: Share experiences about Heating and Cooling planning in other regions.

- Introduction to the Spatial Energy Plan (SEP) project
 - Overview & expected results
 - Use-cases
 - Project steps
- Data model for SEP & data management plan
- Harmonization of data and methods
- Plausibility check of results
- GDPR aspects
- Validation process
- Exemplary project results:
 - Heat atlas
 - Automatic reports

Relevant information for the presentation

Overview of the expectation

- Expected result of the project
- The use cases
- Expectations of the Stakeholders and steps to meet the expectations

Overview of the steps:

- Data model and DMP
- Harmonization of the data and methodology
- Plausibility check
- GDPR aspects
- Validation process

Exemplary project results

- Heat atlas
- Automatic reports

- A research initiative for sustainable energy solutions and part of the innovation offensive „Vorzeigeregion Energie“ ("Flagship region Energy") of the Austrian Climate and Energy Fund.
- Austria's largest "innovation laboratory" for green energy:
 - With about five million end users, more than 300 participating partners from research, industry and the public sector, together with energy providers.
- By 2025, Green Energy Lab will have invested 150 million euros in innovative projects.
- <https://www.greenenergylab.at/>

Green Energy Lab: Spatial Energy Planning (GEL-SEP)

- What is Green Energy Lab:
 - A research initiative for sustainable energy solutions and part of the innovation offensive „Vorzeigeregion Energie“ ("Flagship region Energy") of the Austrian Climate and Energy Fund.
 - Austria's largest "innovation laboratory" for green energy:
 - With about five million end users, more than 300 participating partners from research, industry and the public sector, together with energy providers.
 - By 2025, Green Energy Lab will have invested 150 million euros in innovative projects.

- Spatial energy planning (SEP) has the potential to become the game changer for the heating sector
 - Use of SEP in public governance instruments can make a significant contribution to the necessary support, coordination and cost-effectiveness of investment and financing in the heat transition.
- Aim of the project:
 - Develop all necessary basics for the implementation of Spatial Energy Planning in selected administrative processes of seven demo municipalities and the three pilot regions of Styria, Vienna and Salzburg.
 - Provide available up-to-date data with building-related information, harmonized concepts and models, a heat atlas to show site-specific renewable energy potentials and energy zones as a basis for public governance tools
- Project website: <http://www.waermeplanung.at>

Spatial Energy Planning for Heat Transition

Besides the content of the slide, further information can be extracted from the project website: <http://www.waermeplanung.at>



Spatial Energy Planning for Heat Transition

- Phase II of the project started in October 2021 with additional focuses on mobility and electricity sector
- With regards to the heat transition, the proof of concept was demonstrated in phase I. Phase II, therefore, deals with improvement of existing processes and methods.
- Certain aspects of the Phase I, which were not fully covered before, were shifted to Phase II.
- Focus of this webinar is the spatial energy planning for heat transition.



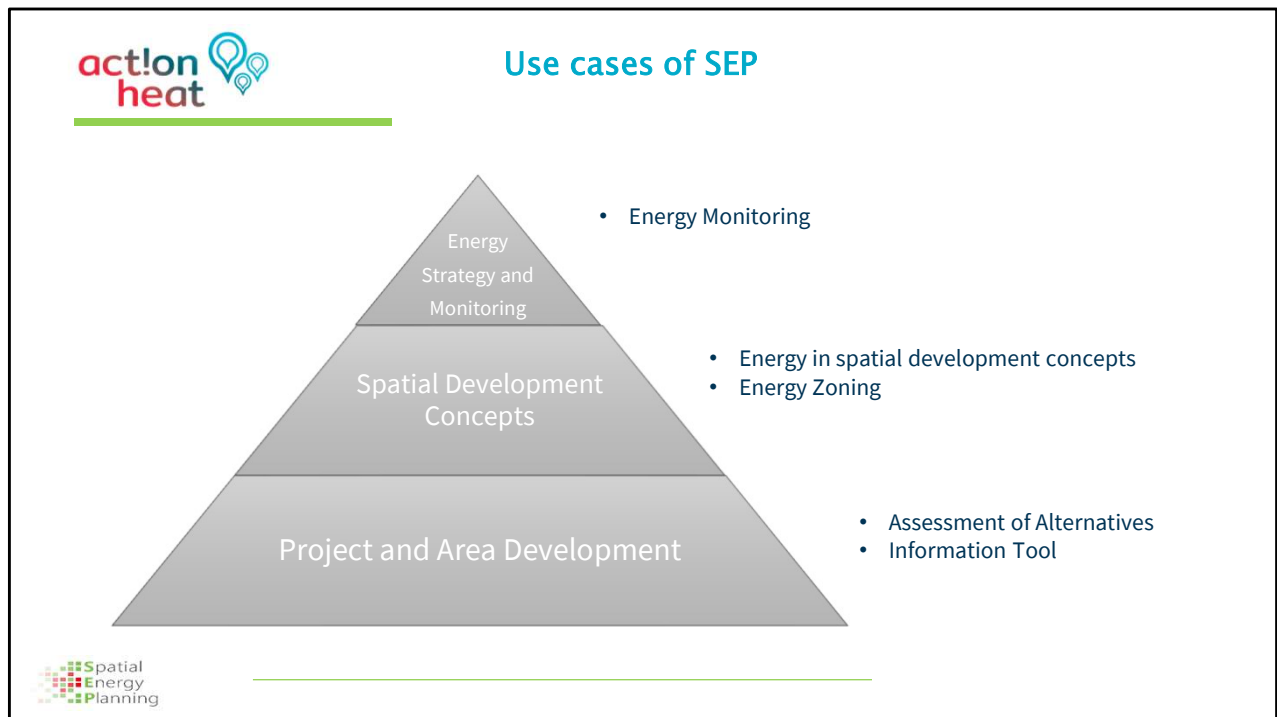
The project started in 2018

- The project started in 2018 and currently is run in its second phase.
- First phase of the project dealt with heat transition and partially is followed in the second phase.
- Focus of this webinar is the heat transition part.

VIENNA	STYRIA	SALZBURG
Area Screening and site request	Energy in spatial development concept	Energy in spatial development concept
Energy-Info for Districts	Assessment of energy supply options	Assessment of energy supply options
Enhancement of spatial energy plans in demo district	Zoning/Commitment for connection to DHS	EnergyAPP
Refurbishment hot-spots in demo district	Strategy & Monitoring	Expert Analysis
Enhancement of energy typologies	Focus area of TU Wien	Energy Reports
Economic assesment of energy supply options		Spatial Differentiation of Subsidies
Complementation by additional topics of Electricity and Mobility		Energy Consultancy
Energy Concepts for Quarters		
Spatial Differentiation of Subsidies		

Users of the project

- Public authorities were the focus group of the study.
- TU Wien was in charge of the authorities of Vienna.
- The table shows the user needs and expectations from the project.



Pyramid of SEP user cases

The pyramid shows the importance and priorities in SEP.

Energy Strategy and Monitoring:

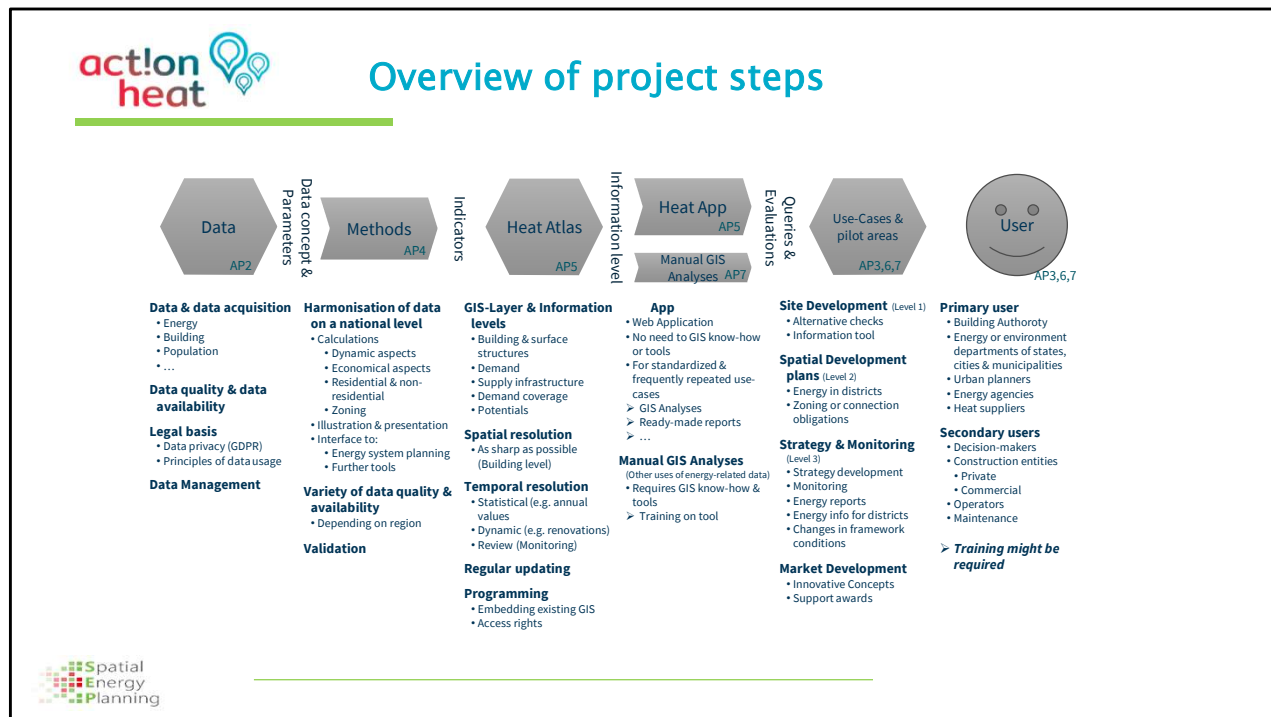
- Analyze the status of Heating and Cooling demand in an area and what the plans are there.

Spatial Development and concepts:

- Discover which areas could be relevant for district heating and if it is possible to define district heating zones.

Project and Area Development:

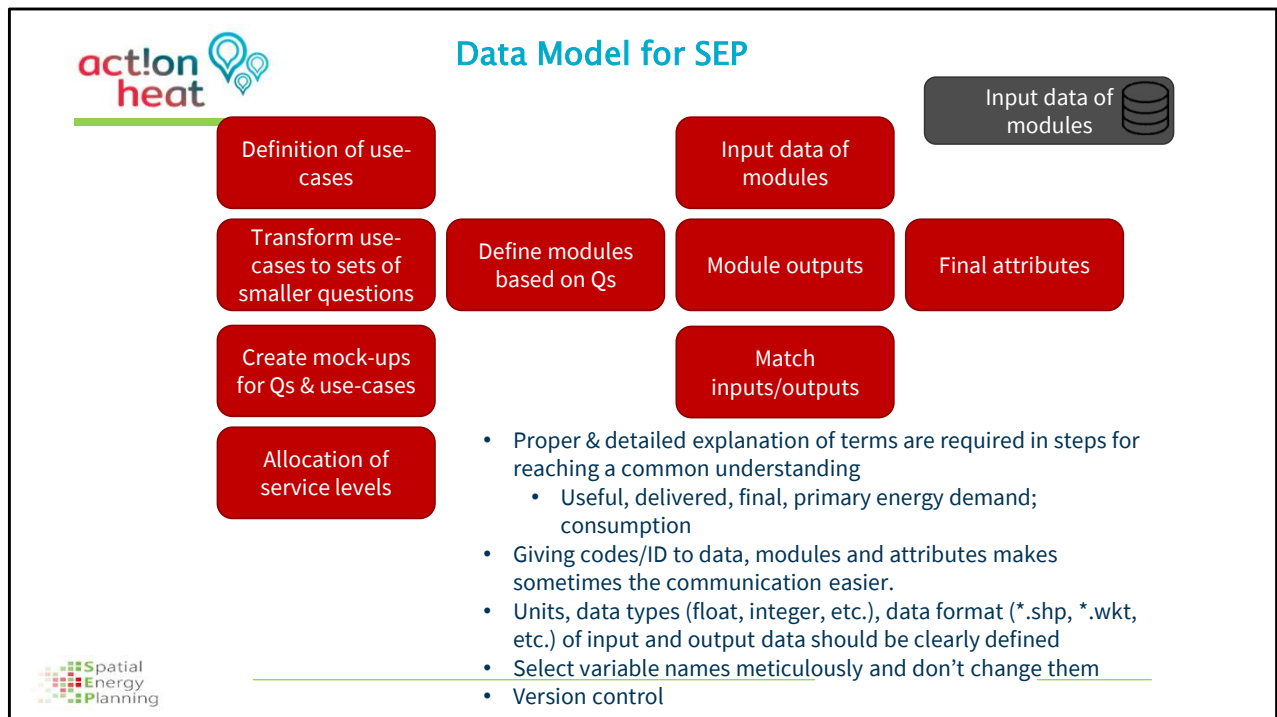
- Provide information to assist or give alternatives to the stakeholders.



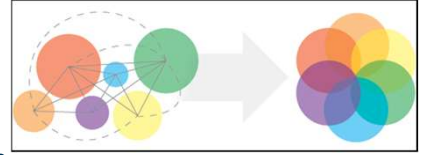
To answer the use cases questions:

Several steps were developed, starting with data and ending with user needs.

- **Data:** All relevant information for the state's Energy Planning. Different resolutions and formats, legal parameters to use them, and data quality was understood and compere to know how to update and join together.
- **Methodology:** Develop a methodology to use the data for the user's interest. Considering different background data in different states, the method should harmonize data. To use the data, the method should provide also a harmonized outputs.
- **Heat Atlas:** The data were ordered and visualized for the users. Different data were shown for different uses in different forms. Different accessibility levels can be defined.
- **Heat App:** Application to generate standard reports.
- **Use cases and users:** can be defined for different parts and functionalities in Heat Atlas and Heat App.



Data model to answer the user needs and cover use-cases



- Data are not available uniformly every where.
- Some regions may also have additional data sets
- Outputs might be expected on different levels (point/polygon)
- Harmonization of methods
 - *Similar calculation approach for diverse aspects*
 - Heat demand and heat density
 - RES potentials
 - Grid infrastructure
 - Dynamic aspects, Zoning und Economics
 - *Possible usage of similar data sets on a national level*
 - Adaptation of methodologies based on the use-cases in each state
 - *Gathering ideas on methods from experts*
- Harmonisation of illustrations
 - *Similar units, intervals and colours*
 - *Comparison of GIS Systems in each state and possibility for harmonising outputs for them.*

Importance of the harmonization of results

It is necessary to harmonize the input/output data, approach, and results presentation.

This will bring interoperability and common understanding of the outcomes.

- A data management plan would help to structure the whole data processes.
 - *Data inventory:*
 - Where to save all data?
 - Metadata (Data package)
 - *Naming conventions:*
 - How to name the files in the database so that they can be easily findable?
 - *Data Formats*
 - *Spatial and temporal resolutions*
 - *License*



Credit: Image: WrightStudio - stock.adobe.com

Data management plan contributes in structuring the data processing and can help to save available resources.



- Automatize as much as possible for this step.
 - *This will be need by any update in the input data sets.*
- You may need to remove irrelevant entries from input data (e.g. garages and not heated buildings)
 - *A proper documentation of all changes made is always required.*
- Keep track of the number of entries
- Check duplicate entries:
 - *Check identifiers of data sets (any duplicate ID?)*
 - *In case of GIS data, check the overlapping geometries.*
- Check data attributes
 - *Diversity: e.g.>*
 - *"MUNICH", "Munich", "munich", "München", "Muenchen"*
 - *"2/1", "2 / 1", "2/ 1", "2 / 1 -", "24 - 28"*

Garbage in -> Garbate out

Not only the methodology and output results should be proofed, but, more importantly, the input data has to be checked for any possible mistakes.

- Calculations should be done with a small sample set.
 - *This saves calculation time especially that in the development phase, you may need to test and adapt the methods and codes again and again.*
 - *This, however, does not guarantee that your module will run without any error on the whole data set.*
- It is a „MUST“ to use version control:
 - *GitHub or GitLab*
 - *Meaningful commit messages*
 - *Regular releases*
 - Or at least after a milestone
 - Testing of the modules only after releases
- Development should respect previously implemented mock-ups, units, input/output matching:
 - *Always refer to the version of mock-ups in the commits*
 - *Update of mock-ups and codes can be done shoulder to shoulder.*



GitHub



Good practice for developing modules:

- Run your module on a small sample set of data to check the functionalities and once smaller errors were resolved, apply the tool to a larger data set.
- Version controlling in tool development is a must. Provide regular releases as you advance.
- Mock-ups helps to bring everyone to the same level of understanding.

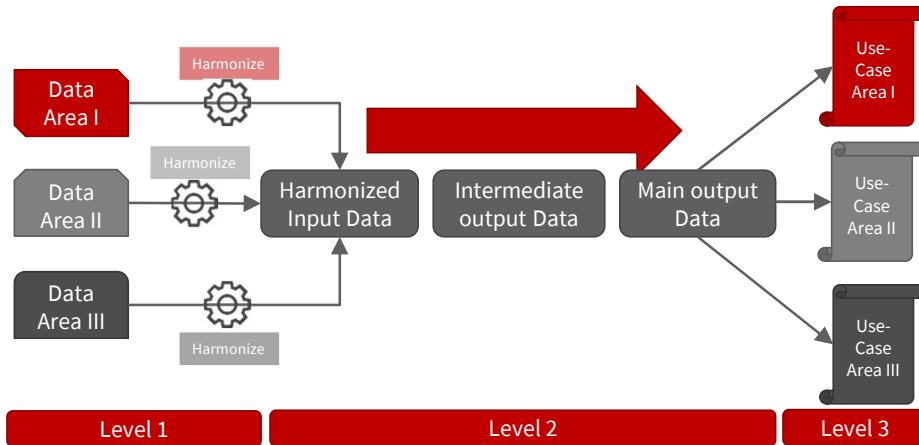
- Regular meetings:
 - *One short meeting with the participation of all team members for reporting:*
 - Implemented work
 - Upcoming work
 - Challenges
 - *Thematic meetings with the participation of relevant parties:*
 - Dealing with a specific module, data or mock-up

Common understanding

Necessary for the module development phase:

- Regular group meeting update
- Discussion about problems in meetings
- Understanding other approaches
- Specific topics/problems can be addressed bilaterally in smaller round of people

- In order to harmonize the same module for different regions with different use-cases, a three-level approach was used.



Harmonization of the module development

Level 1

Generate harmonized data out of different data sets.

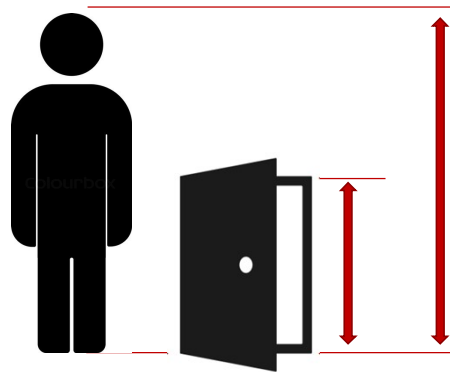
Level 2

Apply same methodology on the data

Level 3

Address the use-cases in the outputs

- The input data require a quality check. ✓
- The output data require a plausibility and validity check



Plausibility

Check if:

- the obtained indicators are in the ranges that they should be.
- If there is any strange behavior in the output data.

Plausibility checks

Before validating the outputs, they should be checked for plausibility.

- Of course, data visualization on maps is a great approach for plausibility check of output data.
- This is a great approach for random check of inputs and outputs.
- However, it is very difficult to check all buildings visually on the map.
 - *In Vienna, there are around 200.000 buildings.*
 - *Even color coding does not help much!*
- For the plausibility check of the results cases, we developed a different tool in a Jupyter Notebook.



Approach to visualize data

TU Wien developed a tool to generate graphics dynamically.

This was implemented in a Jupyter Notebook.

Thanks to the dynamic development approach, the notebook could be kept brief, but still very rich.

GDPR – Legal background

Source: Geissler S, G. Charalambides A, Hanratty M.
Public Access to Building Related Energy Data for
Better Decision Making in Implementing Energy
Efficiency Strategies: Legal Barriers and Technical
Challenges. *Energies* 2019;12:2029.
<https://doi.org/10.3390/en12102029>

GDPR is interpreted slightly differently in different EU Countries:
AT, DE are restrictive while DK (and UK) are more open.

Non-personal data: Geodata,
Open Governmental Data



Environmental Information Directive 2003/4/EG
INSPIRE Directive 2007/2/EG
PSI Directive 2003/98/EG

Building address and other energy
related technical building
information is under open data
legislation

Personal data: Lawfulness of
processing applies



GDPR Article 6 paragraph 1 letter f:
processing is necessary for the purposes
of the legitimate interests

Combination with civil register and
income data for targeted policy
development is under the GDPR

GDPR

The interpretation of the General Data Protection Regulation GDPR differs in European countries.

- Some are more restrictive, like Austria
- Some more open, like Denmark

Building-related information is not part of GDPR; when combined with other data, it is considered protected data. Nevertheless, it can still be used in some instances.

- Questions:
 - *When is a data under the GDPR?*
 - *If a data is under GDPR, which of the conditions for legal data processing applies?*
- The principles of data protection should apply to any information concerning an **identified or identifiable natural person**
- The principles of data protection should therefore **not apply to anonymous information**, namely information which does not relate to an identified or identifiable natural person or to personal data rendered anonymous in such a manner that the data subject is
- An **identifiable natural person** is one who can be identified, directly or indirectly, in particular by reference to an identifier such as a name, an identification number, location data, an online identifier or to one or more factors specific to the physical, physiological of that natural person.
- **range of interpretation regarding "identifiable"** interpretation
 - Address of the building is linked with the building → geodata
 - Registered address of a person in the civil register → personal data
 - → building related EPC data are open data

GDPR Aspects

In general:

- GDPR does not apply to the building data.

In particular:

- Each country has interpretation parameters for personal data.
- If you have personal identifiable data, then this data is protected.

- All the obtained results should be validated.
- Validation is done, for example, via comparing the calculated demand values in SEP with consumption data.
- However, due to the GDPR, we are not allowed to access consumption data.
- For this purpose, an approach was developed to validate data in cooperation with Wiener Netze (Viennese gas grid operator).
 - *Consumption data are final energy demand at counter points.*
 - *A counter may supply one or more buildings*
 - *The heat demand calculation however was done on building level (not address level)*
 - *For the validation a sample set is required **Why?***

Validation of results

Following the plausibility checks, the outputs should be validated as well.

In Austria, heat supplier companies do not provide consumption data of their customers due to the GDPR.

In such cases, alternative, less-accurate approaches need to be developed.

	Count	Share
Total entries	231.552	100%
filtered out buildings	157.472	68%
After cleaning	74.080	32%
with mixed use	15.416	6%
with single use	58.664	25,3%

- To compare the demand data from SEP with the consumption data of Wiener Netze, we should prepare a sample that:
 - *Composed of buildings that are solely supplied with natural gas.*
 - *Make sure that those buildings have only a single use type (e.g. only residential or only commercial; but not combined)*
- The building data set was cleaned to keep only relevant data:
 - *Footprint > 50 m²*
 - *Heated gross floor area > 50 m²*
 - *Nr. Of floors < 65*
 - *No missing information for:*
 - Construction period,
 - Main use
 - No “NaN” values.

Validation of results

For the validation of data, constructive cooperation with all relevant parties, especially the energy suppliers and grid operators is necessary.

In this slide and the next few ones, the steps for the validation of results of SEP tools are presented.

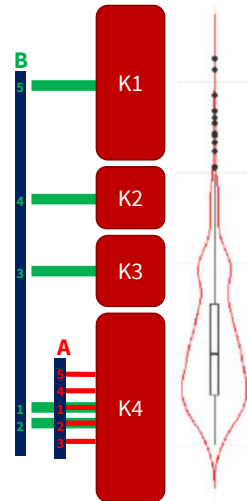
In this process, the Wiener Netze, the gas grid operator in Vienna, was involved.

PARAMETER FOR CLASSIFICATION	UNIQUE CASES
CONSTRUCTION PERIOD	10
USE	14
RENOVATION STATUS	3
FOOTPRINT	5
COMBINATIONS	2100

- The 2100 combinations are not existing the the data set.
 - *Only 76 combinations with more than 100 entries*
 - *Only 219 combinations with more than 10 entries*
 - *Only 318 combinations with more than 5 entries*
 - From which 26 combinations with just 5 entries

- ▶ Sample ID X:
 - Construction period CP1, Use type U1, Renovation status R1, Footprint F1
 - Use natural break algorithm for breaking the entries under ID X to 4 categories
 - **Sample Set A:**
 - Find the category with highest number of entries.
 - Selection of median and 4 of its immediate neighbours
 - **Stichprobe Set B:**
 - Selection of Median of each category
 - 2 entries from largest category

Sample ID X
(heated GFA - distribution)



Validation of results – join and aggregate

- The selected entries of each class (building polygons) should join the gas counters (address points).
- Calibration on HDD is required afterwards.

Sample ID	Sample Set	Building ID	Wiener Netze Identifier	Demand [MWh]
1	A	BWID0	OLAVID0	D0
1	A	BWID1	OLAVID1	D1
1	A	BWID2	OLAVID2	D2
1	A	BWID3	OLAVID3	D3
1	A	BWID4	OLAVID4	D4
1	B	BWID5	OLAVID5	D5
1	B	BWID6	OLAVID6	D6
1	B	BWID7	OLAVID7	D7
1	B	BWID8	OLAVID8	D8
1	B	BWID9	OLAVID9	D9
...

Sample ID	Sample Set	Agg. demand (SEP) [MWh]	Agg. Consumption (Wiener Netze) [MWh]						
			2015	2016	2017	2018	2019	2020	2021
1	A	X	X1	X2	X3	X4	X5	X6	X7
1	B	Y	Y1	Y2	Y3	Y4	Y5	Y6	Y7
...

- Once the calculations are completed, the results can be shared with different groups within municipalities.
- It is possible to define different permission levels for different users.
 - *Limited access to certain data*
- Advantages of heat atlas:
 - *No need to GIS know-how*
 - Simple object query by clicking on a feature
 - *Access permission and limitation*
 - *Pre-defined themes:*
 - No need to update of the symbologies and layer legends
 - Pre-selected view of data
 - *Immediate update due to the connection to the database*

Heat Atlas as output

Once the calculations are completed, and all necessary plausibility and validity checks were finished, the results can be shared with different groups within municipalities

- Two types of automatic reports were developed:
 - *District report*
 - Vienna has 23 districts.
 - The report is composed of a template with a set of keywords which their corresponding query is run on the database and substitute in the report.
 - *Area report*
 - A jupyter notebook where the user can select one or more regions (polygons) and queries is run for selected areas.

Automatically generated reports

The idea is that police makers can access the information to monitor different zones or areas without dealing with the knowledge of codes, data, or methodology.

- If possible, strive for long-term sustainable solutions of building the dataset (i.e. automatic integration of data sources and continuous update instead of one-shot data set solutions)
- Include validation/plausibility procedures in the whole set-up
- Include all relevant persons/institutions/departments, including DSOs, utilities, ...
- Effective procedures are crucial:
 - *Use of version-control based platforms (GitHub, etc.)*
 - *Set up regular meetings between targeted users (e.g. energy planning department of the municipality), data providers (might be other departments of the municipality) and the technical implementation*
 - *Orientation towards the targeted end-use and the long-term sustainability of the system/data platform*

Lessons learned from the SEP project

As stated in the slide.



Thank you.

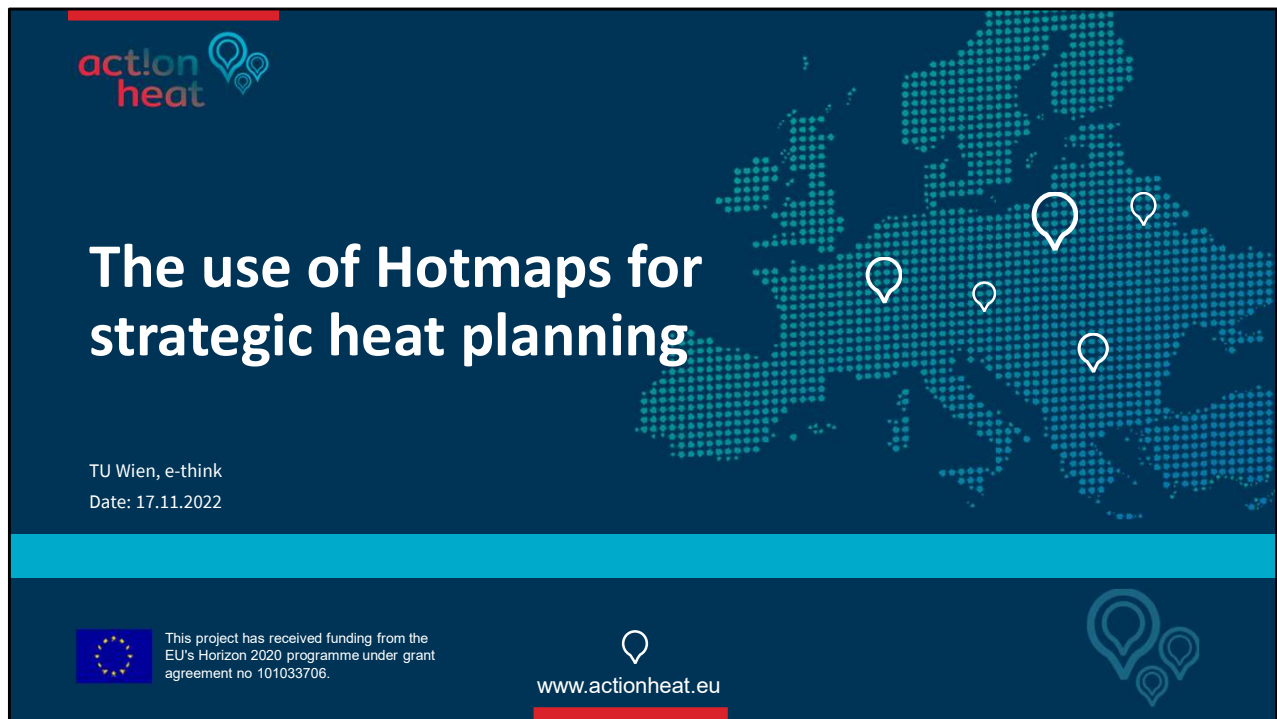


This project has received funding from the EU's Horizon 2020 programme under grant agreement no 101033706.



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Webinar 3: The use of Hotmaps for strategic heat planning

ActlonHeat SF1

Time: 1 h 19 min

- Serial 1:
 - Webinar 3
 - Strategical Heating & Cooling planning
 - Group support for municipalities and stakeholders
- Presented by:
 - e-think / Austria
 - TU-Wien / Austria

Agenda

Welcome

- I. Strategic heat planning in the vision of Act!onHeat**
Short recap of previous webinars and the ramp-up call
- II. The Hotmaps Platform**
Overview of the project (development, platform, dataset, wiki)
- III. Live demonstration of the Hotmaps Toolbox**
Presentation of the functionalities (features, layers, calculation modules, account)
- IV. Individual exercise**
- V. Further training material**



Part 1

- Recapitulation of Webinars 1-2

Part 2

- Preview to Hotmaps.

Part 3

- Live introduction to the Hotmaps tool

Part 4

- Interactive use of Hotmaps with participants

Part 5

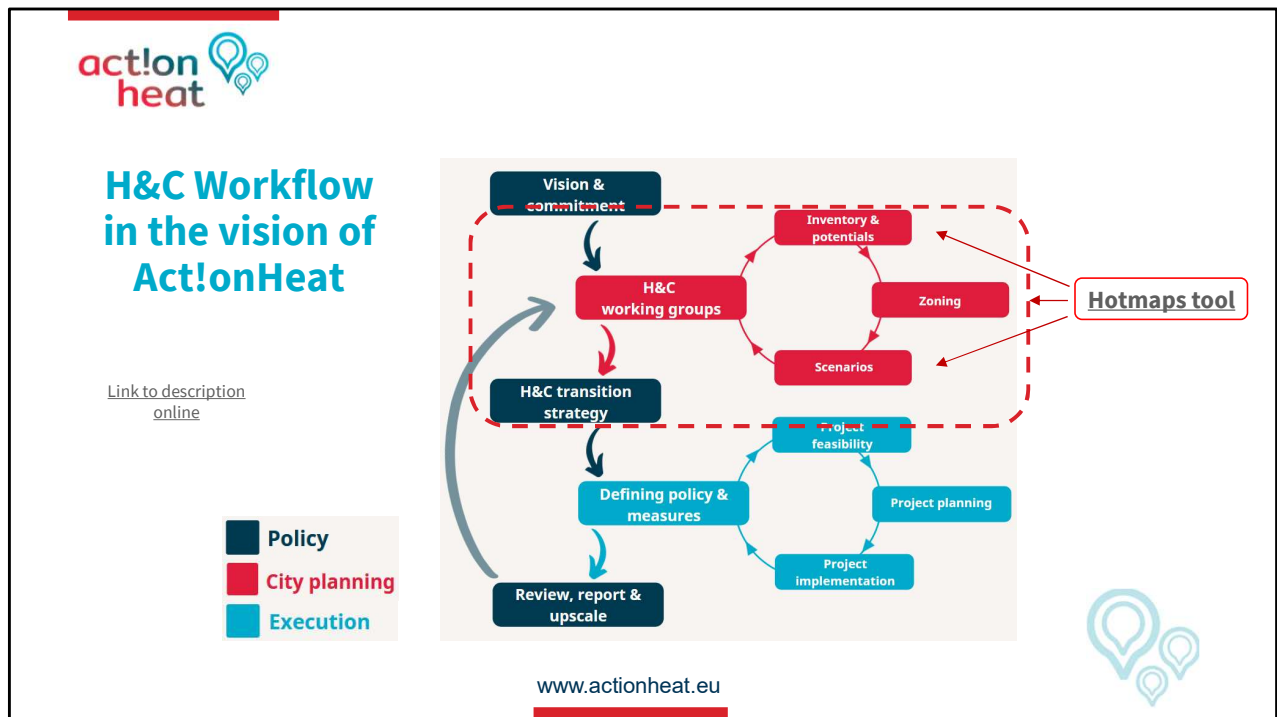
- Extra information for own learning process

PART I

Strategic heat planning in the vision of Act!onHeat

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Act!onHeat Workflow

- Focus on City planning

Policy

- Necessary to know EU targets to achieve them (*Visualization of needs*).

City planning

- Hotmaps can help to prioritize the zoning and requirements (*Overwie situation*).

Execution

- Group participation in project implementation steps (*Division of activities*).

PART II

The Hotmaps Platform

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Background

- Climate change
- Low CO₂ economy and energy system is necessary
- Heating and cooling is highly relevant
- Heating and cooling needs long term planning
- Aim of Hotmaps: assist long term planning in heating and cooling

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What we can do against the **climate change** crises

- **CO₂ reduction:**
For example, using less fossil fuels for Heating and Cooling.

How can we do that?

- **Changenging H&C systems**
Which requires a transitory plant for old to new alternatives.

How started?

- Hotmaps assist **long-term planning**
A tool for H&C visualization for municipalities or stakeholders.

Hotmaps – What for?

*Hotmaps develops, demonstrates and disseminates **a toolbox to support public authorities, energy agencies and planners in strategic heating and cooling planning** at local, regional and national levels, and in line with EU policies.*

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Hotmaps objective

The tool will be used for Act!onheat project as a part of support facility 1 to help authorities or stakeholders quickly estimate the heat and cooling regional demand.

Hotmaps – The 3 pillars

- **User-driven**: developed in close collaboration with 7 European pilot areas
- **Open source**: the developed tool and all related modules will run without requiring any other commercial tool or software. Use of and access to Source Code is subject to Open Source License
- **EU-28 compatible and adaptable**: the tool is applicable for cities in all 28 EU Member States by default and users can upload their own data

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Hotmaps fundamental development

User-driven:

- Collaboration of different countries in developing.

Open source:

- Free for use and continue developing.

EU-28:

- Whit EU reliable database for 28 countries.

Technology Readiness Levels

Achieved during the Hotmaps project duration

TRL 7 – System prototype demonstration in operational environment

**Follow-up project started under the ERA-Net
MICall20 to get there (OpenGIS4ET)**

TRL 8 – System complete and qualified

TRL 9 – Actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)

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Technology Readiness Level (TRL)

- Indicator of how ready is a software for the market

Hotmas has a readiness level of 7

- Feedback on the tool are in implemented process for level 8, which will be complete in 2024
- The final intention is to achieve a Technological Readness level of 9

Status of the database and toolbox

- Database:
 - For many data necessary for heating and cooling analysis default data are in the database; however, not all data contained, and data not necessarily correct
 - Follow-up project providing further data → H2020 EnerMaps – finished in July 2022
- Toolbox:
 - Numerous automated and manual tests have been performed on stability and usability for all release versions
 - In this release it's the first time that all CMs relevant for the toolchain are included
 - Still we cannot be sure that no errors occur
- Wiki:
 - Comprehensive with tutorials and training materials
 - Handbooks, strategic energy planning reports available



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Hotmaps database status

Data:

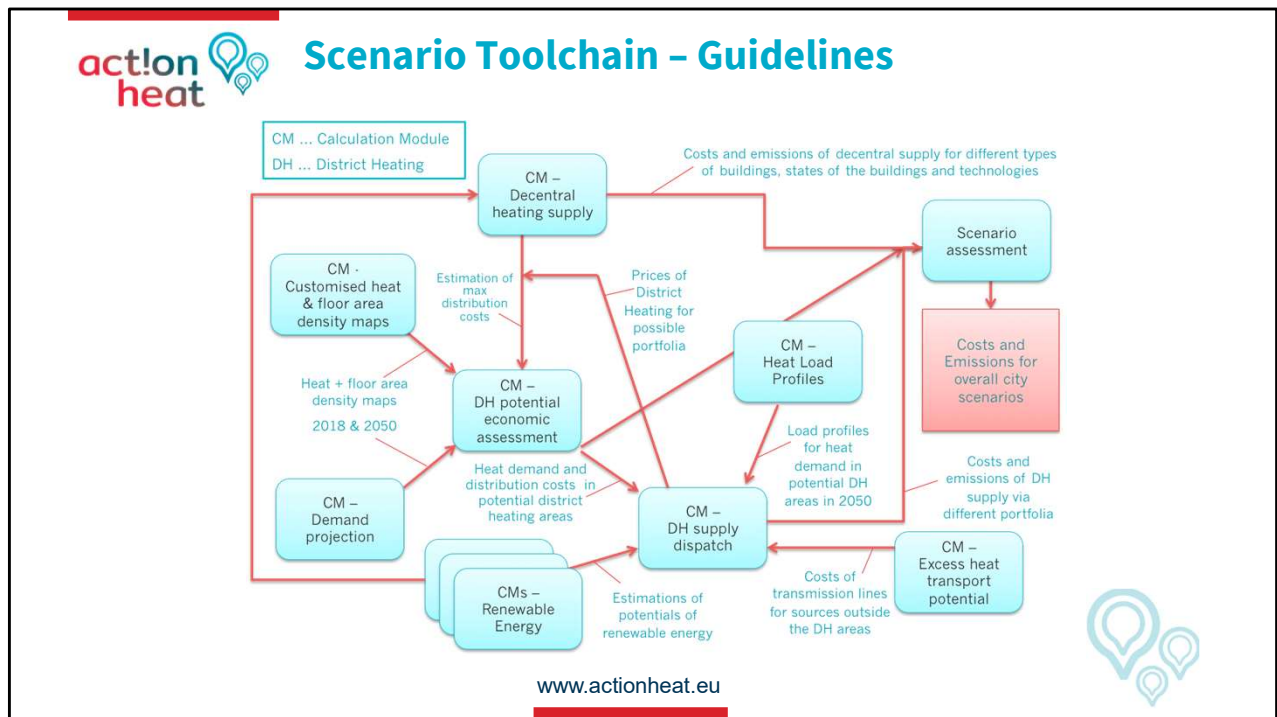
Statistical data change with time and are not 100% accurate. But if required, it is also possible to check the developed calculation methodology in the Wiki link.

Toolbox:

It is possible to find errors in the platform when using it; if that happens, press control F5 to reload.

Wiki:

It is possible to find extra explanation information for the tool and its use, but it must also be completed.



Hotmaps Calculation Modules CM

- CM could be used independently:
The illustration shows how different calculation modules can be used to analyze different aspects of the heating and cooling system and research questions. Furthermore, it also shows how the calculation modules can be used as a chain of tools to derive scenarios for heating and cooling in certain areas.
- CM are combined to generate another model:
The main idea is to combine CM in different ways to create another CM more complex combination. Nevertheless, all of them are a combination of different statistical data.

PART III

Live demonstration of the Hotmaps Toolbox

www.hotmaps.eu

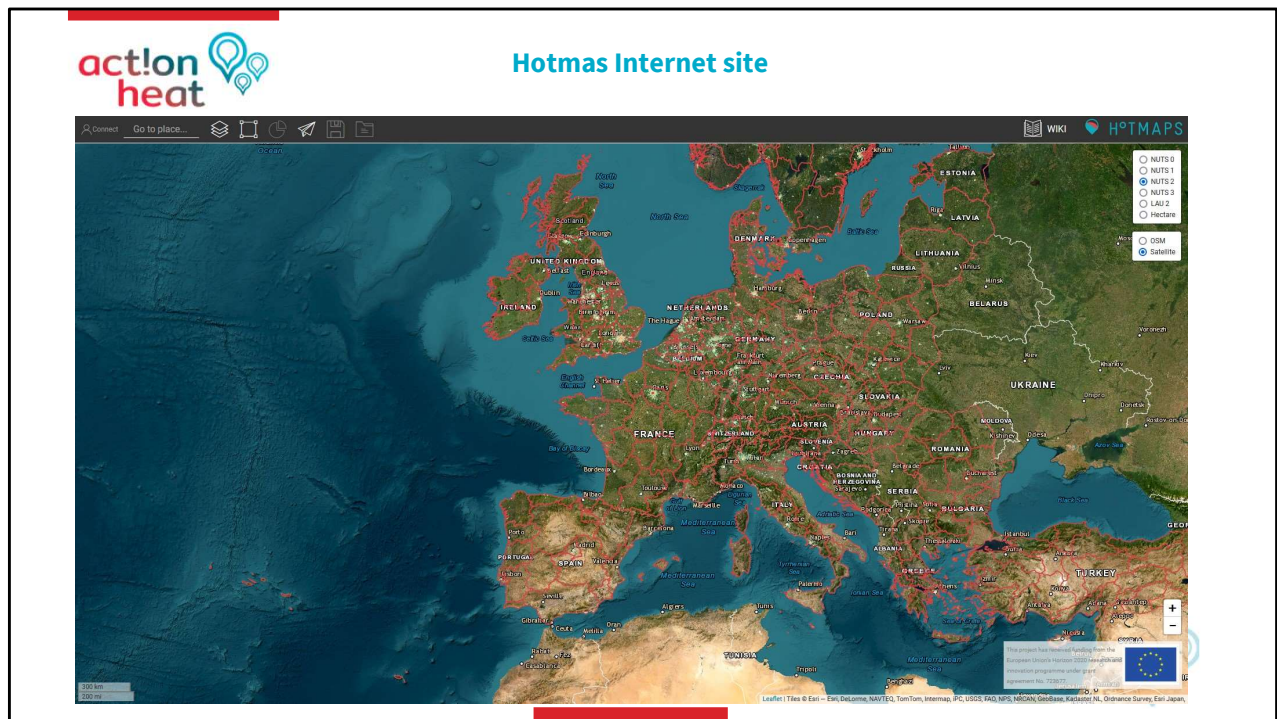
www.actionheat.eu



This part of the Webinar was shown online going to: www.hotmaps.eu

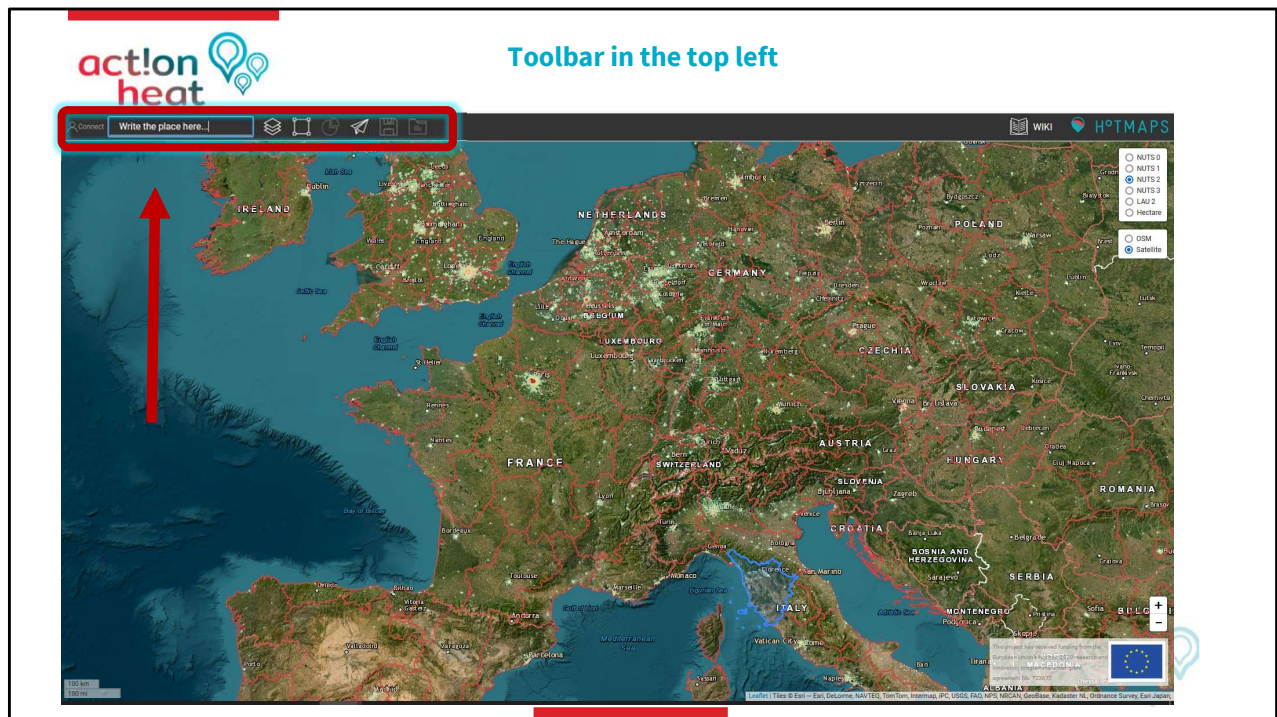
Note:

The next slides are not part of the original presentation. Those were added with the intention to continue explaining this part of the Webinar because the tool was shown online. During the next part of this document, the platform will be described step-by-step, showing images tokened from the internet to follow the demonstration for this part of the Webinar explanation.



Vizualization of Hotmaps and explanation

1. Enter the website and accept the terms and conditions.
It will open a map of Europe.
2. Zooming in/out and moving on the map is possible.
To visualize a specific area in the browser.
3. Pictographic interactive parts on the top left and top/downright sites.
To activate the function on the tool.



Pictographic icons or windows in the top left

First icon: Connect

- Allow you: To register on the platform to use specific functions.

Second window: localization

- Allows you to go to a specific region. Taping the name of the place.

Third icon: Layers

- Allows you to activate visualization of different H&C Parameters.

Fourth icon: Selection

- Allow you to select a specific region on the map to work with.

Fifth icon: Results

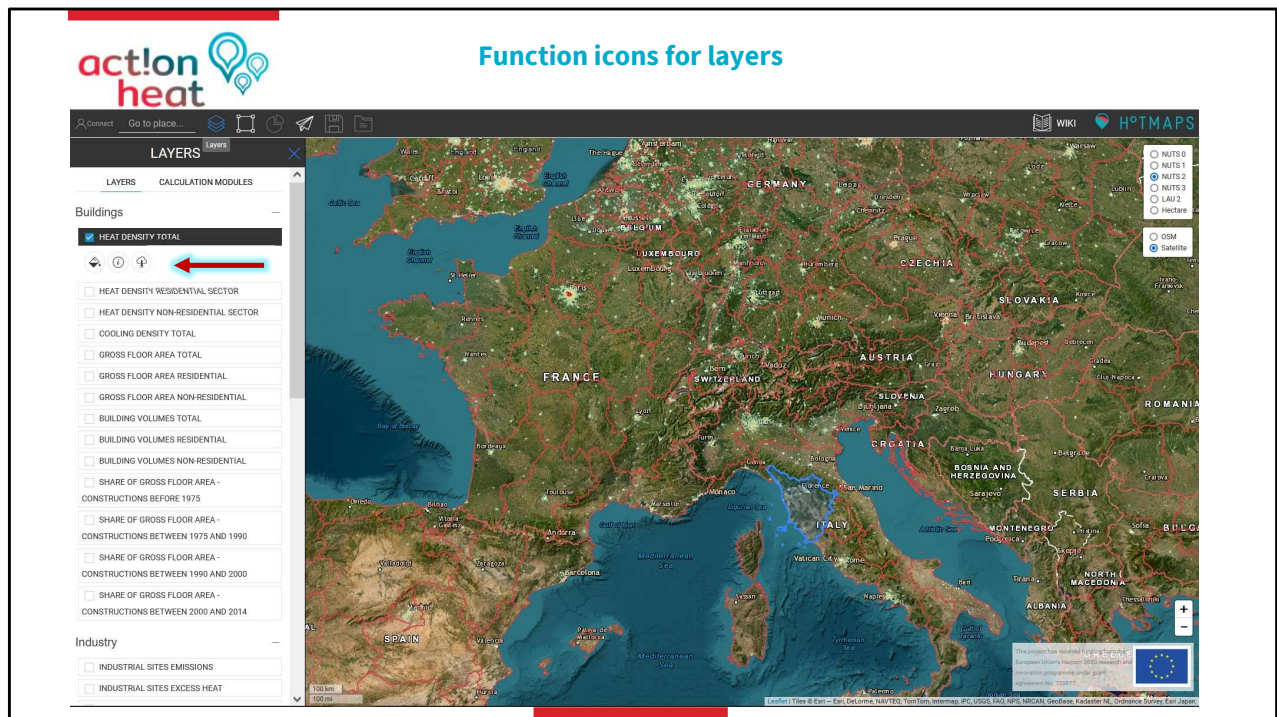
- Allows you to close and open the result window.

Sixth icon: Feedback

- Allows you to write a comment to the developers for issues.

Seventh and eighth icons: Save and Folder

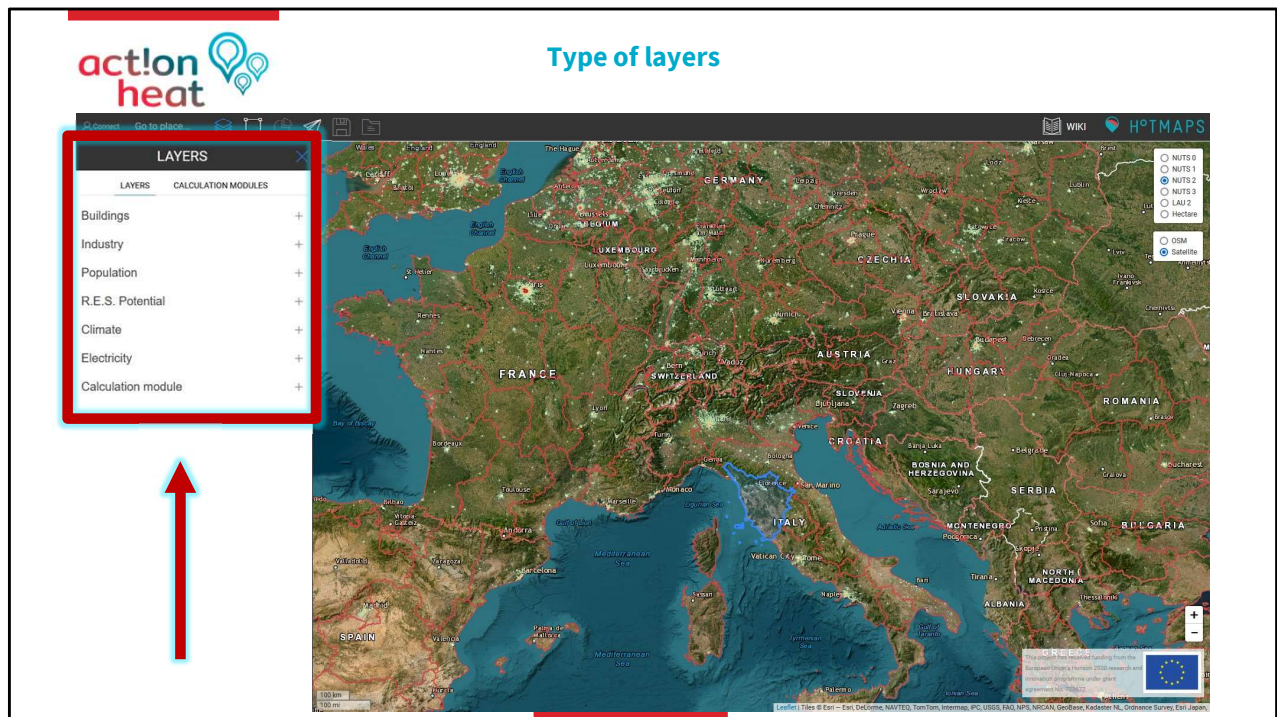
- Allows you to save your calculations and find them in a specific folder.



Layers functions and description

Go to the layer and click on it.

- Allows you to activate the layer function and the next iconic possibilities:
- Icon one: Symbology
Allows you to know the parametrical color description on the layer
- Icon tow: Information
Allows you to address you to extra information about the layer
- Icon tree: Download
Allows you to download default data set



Different kinds of layers and its visualization

Buildings. Is a Raster Layer (RL) that indicates building volume or a construction area and the heat cooling demand for residential and non-residential areas.

Industry. Is a Vector Layer (VL) that shows you specific information about industries like excess heat and carbon emissions.

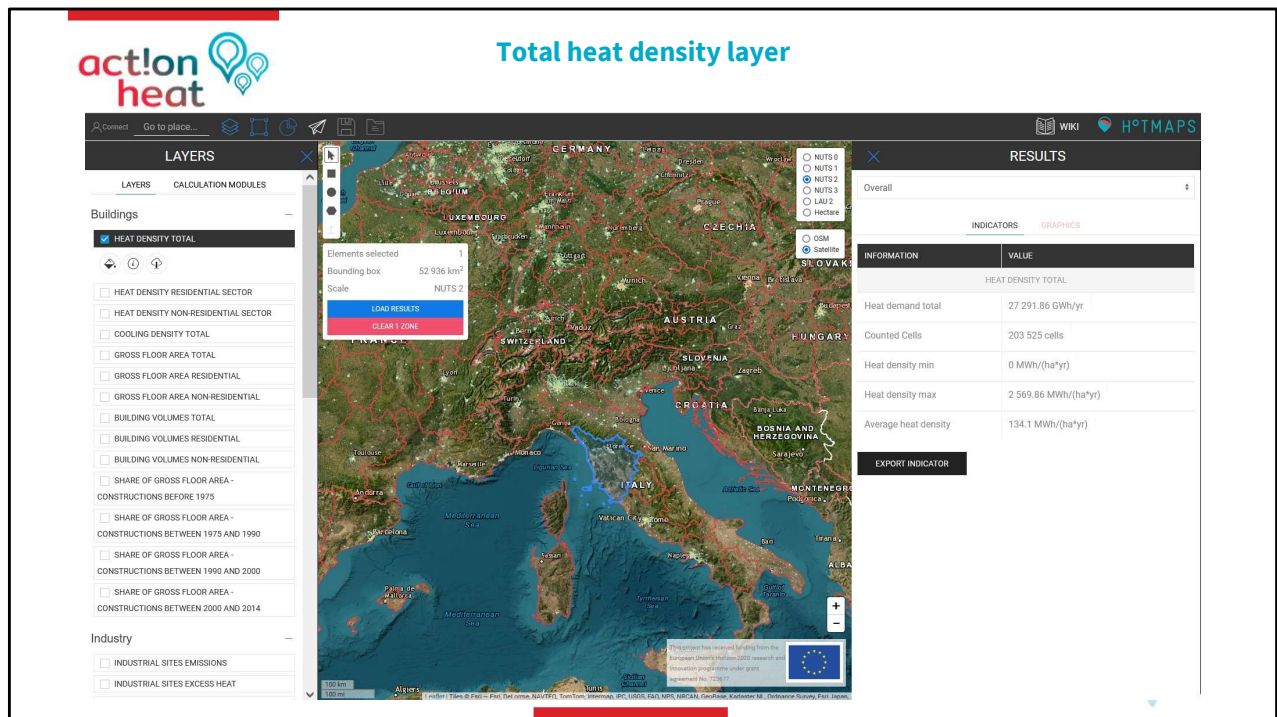
Population. VL that shows you the total population in a selected area,

Renewable Energy Sources R.E.S Potential. RL that shows you energy potentials like solar radiation, wind, or forest residues.

Climates. RL that shows you temperature percentage like cooling or heating days, wind speed, or solar radiation.

Electricity. VL shows you the electricity CO₂ emission in a country average.

Calculation Modes. RL and VL layers that are combined to give more specific information. This layer will only open if you select an area and load results.



To visualize layer results, it is necessary to select a specific area.

Example:

1.- Selection: Specific area on the map.

Visualization: That area will appear in another color, like blue.

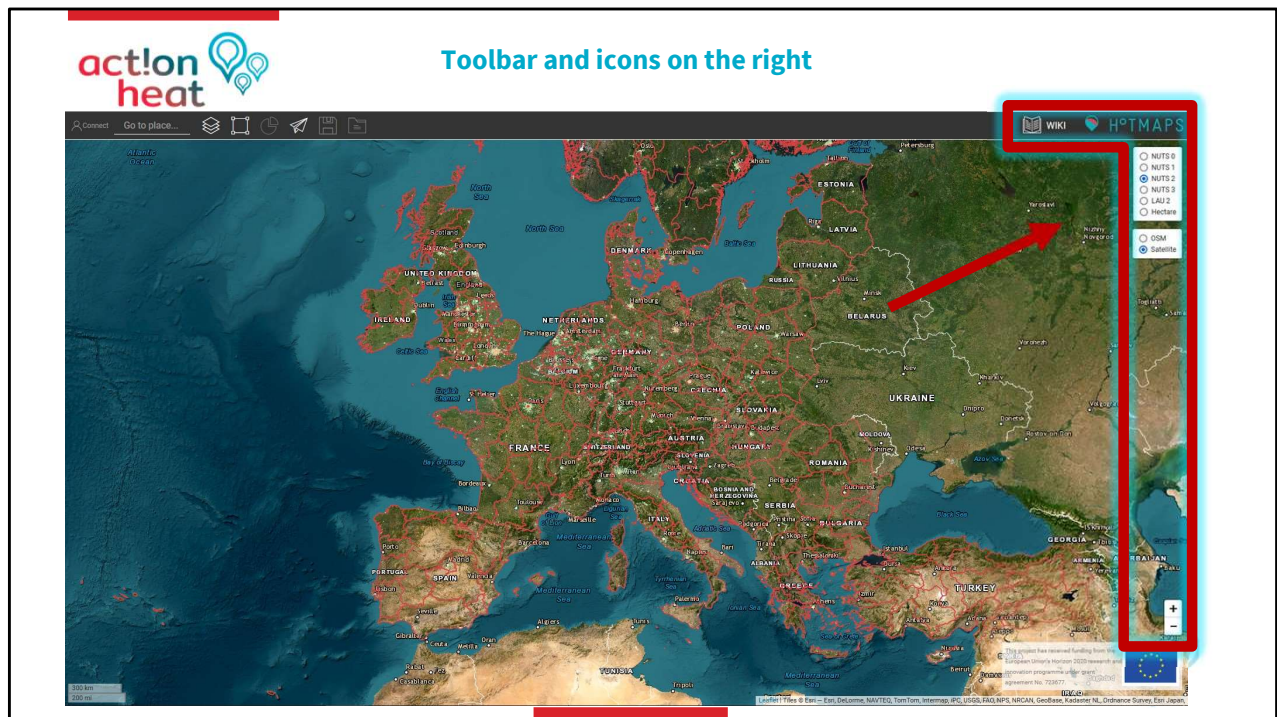
2.- Selection: Specific layer, for example; HEAT DEMAND TOTAL

Visualization: A box right to the layer will appear with information about the selected zone with the number of elements selected. Bounding box. Scale. and the possibility of Loading results or Clear the zone.

3.- Selection: The box color blue, and LOAD RESULTS

Visualization: A RESULT box at the right of the window appears and will show you the results of the selected layer according to that area; for the HEAT DEMAND TOTAL layer, you will observe the Heat demand total. Counted cells. Heat density min and max., and Average heat density.

Note: The CALCULATION MODULES will be open only following the steps already mentioned; select a specific area, and load the results for some layer.



Pictographic icons or windows on the right side

On the top

First icon top: Wiki

- Allows you to open a Hotmaps general explanation.

Second icon top: HOTMAPS

- Allows you to open the project development homepage.


On the side

First window side: NUTS and Hectare

- Allows you to change the territorial unit division on the map.

Second icon bottom side: Zoom

- Allows you to zoom in or out on the map window.



Hotmaps Wiki

The Hotmaps Wiki hosts the documentation, guidance and manual of the Hotmaps toolbox. It consists of the following main parts:

1. Data sets,
2. General toolbox functionalities,
3. Calculation modules,
4. How to apply the Hotmaps toolbox?
5. Developers.

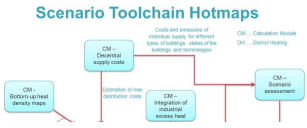
These sections are accessible in all Wiki pages in the sidebar.

The **Data sets** section provides information about Hotmaps data set repositories as well as methodologies for gathering these data sets.

The **General tool functionalities and structure** section guides the user through the interface of the toolbox. The section covers all general aspects of the toolbox, which are related to the user experience, e.g. navigating through different parts of the toolbox, layer selection, retrieving indicators, data upload and export functionalities etc.

The **Calculation Modules** section provides an in-depth explanation of concepts and methodologies behind the calculation modules. Besides the explanation of the methodology, the provided examples and test runs for each calculation module help the user to obtain an understanding of input parameters and output results. Some calculation modules are integrated into the toolbox, while others are stand-alone.

The section **"How to apply the Hotmaps toolbox"** is one of the most important sections of this wiki. It helps Hotmaps users to perform heating and cooling planning with the Hotmaps toolbox and includes guidelines on using Hotmaps at the local and national levels, as well as training materials. This section illustrates how different calculation module can be used to analyze different aspects of the heating and cooling system and different research questions. Furthermore, it shows, how the calculation modules can also be used as a chain of tools to derive scenarios for heating and cooling of certain areas. This toolchain is depicted schematically below:



Wiki link in Hotmaps

Calculation modules (CM)


- CM - Customized heat and gross floor area density maps
- CM - Scale heat and cool density maps
- CM - Demand projection
- CM - Heat load profiles
- CM - District heating potential areas user-defined thresholds
- CM - District heating potential: economic assessment
- CM - District heating supply dispatch
- CM - Decentral heating supply
- CM - Solar thermal and PV potential
- CM - Shallow geothermal potential
- CM - Heat source potential
- CM - Biomass potential
- CM - Wind potential
- CM - Excess heat transport potential
- CM - Scenario assessment
- CM - Add industry plant
- CM - Vehicle stock at NUTS 2 level

How to apply Hotmaps toolbox

- Guideline: Hotmaps toolbox on local level
- Guideline: Hotmaps toolbox on national level
- Concept for using Hotmaps for district cooling
- Scenario assessment**

For Developers

- Developers section
- Guidelines for defining indicators
- Guidelines for writing a Hotmaps Wiki page



Exercises 1-2

- Webinar: introduction to exercises 1-2 [English / German](#)
- Presentation used for the webinar [English](#)
- Exercises 1-2 word [English / German](#)
- Exercises 1-2 excel [English / German](#)
- How to open a CSV [English / German](#)

Exercises 3-4

- Webinar: Wrap-up of exercises 1-2, introduction to exercises 3-4 [English / German](#)
- Exercises 3-4 word [English / German](#)
- Exercises 3-4 excel [English / German](#)

Exercise 5

- Webinar: Wrap-up of exercises 3-4, introduction to exercise 5 [English / German](#)
- Exercise 5 word [English / German](#)
- Exercise 5 excel [English / German](#)

Closing Webinar

- Webinar: Wrap-up of exercise 5, feedback questionnaire, certificates and final remarks [English / German](#)
- Exercise 5 complete [English](#)
- Exercise 1-2 complete [German](#)
- Exercise 3-4 complete [German](#)
- Feedback questionnaire [English / German](#)
- Template for certificates: please contact conforto@e-think.ac.at
- Presentation used for the webinar [English](#)

What the Hotmaps Wiki contains:

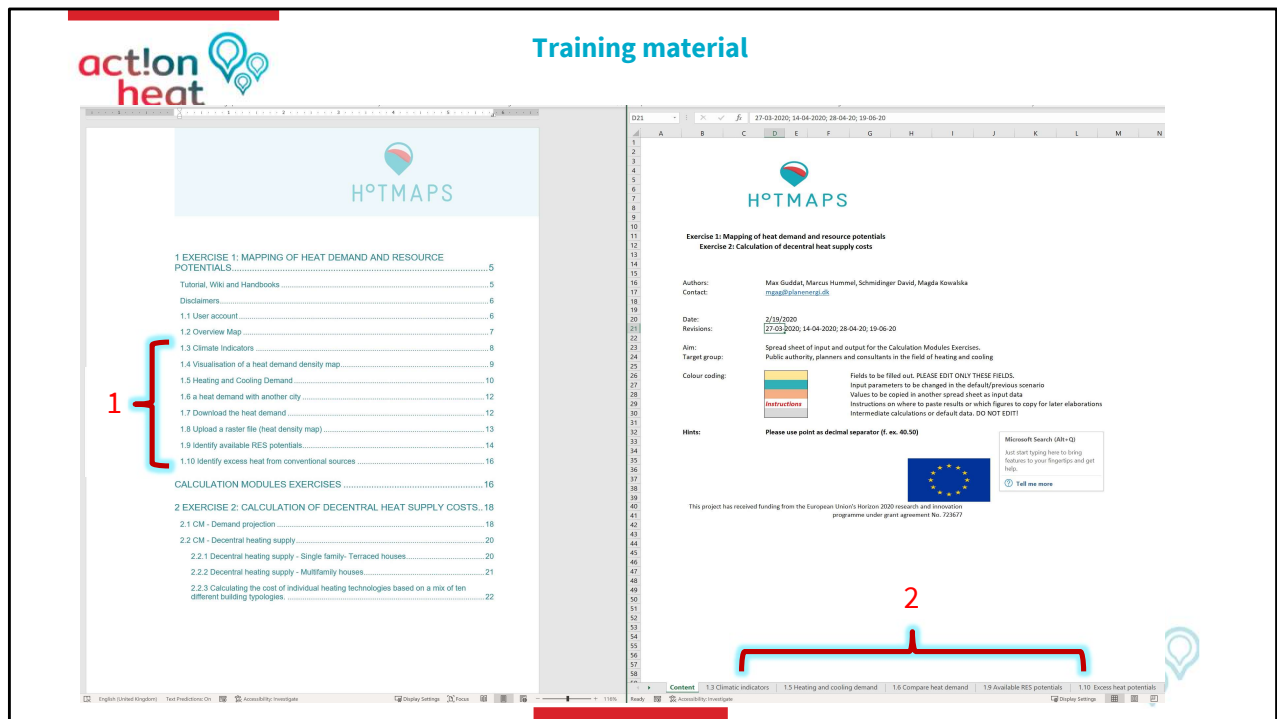
- 1.Data sets
- 2.General toolbox functionalities
- 3.Calculation modules
- 4.How to apply the Hotmaps toolbox?
- 5.Developers

Wiki explains how the data are generated in Hotmaps and how the tool could be used through the next elements:

Introduction: Explain each of the elements from the tool
 Functionalities: Explain general toolbar information
 Methods: Explain how the functions and modules are calculated.
 Guidelines: How to use Hotmaps
Training material: Exercises to improve your knowledge
 Developers: How to improve the tool

For the webinar:

First, click on **Traning material** and then scroll down to **Exercises 1-2** and download the Word and the Excel format.



Training material: Download and open **Word** and **Excel** exercise documents.

The Hotmaps explanation list of the exercises with the number 1 on the Word document is used to understand how to fill out the Excel sheet marked with the number 2.

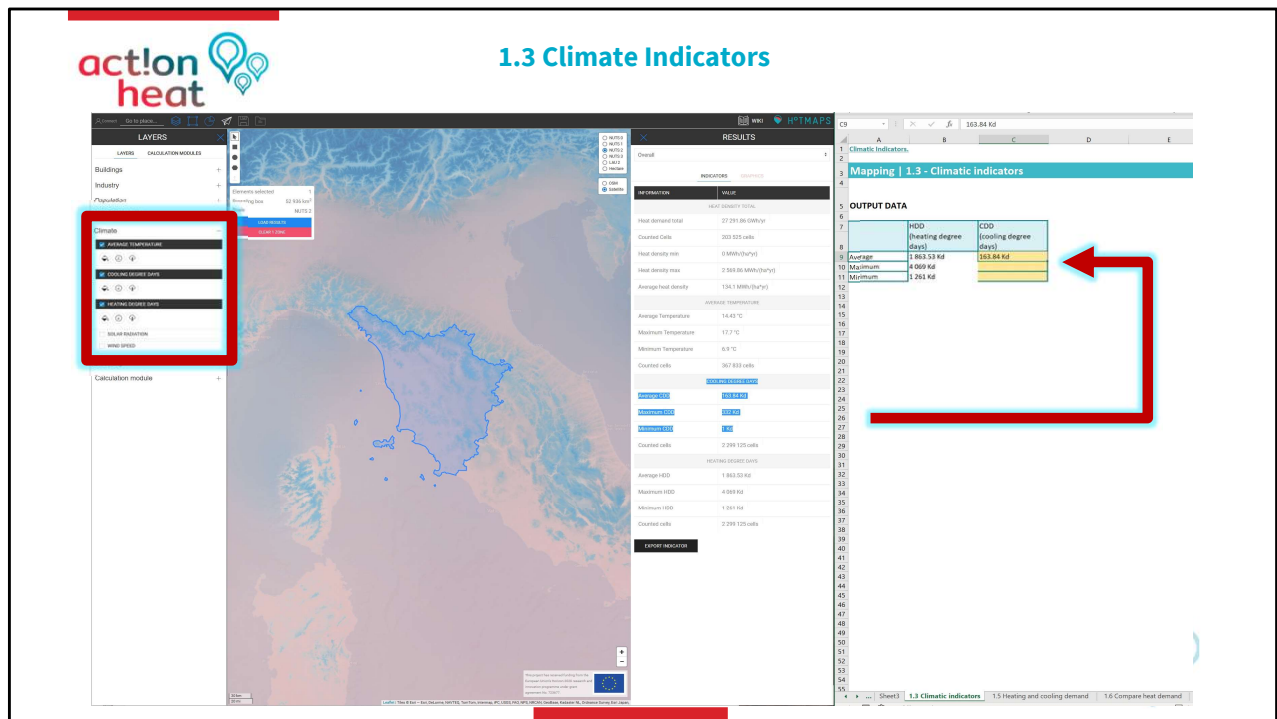
Word 1

- 1.3 Climate Indicators
- 1.5 Heating and Cooling Demand
- 1.6 a heat demand whit another city
- 1.9 Identify available RES potentials
- 1.10 Identify EH from Conv. Sources
- 2.1 Demand projection
- 2.2.1 Decentral heating supply-Single fam.
- 2.2.2 Decentral heating supply-Multifam.
- 2.2.3 Calculating heating tec. on ten dif. building typologies

Excel 2

- 1.3 Climatic Indicators
- 1.5 Heating and Cooling demand
- 1.6 Compara heat demand
- 1.9 Available RES potentials
- 1.10 Excess Heat (EH) potentials
- 2.1 Demand projection
- 2.2.1 Decentral heating supply
- 2.2.2 Decentral heating supply
- 2.2.3 Decentral heating supply

Note: The data to fill the Excel table will be found on the Hotmaps plataform; follow the instructions.



The Excel data can be found on the Hotmaps platform:

Word 1

1.3 Climate Indicators

1.5 Heating and Cooling Demand

1.6

Excel 2

1.3 Climatic Indicators

1.5 Heating and Cooling demand

1.6

For example, for **Climate Indicators**:

1.- Go to Hotmaps layers and choose **Climate**

2.- Select an area of interest and click on it.

3.- Select the climate indicators that you are looking for from Excel:

Average temperature

Cooling degree days

Heating degree days

4.- **LOAD RESULTS** from an interest area with specific parameters according to the interest municipality area for H&C planning.

5.- Fill out the results from Hotmaps in your Excel sheet to complete the exercise.

PART IV

Individual exercise

www.actionheat.eu



Individual exercise

1. Open the toolbox in your browser (firefox or chrome preferred) -> www.hotmaps.eu
2. Enter the name of the region you are interested in in the search field
3. Select the level of detail (NUTS 0 - NUTS3, LAU2, Hectar)
4. Activate the layer „HEAT DENSITY RESIDENTIAL“ and „GROSS FLOOR AREA RESIDENTIAL“
5. Select the region of interest in your desired level of detail by clicking on the shape
6. Click on the button “LOAD RESULTS” to receive the results-> write down the results
7. Click on the tab “CALCULATION MODULES”
8. Select the CM “CM - District heating potential areas: user-defined thresholds”
9. Define a threshold for min. heat demand in hectare
10. Click “RUN CM” to receive the potential share of district heating from total demand in selected zone

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For the participants:

The participant needs to follow the instruction, open the Hotmaps tool, and complete the exercise. The intention is that they start to familiarise themselves with the tool.

The decision to perform the calculation should remain flexible and tailored to each specific case.

Users were provided with a 10-minute window to transition between discussion and tool testing.

Further training material

- Extensive training materials in the [hotmaps wiki](#) (training videos, guidelines, exercises, etc.)
- Experts from the Act!onHeat - consortium offer live training sessions for local authorities, energie planners, stakeholders, etc.

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Wiki:is the starting point for strategic Heating and Cooling planning.

Act!on heat offers as a part of its support package the possibility to make an appointment and receive workshops making an appointment.



Thank you.



TU Wien, e-think
Date: 17.11.2022



This project has received funding from the EU's Horizon 2020 programme under grant agreement no 101033706.



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Webinar 4: Use of Industrial Excess Heat in District Heating

Act!onHeat SF1

Time: 1 h 28 min

- Serial 2:
 - Webinar 4
 - Strategical Heating & Cooling planning
 - Group support for municipalities and stakeholders
- Presented by:
 - e-think / Austria
 - TU-Wien / Austria

Part I – Excess Heat: What it is, Why it is used and How

- Introduction to Excess Heat (EH) (5') - Giulia
- Best Practices: Common EH sources and uses (20') - Giulia
- EH Cadasters (10') - Marcus
- Challenges & Factors of success (5') - Marcus
- Discussion, Q&A (5')

Part II - Assess Excess Heat potential exploitation

- Hotmaps: Layers on Excess Heat in the tool; CM add industry plants, CM transport potential (20') - Salvador
- THERMOS: a simple example (10') - Aadit
- EMB3Rs: an overview of the tool (5') - Marcus
- Discussion, Q&A (10')

Part 1

- Introduction to Excess Heat use, some examples, and extra information

Part 2

- Three different tools that can be used for the use of Excess Heat in District Heating

Introduction to Excess Heat

Part I - Excess Heat: what it is, why it is used and how



This project has received funding from the EU's Horizon 2020 programme under grant agreement no 101033706.



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What is Excess Heat?

Excess Heat (EH) is the heat generated by any thermodynamic process whose main objective is manufacturing products or providing services, and which is released in the environment as a by-product.

Typical industrial processes that produce excess heat:

- Production: refineries, metallurgy, chemical industry, manufacturing ...
- Services: data centres, laundries, cold stores, water management, ...
- Waste Disposal: waste incineration, closing material cycles, ...
- Energy Conversion: condensation power plants, hydrogen electrolysis, ...

Short Introduction to Excess Heat

Which industrial process commonly generated Excess Heat

- Production Processes
- Provision of services
- Process of waste disposal
- Energy conversion plants

How is Excess Heat used?

Space Heating (Cooling, less common, but on the rise)

- District networks + pressure/pumping system
- Additional Heat pumps for low-temperature
- Heat storage and backup capacity to address fluctuations

Process Heating (Cooling)

- Internal network and pumping system

Benefits: increased energy efficiency and decarbonization, additional income/reduced disposal costs for the industry, improved public image, unbundling of consumers' heating price from market price

Challenges: needs accurate planning, detailed heat supply contracts, high coordination and substantial infrastructure investments

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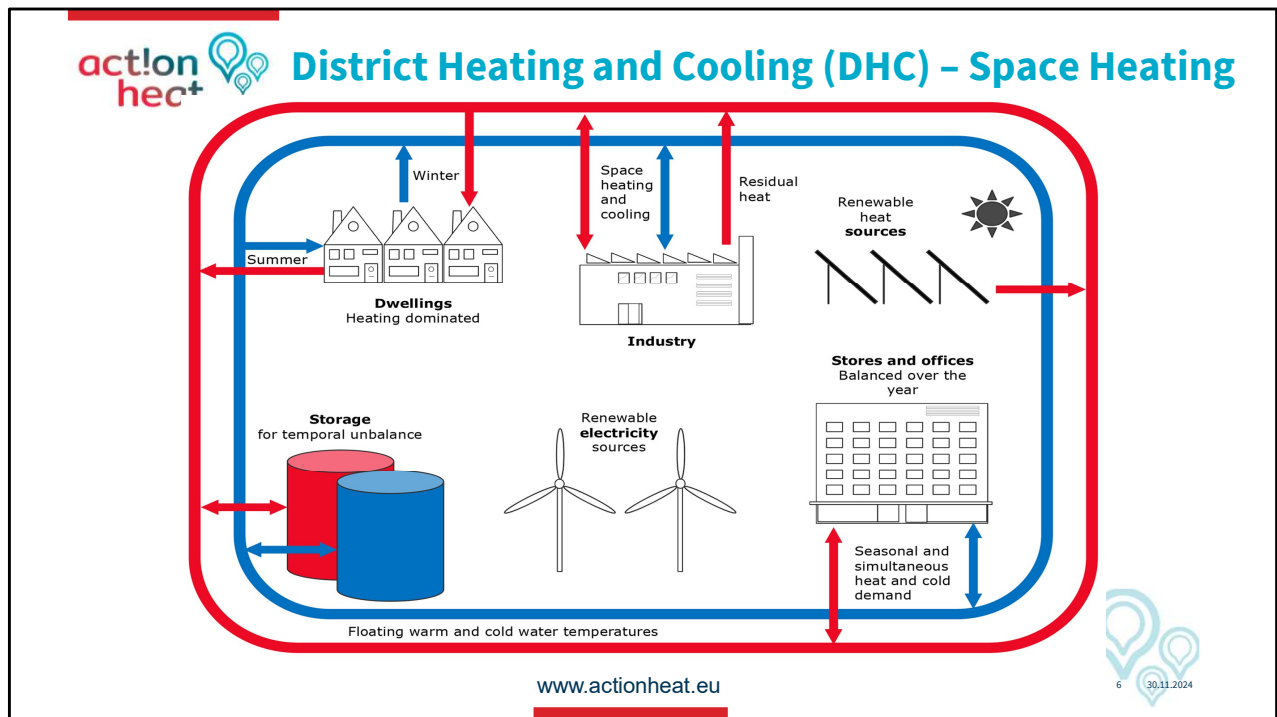
How is excess heat commonly used?

- **Space Heating:** The heat produced in the plant is distributed externally through different systems. Requires much infrastructure and needs to be planned
- **Process Heating:** The heat produced is used internally in the plant for other processes or internal Heating and Cooling. A ceramic factory is an example of that because it uses the production temperature for its drying process.

Excess heat for cooling is rising and is less common in space heating.

Why use Excess Heat?

Excess heat offers significant economic and environmental benefits for both industries and consumers. However, utilizing excess heat from industrial processes necessitates careful planning and the development of extensive infrastructure to meet the needs of stakeholders.



Elemental parts of a D&C network

- Sources

Different energy providers: like industries and other electrical renewable energy producers connected to the network

- Storage

System to store the produced Heating and Cooling

- Consumers

People living in residential buildings and commercial buildings

Best Practices: Common heat sources and uses



Part I - Excess Heat: what it is, why it is used and how

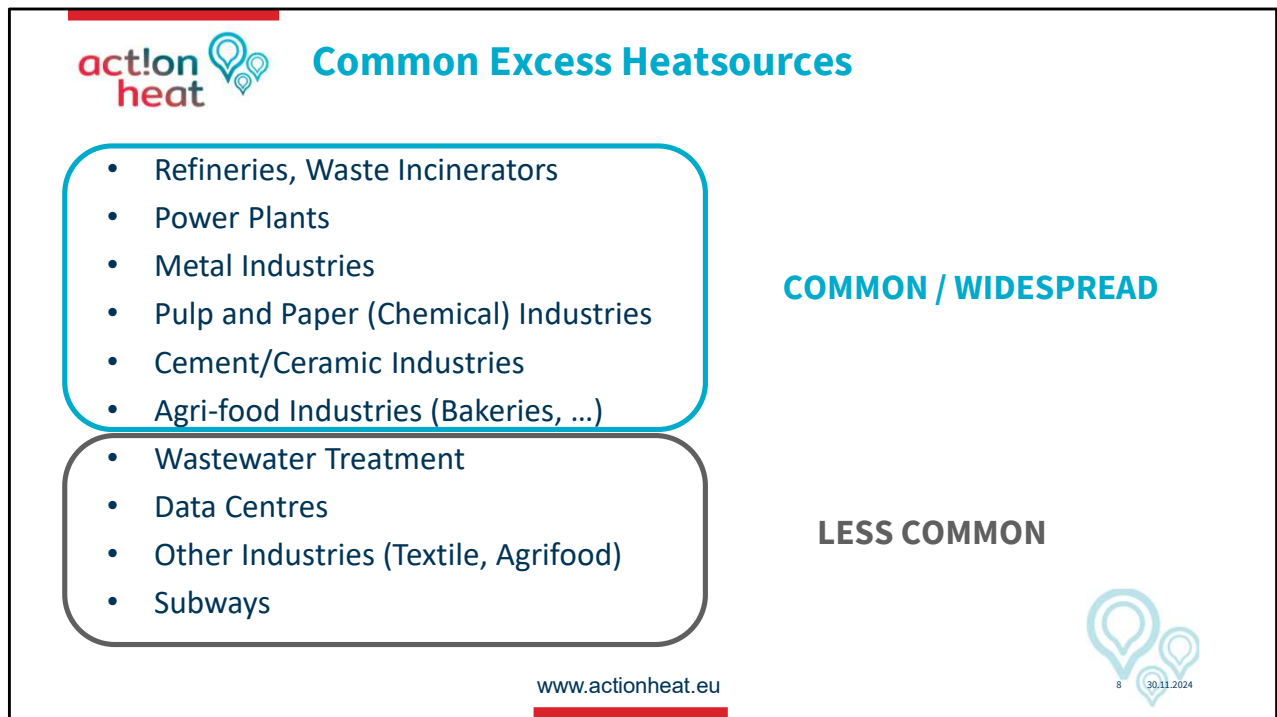


This project has received funding from the EU's
Horizon 2020 programme under grant
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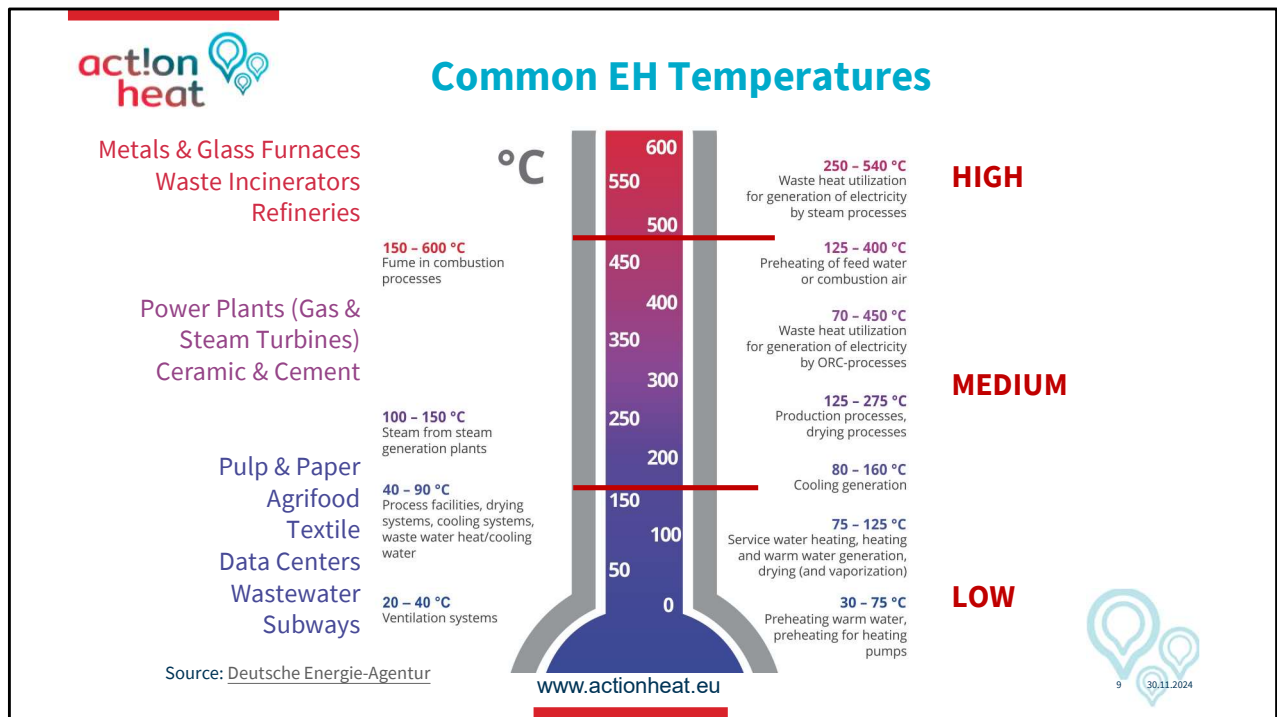




Kind of Excess Heat sources

- High-temperature sources:
Refinery, Metal, and Cement industries...
- Low-temperature sources:
Agro-food, wastewater, data centers...

Note: The Excess Heat from waste water treatment plants and data centers will be the object of the next Webinar; therefore, those sources will be shown briefly.



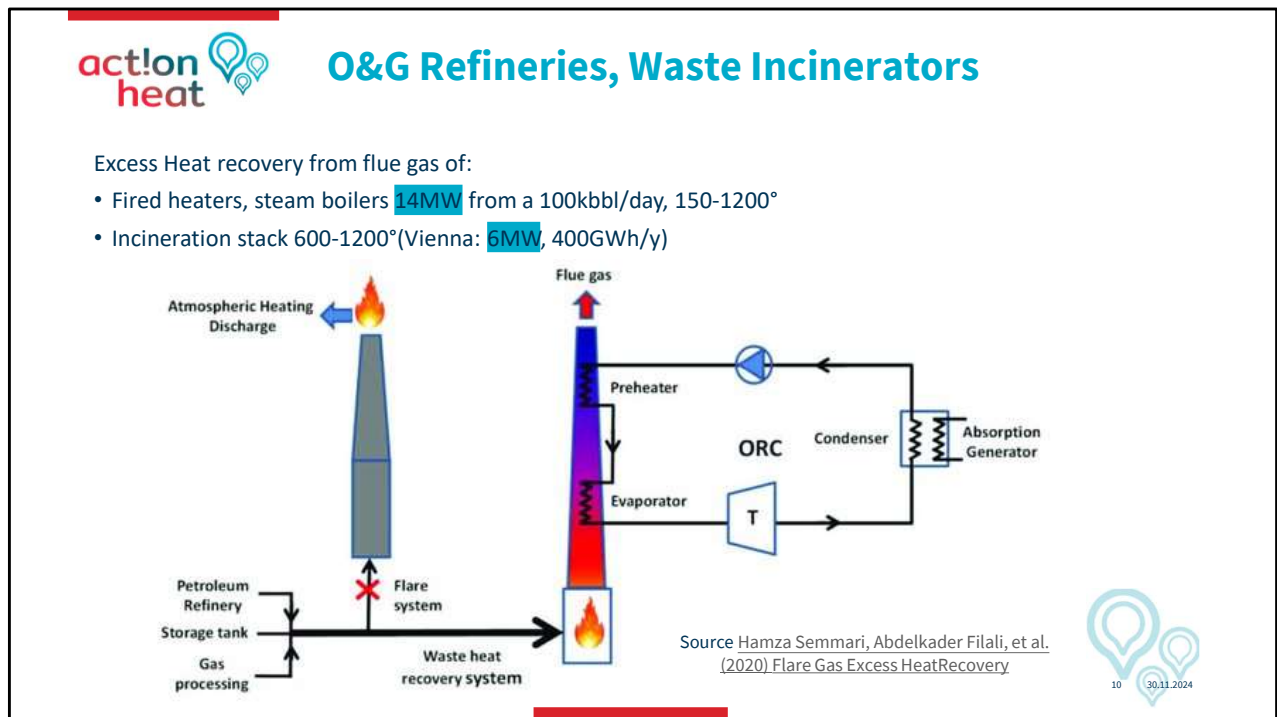
EH temperature industrial ranges

- Low temperatures are everything that is below 100 degrees or max 150 degrees Celsius
- Medium temperature between 160 and 450 degrees
- High temperatures all above 450 degrees

Note: the Industrial temperature of the process is not the temperature of the Excess Heat source. It is lower because of some loss during the process.

In the case of a low-temperature process if the Excess Heat is pretended to be reused, normally Heat Pumps are added to the system to increase the temperature.

Next: some excess heat industries



Incinerator is a High Excess Heat

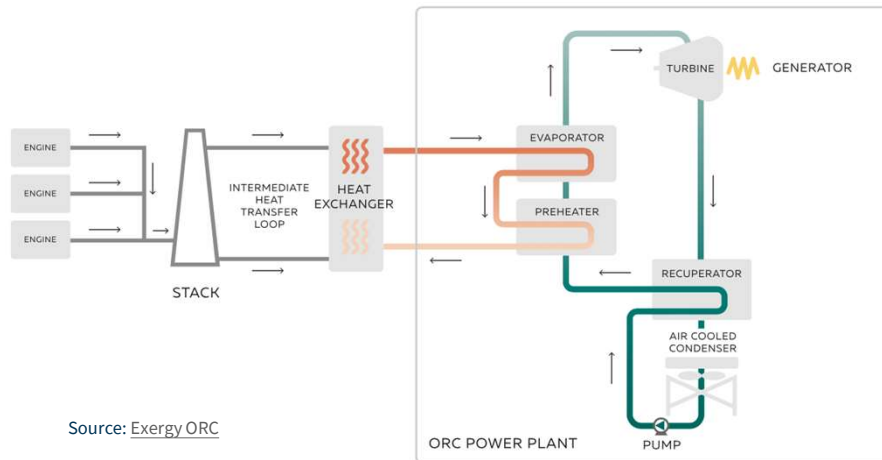
The Chart shows what happens in each industrial process.

- In this case, the incinerator: The flue gases that excess the incinerator process are reused for a heat exchanger to provide Excess Heat or for an ORC circle

The highlighting shows the typical capacities and temperatures of each industrial process. Each case needs to be distinguished by what could be the potential and the temperature.

- In the case of a refinery: Steam boilers operating with 100 thousand barrels per day and a temperature range between 150 and 1200 grades could be equivalent to 14 megawatts of internal power.
- In the case of an incinerator finding in Vienna: The incinerator stack has temperatures between 600 to 1200 grades, with a power of 6 megawatts.

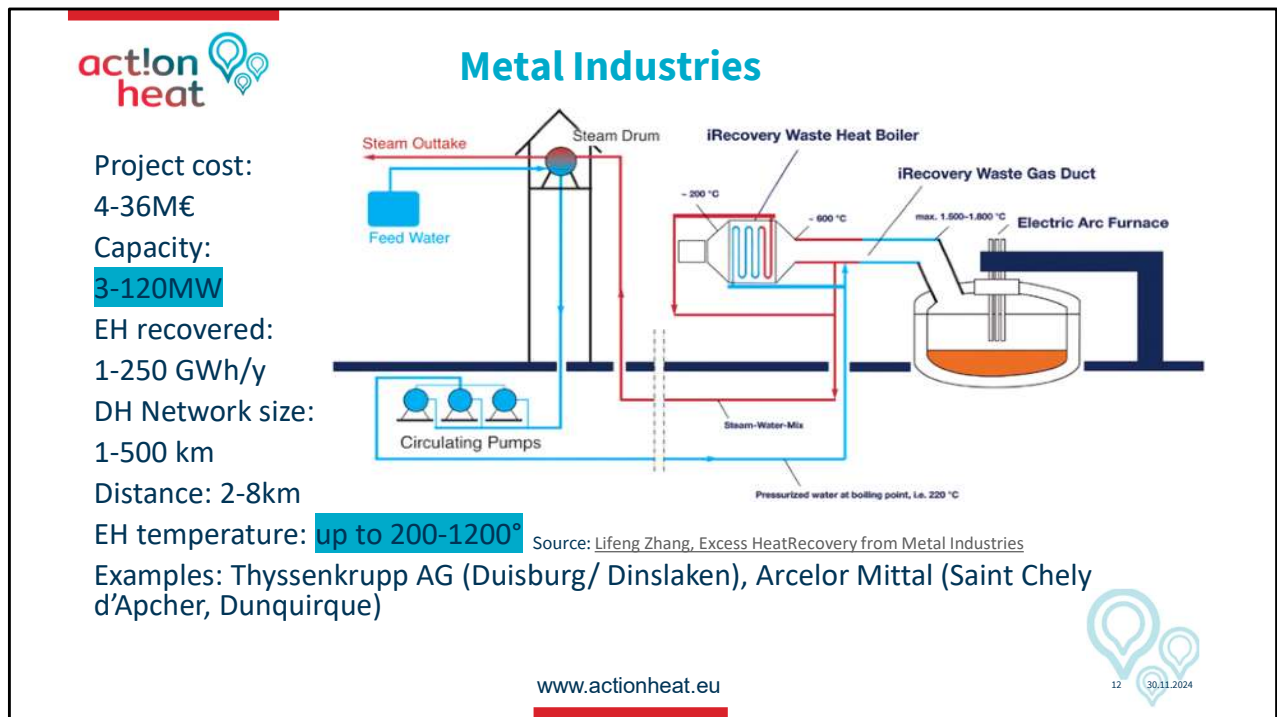
Excess Heat recovered from flue gas of turbines and steam condenser
(150°-1200°, 10-30MW, average supercritical coal plant)



Source: Exergy ORC

Power plans can also have High temperatures

Those that are around Europe with a capacity between 10 and 30 megawatts could be considered as a High temperature.



Metal industries are common sources of Excess Heat.

They can have a capacity between 3 to 12 megawatts, depending on the size

The temperatures are going from 200 to 1200 degrees

Note: the temperatures that are highlighted are the industrial process temperature but not the Excess Heat temperature, which is lower

Project cost: 4-23M€

Capacity: 2-35MW

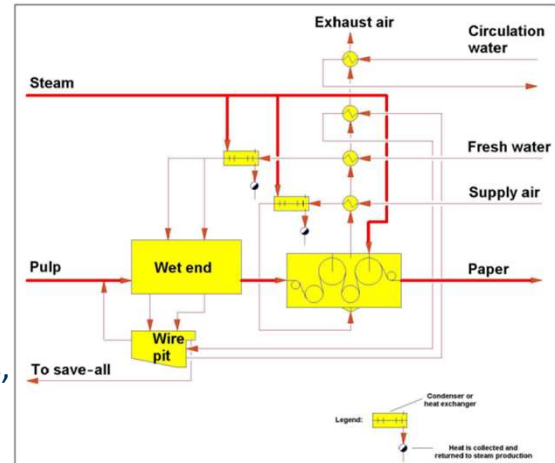
EH recovery:
5-175 GWh/y

DH Network size: 7-1200 km

Distance: 1-7 km from plant

EH temperature: 150-400° from vessels
containing pulp, from flue gases of boilers,
from sewage water and pulp drying

Examples: Zellstoff Pöls AG (Aichfeld,
Austria)



Source: Paper Machine Heat Recovery

Pulp and Paper could be a medium temperature source

The Excess Heat can come from:

- The flue gases of the boilers
- The bases containing the pipe
- The waste water
- The drying process

Cement Industries

Project cost: 1-5M€

Capacity: 4-5MW

EH after internal recovery:
4-22 GWh/y

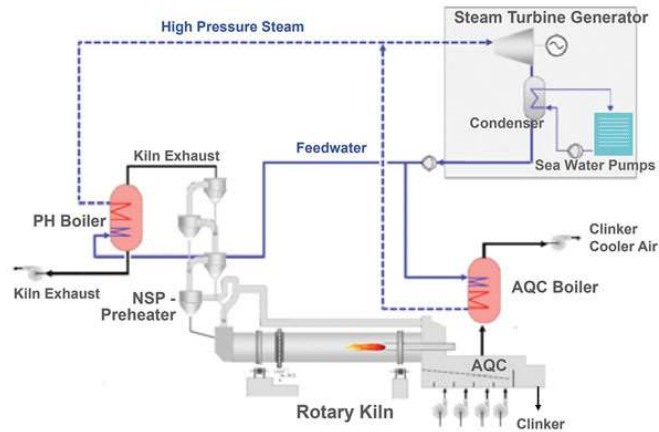
DH Network size: 4-22 km

Distance: 1.5-2km from plant

EH temperature: 300-350°

Examples: Kirchdorfer
Zementwerk Hofmann,
Zementwerk Hatschek, Lafarge Zementwerk Retznei (Austria)

Source: WHR in a Cement Plant, The international Cement Review



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Cement industries are a medium-temperature source.

The chart information shows the development cost for small District Heating networks that were constructed in different parts of Europe described in the example part.

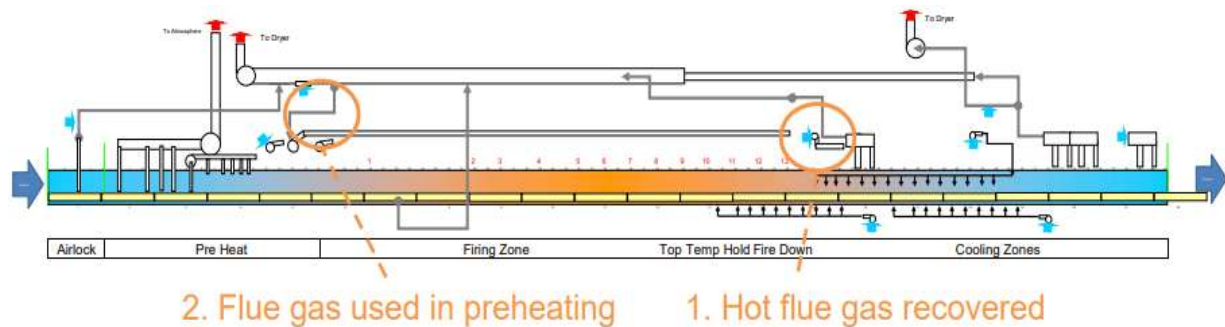
Ceramic Industries

Common heat recovery (150-200°) from roller kilns (750-1800°):

- Self-consumption for spray drying and drying phase
- CHP turbine/generator (~3-5MW) saving 10-50% of heat input

Additional heat recovery from firing roller kiln(s):

- KPM Porcelain - Vattenfall urban DHC, Berlin (110°- 1MWh/y)



Source: [Weinerberger and Ceramics Federation, The potential for recovering and using surplus heat from industry](#)

15 30.11.2024

Ceramic Fabric has a Medium temperature EH

The chart shows the recovered temperature of a ceramic industry which is lower than the used during the process but stays considered higher for its reuse.

For example, in Berlin exists a ceramic industry supplying the local network with a temperature of 110 degrees with a capacity of 1 megawatt per hour.

Implementation example:

- 110 MWt at full capacity with over 90°C flow temperature

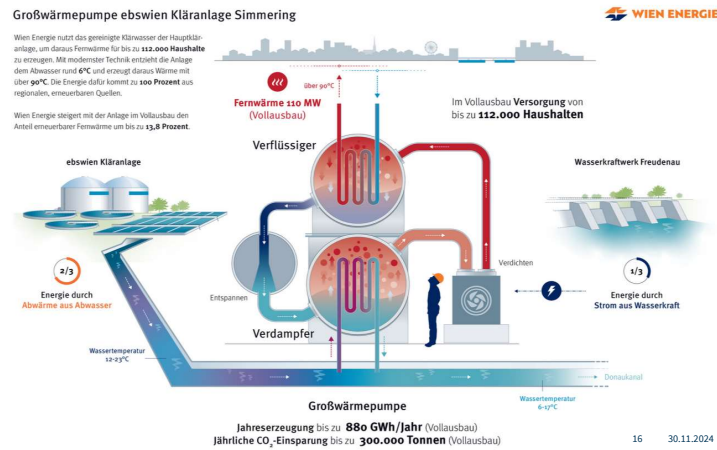
- 70 MEUR Investment

- Delta T: ~20-5°C

- 2/3 of energy by waste heat from waste water

- Production: 880 GWh/year

Source: Wien Energie



Wastewater treatment plants are low-temperature sources

Regarding treatment plants, there are two possibilities for recovering Excess Heat.

- The first is before the treatment of the water.
- The second is after the treatment of the water.

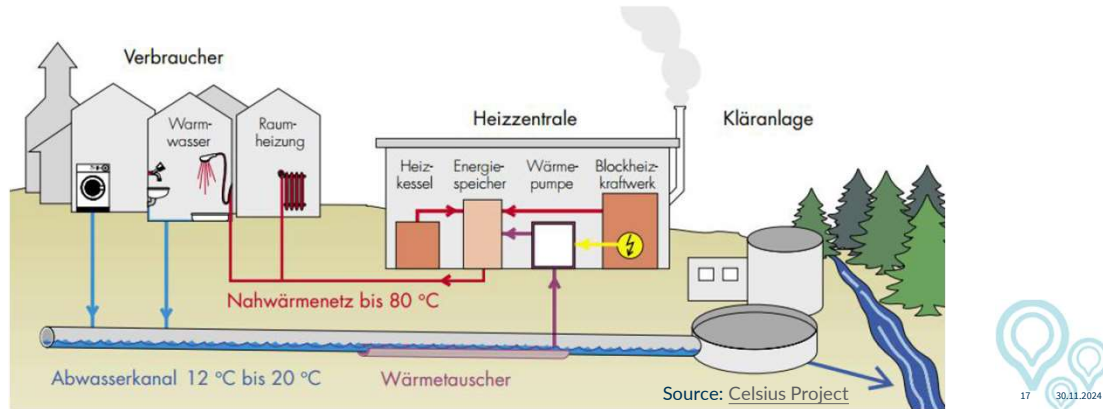
Wastewater before treatment

Example:

Capacity: 243 kW heating - 200 kW cooling (Singen)

Heat pump COP: 3.9 (Singen) Temperatures: ~15°C

Period: since 2004 (Singen) - GVV Städtische Wohnbaugesellschaft mbH



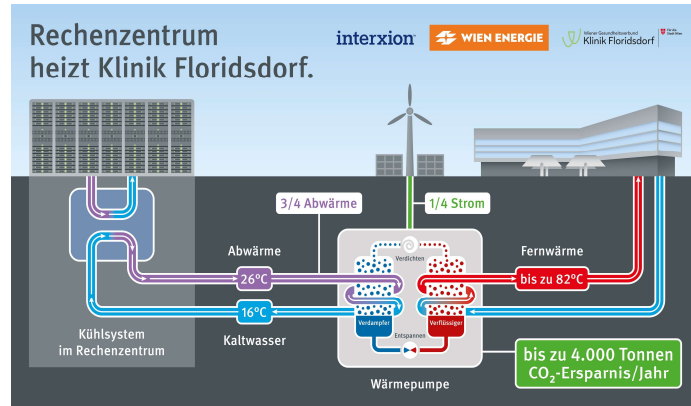
Waste water before and after treatment are low temperature

The Excess Heat reuse from waste water treatment plants will be explained in detail during the next webinar; here is only to show the places where the EH is recovered.

Datacenters

Implementation example:

- 3.5 million € investment
(incl. support from the government)
- Approx. 120,000 servers
- Realization: mid-2023
- Delta T = 10°C
- Total of 3 HP:
- Heating capacity: 3 MWth
- Cooling capacity: 2.1 MW
- Flow: up to 82°C
- ¼ renewable electricity
- 3/4 of the energy by Excess Heat from the data center.
- Examples: Val d'Europe (FR), Mäntsälä (FL)



Source: Wien Energie

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Data centers are low-temperature sources

Normally the use of Excess Heat from low-temperature sources, which is moderate, requires the assistance of a Heat Pump that increases the temperature to reach the desired temperature for the use in a District Network.

Project cost: 0.5-19M€

Capacity: 0.5-5MW

EH: 2-20 GWh/y

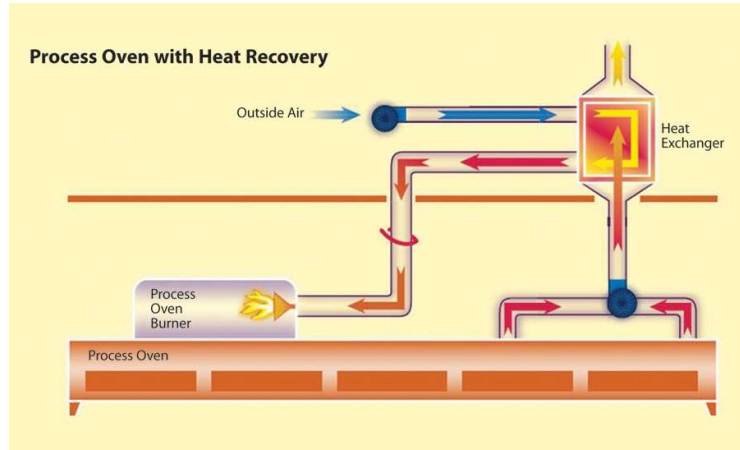
DH Network size: 3-30 km

Distance: up to 8km

EH temperature:

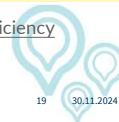
100-250° from flue gases of
baking ovens, 20-50° from
breweries, distilleries and
milk pasteurization

Examples: Manner, Meyer
Waffel, Breweries
(Puntigamer, Leoben), Tirol Milch



Source: Process Heating, Heat Recovery for Process Efficiency

www.actionheat.eu



The agri-food industry is at a low and medium temperature

The Excess Heat from the Baking ovens can be reused:

- Internally for destillation, fermentation process
- Externally for District Heating reuse

Texile/Laundry Industries

Project cost: 1M€

Capacity: 0.5-1MW

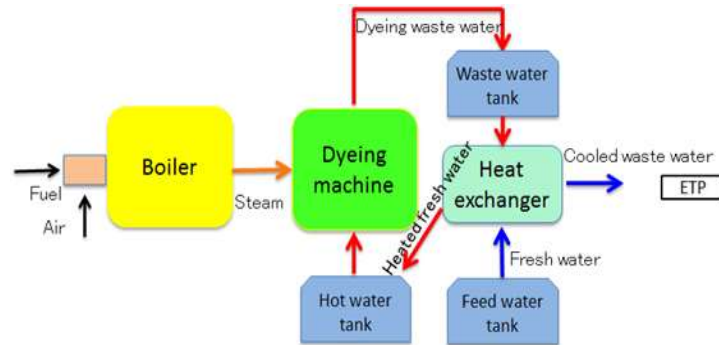
WH: 4 GWh/y

DH Network size: 1 km

EH temperature: 60-90°

from exhaust hot water
(washing machines,
dyeing process) and steam (dryers)

Examples: Getzner Textil (Bludenz)



Source: Excess Heat Recovery and Utilization in Textile and Garment Factories

Textile and Laundry industry are low-temperature sources

Textil industries have a limited production capacity. Nevertheless, the excess heat can be reused, which is normally coming from:

- Washing machines
- Drying process
- The steam of the dryers

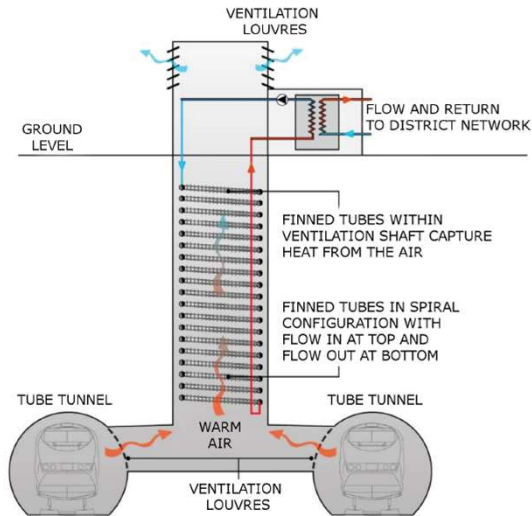
Subways

Temperature:
10-30°
(winter / summer)

Capacity: 1MW

Examples: London,
Turin, Vienna, ...

Source: Celsius Project



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Subway is a low-temperature source

The reuse of Excess Heat coming from the subway is a relative new discovery, that can be exploited in the most of the big cities and this is coming normally from:

- Brakes of the trains
- Air circulation on the tunnels

Excess Heat Cadasters: sources mapping, registry set-up, and examples of existing ones

Part I - Excess Heat: what it is, why it is used and how



This project has received funding from the EU's Horizon 2020 programme under grant agreement no 101033706.



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Purpose: mapping sources, raise awareness, provide data

Heat sources are identified by:

- Location
- Temperature level: low/medium/high
- Heat flow: water/fumes (GWh)
- Fluctuations: daily, weekly and annual

Exploitability is assessed in function of:

- Heat demand in the heat sink
- Proximity to the heat sinks -> cost of transport
- Costs of heat extraction
- Existence of generation and grid infrastructures

Overview of what is Cadasters

- Excess Heat Cadasters development is increasing.
- Some regions could have similar approaches or different ones.

The main idea with Cadaster is to map sources:

- It helps to be aware of the existence of Excess Heat sources.
- Providing different kinds of data to connect possible suppliers with sinks.

The chart explains how to find Excess Heat sources and exploit them according to their location and operative data.

Set up an Excess Heat Cadaster

Steps:

- Identify potential EH sources: by sector (NACE codes)
- Estimate data: conversion tables for subsector and production
- Contact sites and confirm via surveys/interviews

Useful documents:

- [Manual for Excess HeatCadaster Development](#)
- [Data Collection Survey](#)

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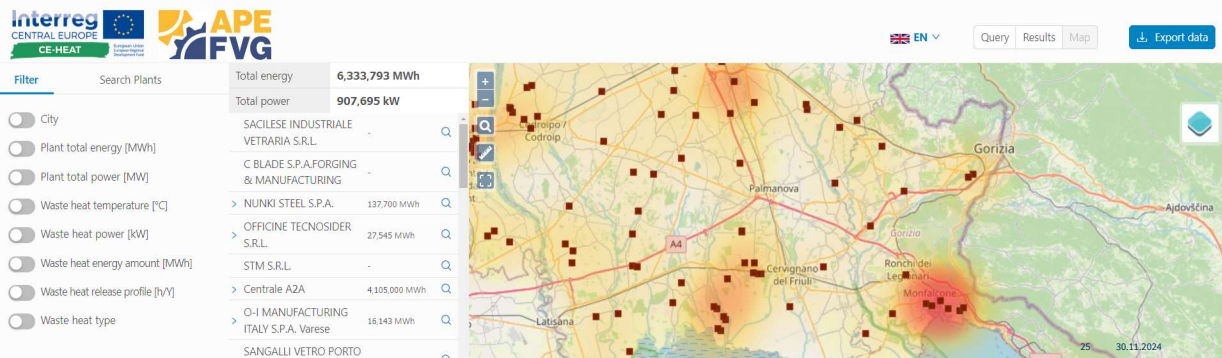
Find a sources with Cadaster

Look and the industries that you have nearby, remembering that the information could be:

- An outside estimation for the potential EH
- Information provided by the industry

Note: The links can help to find extra information about cadasters and its data collection, and the presentation slide can provide questions in case a participant requires other regions.

- [Styria Digital Atlas & Excess HeatRegistry](#)
- [Bavaria Excess HeatCadaster](#)
- Interreg CE-HEAT [Excess HeatPotential: United Kingdom, Slovenia, Croatia, Burgenland \(Austria\), Thuringia \(Germany\), Czech Republic, Lower Silesia \(Poland\), Friuli Venezia Giulia \(Italy\)](#)

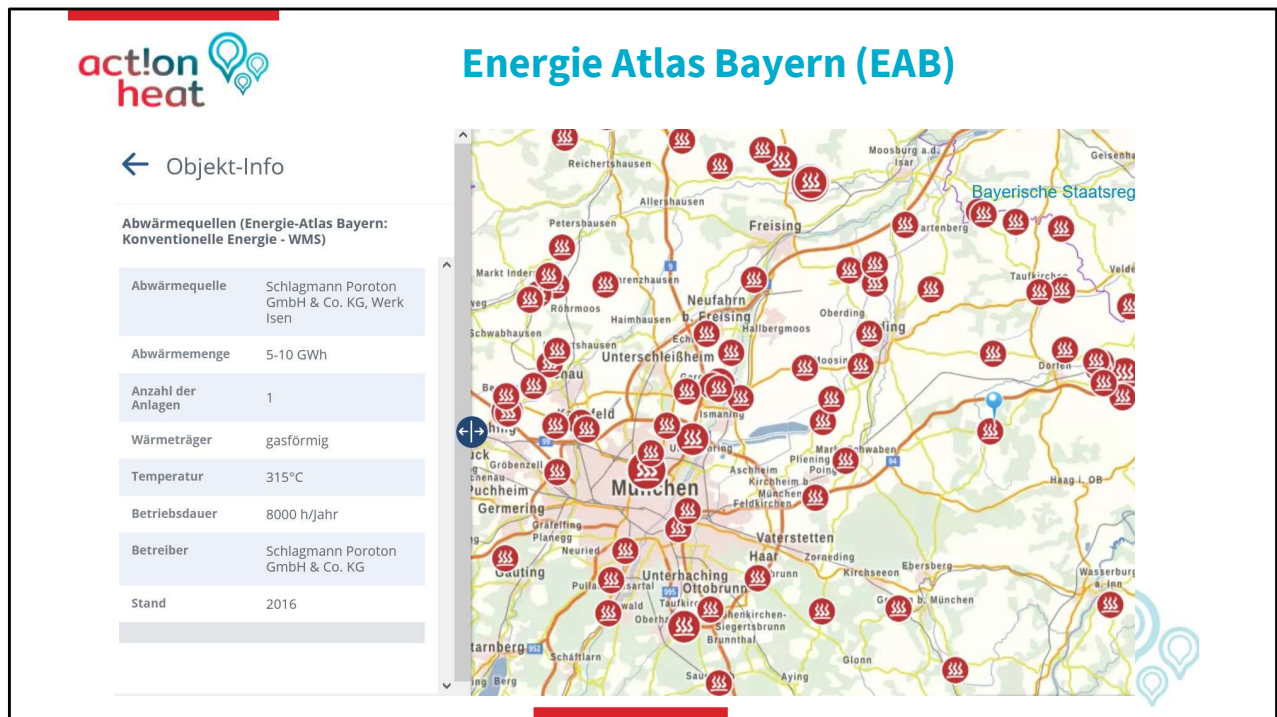


Different Cadasters

The chart shows two different cadasters,

- The Barvarian
- An interactive project with some Cadasters for region of Styria.

First, the Barvarian, was presented.



EAB is in the GIS mapping for Excess Heat and other renewable sources like:


- Geothermal
- Hydropower
- Wind energy
- Biomass

It is possible to go to Excess Heat and open the potential to see all the sources they identify. If you zoom in on the map, you can see where it is, and by clicking on it, you can identify:

Company name: Schlagmann Poroton

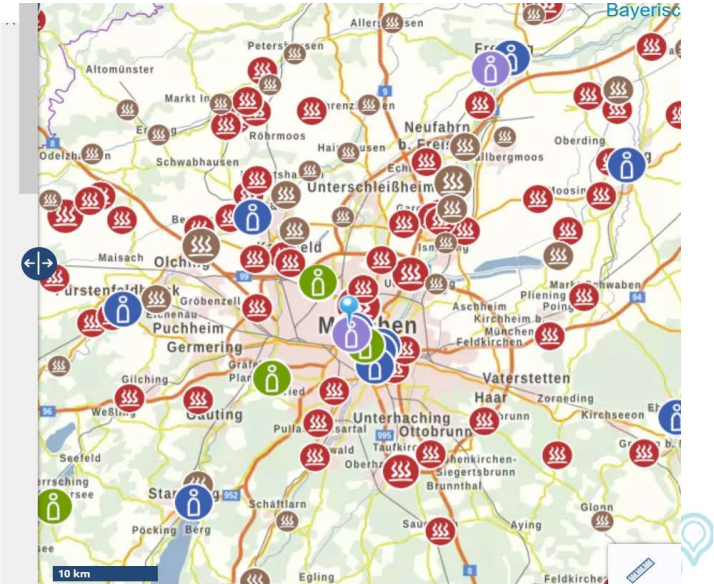
- Estimation of Execes Heat potential: 5-10 GWh
- Heat transfer medium: gaseous
- Temperature range: 315°C

- During how many hours in the day is it possible to have that: 8000 h/Jahr



EAB implemented projects

Institution	Wasserwirtschaftsamt München
Angebot	Fachinformationen und Beratung
Angebot im Detail	Informationen und Beratung zu wasserwirtschaftlichen Fragestellungen bei (oberflächennaher) Geothermie, Wasserkraft und Energie aus Abwasser (Abwärme).
Anschrift	Heißstraße 128, 80797 München
Kontakt	Tel. (089)21233-03, poststelle@wwa-m.bayern.de
Webseite	Wasserwirtschaftsamt München
Institution	Amt für Ländliche Entwicklung Oberbayern



Implemented projects information

On the left side, it is possible to find:

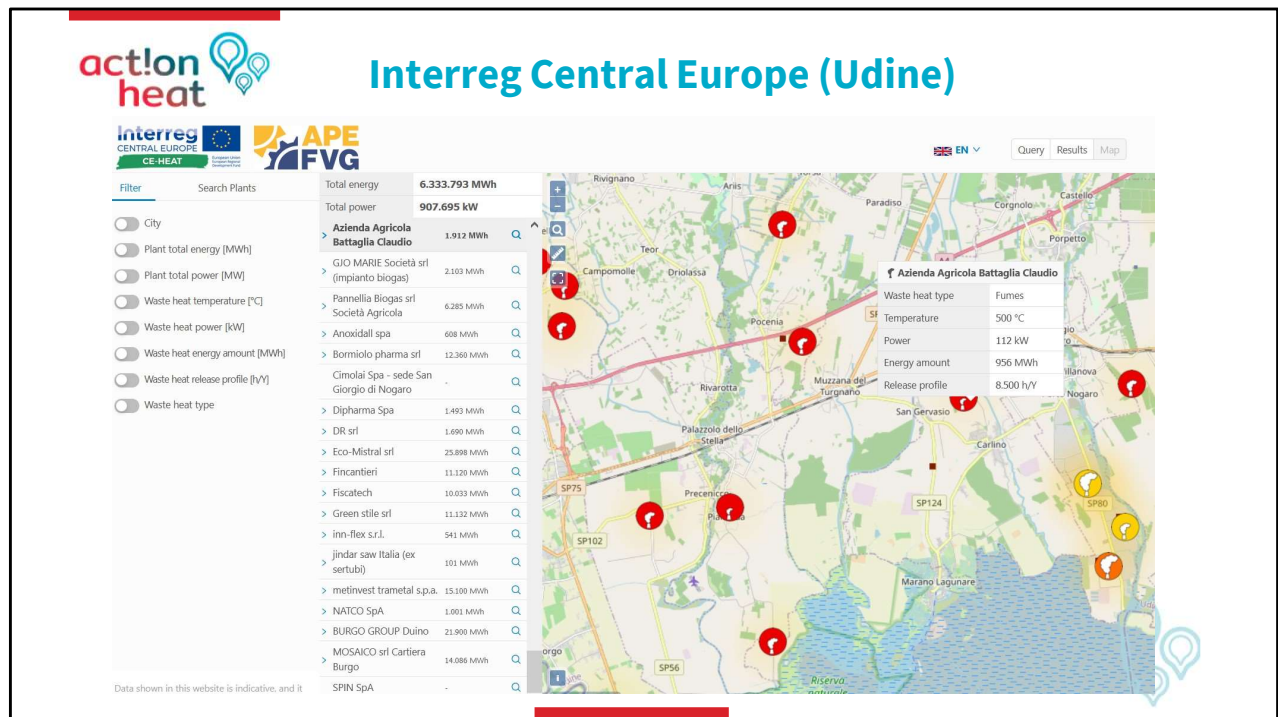
- Waste water potential
- Places where the Excess Heat is already reused

Those implemented projects can help as a significant driver.

A click on the info symbol, it will be possible to see:

- The contact person's data to get in touch and have more information.

Note: they are also heat networks implemented to understand how it mainly supplies one area.



The Interreg project.

It is a central European project for the region of **Udine, Venecia**. In its internet atlas will be possible to visualize the locations for:

- High-temperature Excess Heat potential industries in red
- Medium temperature potential and lower with other colors

If you click on one, it will be possible to see information about:

- The media
- Temperature
- Power
- Energy amount
- How stable

Excess Heat: Challenges & Factors of success



Part I - Excess Heat: what it is, why it is used and how



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Common Challenges

- **Lack of data** --> Excess HeatCadasters can provide a starting point
- **Lack of interest** from industries in participating in EH recovery projects
 - Economy -> heat supply can be paid to the EH source
 - Motivation -> Energy Industries can be subject to emission targets
- Industrial EH suppliers and Network Managers/Heat Suppliers usually have **different priorities** (reduce costs vs security of supply) and amortization periods (short for industry, long for heat supplier)
- **Misaligned heat load profiles** of supply and demand (daily/seasonal)
- **Default Risk:** the industry shuts down/relocates -> Backup capacity
- Managing temporal fluctuations -> Heat Storage, back-up capacities

Important challenges

To unify the information for sources and sinks

Contact with the information companies.

Convince companies about the importance because they have other priorities

The connection between companies as suppliers and the demanders.

The company stops working because it is closed.

- **Spatial proximity** of heat source/sinks reduces connection costs.
- The better the **profile** of the heat **source matches** the **profile** of the heat **sink** and the higher the **current heat supply costs** of systems to be replaced, the better.
- The more **constant** and the **higher** the **temperature**, the more valuable and better suited the Excess Heat is for recovery and use.
- **Accurate contract negotiations** between EH supplier, system heat supplier and customers.

Important Success Factors

The proximity between suppliers and users helps reduce costs.

In some projects, distances exceeding 20 km are feasible due to the significant availability of excess heat (EH). Systems with consistent and higher temperatures are generally more advantageous.

Additionally, contract templates between sinks and suppliers are now available, streamlining agreements. These templates were offered to participants during the webinar as a resource.

Discussion - Q&A

Part I - Excess Heat: what it is, why it is used and how



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Hotmaps: EH Layers, CM Add Industry Plant, CM Excess Heat Transport Potential



Part II - Assess Excess Heat potential exploitation



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Hotmaps: visualise Excess Heat

HOTMAPS is an open-access tool that allows public authorities to identify, analyse, model and map resources and solutions to start heating and cooling planning in their territory in a resource- and cost-efficient way.

Excess Heat Potentials

- **Industrial Sites Excess Heat**(layer of default database)
- **CM Add Industry Plant** (to upload own data)
Add industrial sites not mapped in the default database with their heating and cooling demand and Excess Heat potential through a stand-alone Excel form.

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HOTMAPS is an open-access tool built in 2020.

Hotmaps is a platform with several layers and calculation modules, but for this webinar, we will focus on two-specific tools of hot maps.

Has a database that estimates excess heat potential for around 5000 energy-intensive industrial sites in Europe. This means you must find an Industry with excess heat in your territory, but if you don't find one, you need to start an action-heat plan. Then, the platform will allow you to add an industry plant, uploading some specific data in its calculation module.

How to do that; download a stand-alone Excel form and fill out basic information for the industrial plant, like sector, subsector, the location with coordinates, and an estimation for the production, in case you know it. Of course, If you have more precise information, such as the excess heat and the temperature distribution, it will be better.

Finally, this Excel has some macros that allow it to be uploaded as a CSV file to add to the program in the database.



Hotmaps: visualise Heat Density

Heat Demand

- **Visualize Heat Density Map** default layer/(upload own data)

Assessment

- **CM Excess Heat Transport Potential**

Calculate the flow and costs of heat transmission from potential Excess Heatsources to potential district heating areas.

- Thresholds data for Calculate DH potential within a selected region:
 - 1) Minimum heat demand per hectare, 2) Minimum heat demand in the DH area.
- Extra inputs: Industrial Site Subsector and Excess Heat

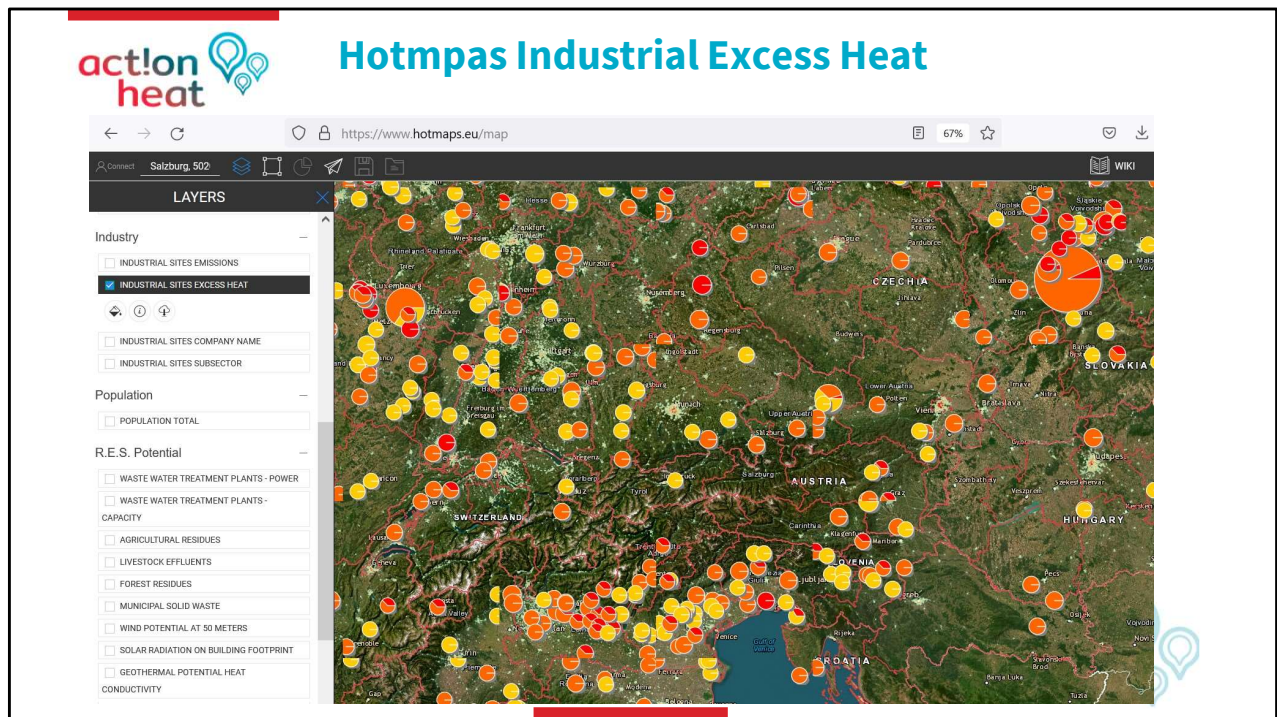
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Heat demand calculation

The tool allows you to visualize if there is heat demand near the industrial excess heat site you are interested in and helps you calculate the economic potential to build a heating or cooling network and the cost for the distribution from the industry to that network area.

In other words, Hotmaps will help you visualize a specific heat demand area. The excess heat transport potential module will assist you in prioritizing the demand according to the percentage of users to create a district heating network. Then it will help you to calculate the flow and cost of heat transport from the industry source to that district heating network area, as I will show you next.



How does an industrial Excess Heat look in Hotmaps?

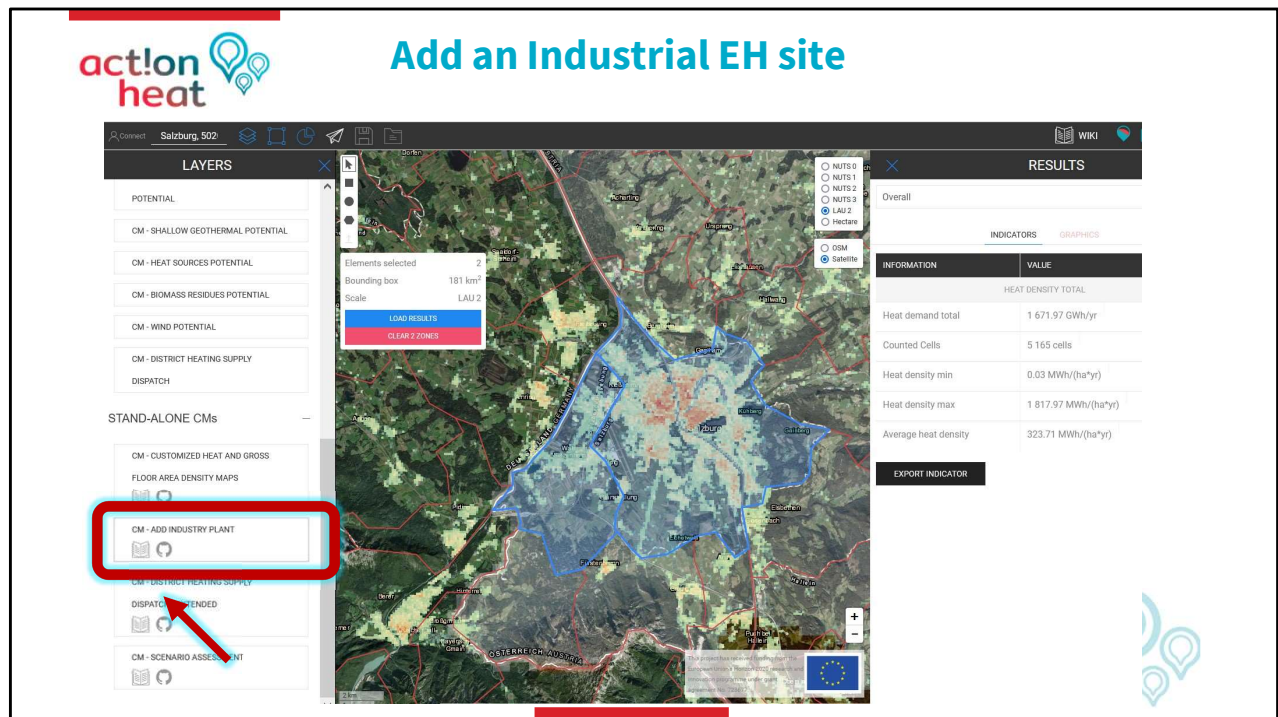
- 1.- Connect to the Hotmaps Toolbox: <https://www.hotmaps.eu/map>
- 2.- Search a location with the search bar (top left). In this case, it will be Salzburg
- 3.- Select the Industrial Sites excess heat layer and click to visualize (low, medium, high excess heat) and zoom out to see more industries:

Low temperature represented in Yellow

Medium temperature represented in Orange

High temperature represented in Red


Identify an area with significant heat demand near the industrial site and select it with the polygon at the hectare level.



How to add an industry source:

In case an industry you are looking for is not in the Hotmaps database, you can add one:

1. Search a location with the search bar (top left) giving the name of the place where your plant is located to see if it exists; for the case of this demonstration will be Salzburg.
2. Hotmaps do not show industrial sites in Salzburg, Nevertheless is necessary to select the place on the map at Hectare or NUT level (will appear selected in blue) in that moment, a small window on the left side will appear.
3. Click on the window Load Results to visualize (Heat Demand Total/ Res /Non-Res). The Calculation Modules option will also be open at this moment.
3. Open The Calculation Modules CM function (top left by the layers) and scroll down to find the **CM Add Industry Plant**.
- 4.-Click on the Wikipedia symbol



Download an Excel on the Wiki link.


Data input in Excel-tool by user

Please download the provided Excel-tool from [HERE](#)

The approach on how to use the Excel-tool is illustrated in the figure below and described in more detail in the following sections.

1st step:
General Information

Please enter general information about the sites for which heat and cooling demand and excess heat potential should be calculated
--> possibility to enter 10 sites



2nd step:
Choose option in tab sheet

Option 1
- Manual input

Option 2
- Plant selection

Option 3
- Sector selection

Please fill in manually, if data on heat/ cooling demand and excess heat potential and its temperature distribution is available for the company

Please choose this option, if no information about heat/ cooling demand and excess heat of the company is available. The calculation is based on plant specific data.

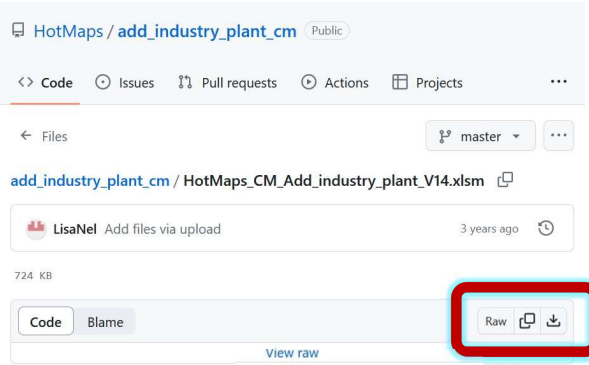
Please choose this option, if your plant type is not available in option 2.

Step-by-step approach how to use the Excel-tool.

1) Add general information

Please go to tabsheet: Input - General information


In the first step, please enter all necessary general information about the sites for which heating and cooling demand and excess heat potential should be calculated. It is possible to add up to 10 industrial sites.



CM Add industry plant: click on the wiki link to download the [Excel](#) file

1. The wiki link will be open; scroll down until you find Data input in Excel-tool by users
2. Click on Please download the provided Excel-tool from **HERE**
3. Another window will open; go down to find the icon where to download the Excel
4. Click on it, and decide the place to be discharged in your computer

Note: The instructions for adding industrial Excess Heat data in the Excel sheet CVS format are explained step by step in the first wiki link.



Add the industry EH information

1st step:
General Information

Please enter general information about the sites for which heat and cooling demand and excess heat potential should be calculated
--> possibility to enter 10 sites

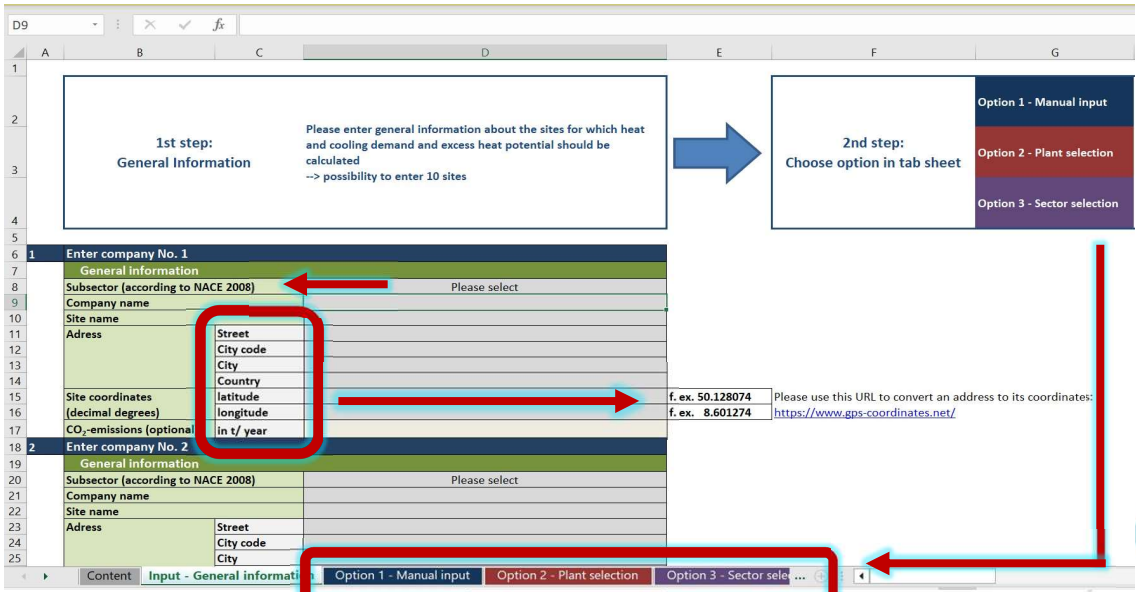
➔

2nd step:
Choose option in tab sheet

Option 1 - Manual Input

Option 2 - Plant selection

Option 3 - Sector selection



Open the Excel and add the Industry information

1. Populate the general info for the industry. Important data are the subsector and the GPS coordinates to find the industry.

2. For the second step, choose an option and fill in the data on the Excel:

If you know the exact heat demand and supply

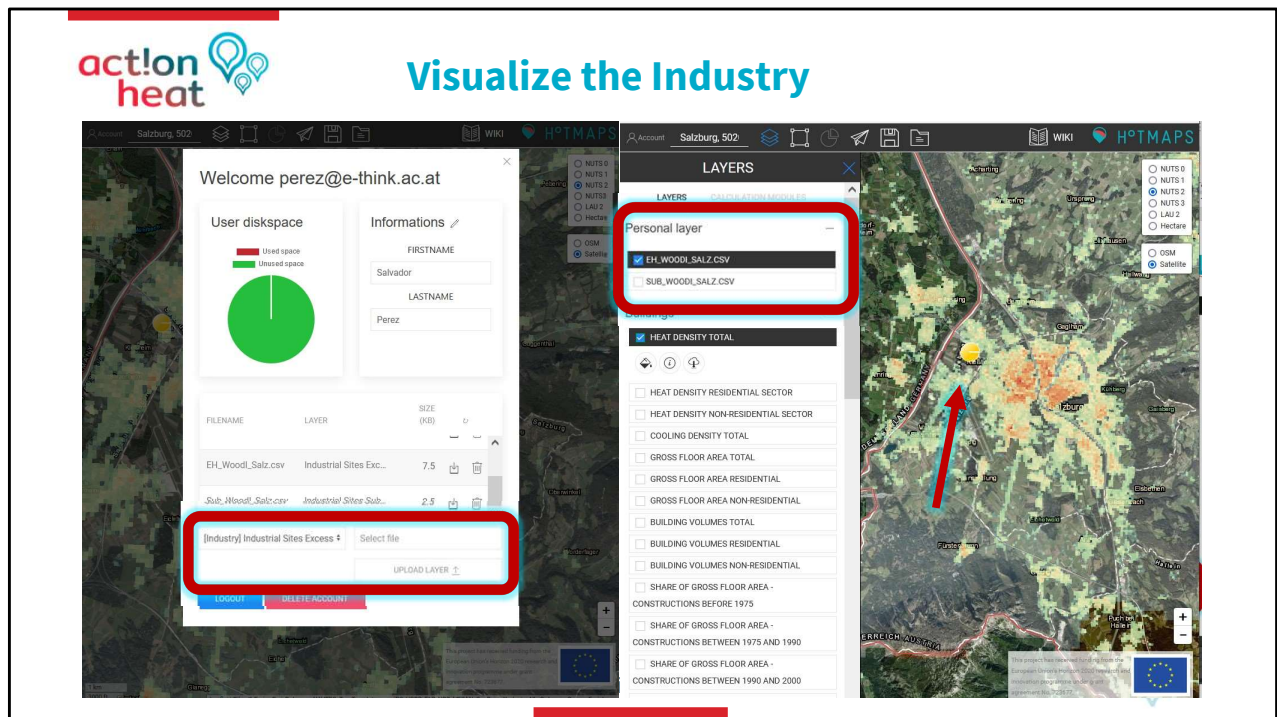
If you know only the subsector and annual production

If the subsector is not listed in Option 2 is it possible to add

3. Extract 2 CSV files from the last two sheets (after completing the data)

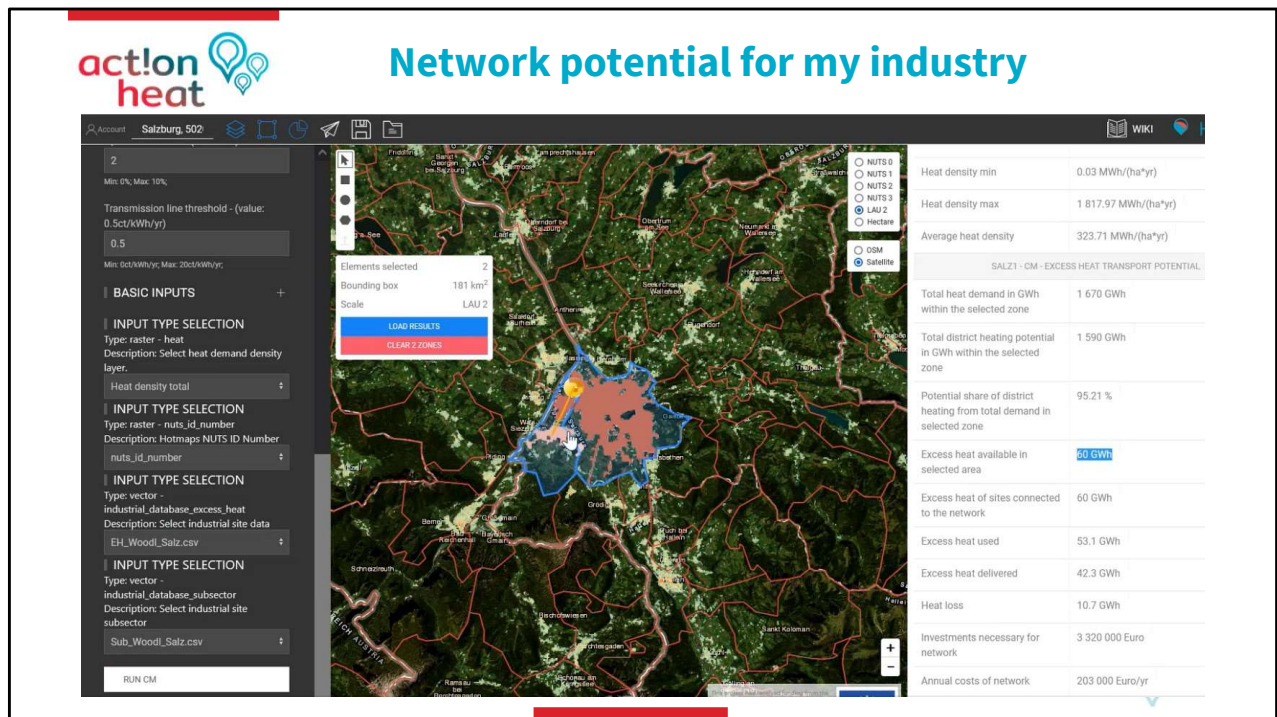
If you need help to understand read the Wiki link indication.

Note: It is necessary to allow macros when in order to add information and save the CVS data that will be uploaded on the Hotmaps platform.



To visualize the new industry on Hotmaps

1. Create a User Account (click on Connect on the top left) and activate your account by clicking on the link in the email you received.
2. Access to your user account, select the kind of file you will add, in this case, Industry Sites Excess Heat, the localization on your computer, and upload the 2 Excel CSV data.
3. Close the account window, and on the layers will appear two industry sites you add to the list as a personal layer.
4. Click on in and the newly added plant is visualized on the map, with a circle for Excess Heat potential and a triangle for the subsector



Calculate the Excess Heat Transport Potential on Hotmaps

1. Select a place near the industry side on the map at Hectare or NUT level (selection will appear in blue). Load the results in order to visualize the Calculation Mode CM function (on the top left by the layers)
2. Scroll down and go to the CM - Excess Heat Transport Potential and click on it.
3. The Calculation Mode window will be open, and there you can manually change the inputs for your heat demand or leave the default data.
4. It is important to Scroll down again and select the last two input type selection windows to add your own uploaded excess heat and subsector layers.
5. Run CM and assess results. If any potential area is found, it is colored on the map. Otherwise, lower the parameters until you find a potential DH area.

THERMOS and EMB3Rs Demo



Part II - Assess Excess Heat potential exploitation



This project has received funding from the EU's Horizon 2020 programme under grant agreement no 101033706.



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THERMOS is a free, web-based **DHC planning software** that analyses **network options including paths, load anchors and connection to single additional buildings** for the deployment of new and upgrade/expansion of existing DHC systems.

EMB3RS is a free web-based **matching-tool** that evaluates the **compatibility of Excess Heat and cold sources and sinks** in industrial processes, energy systems and District Heating and Cooling (DHC), based on the simulation of technical and economic supply-demand scenarios.

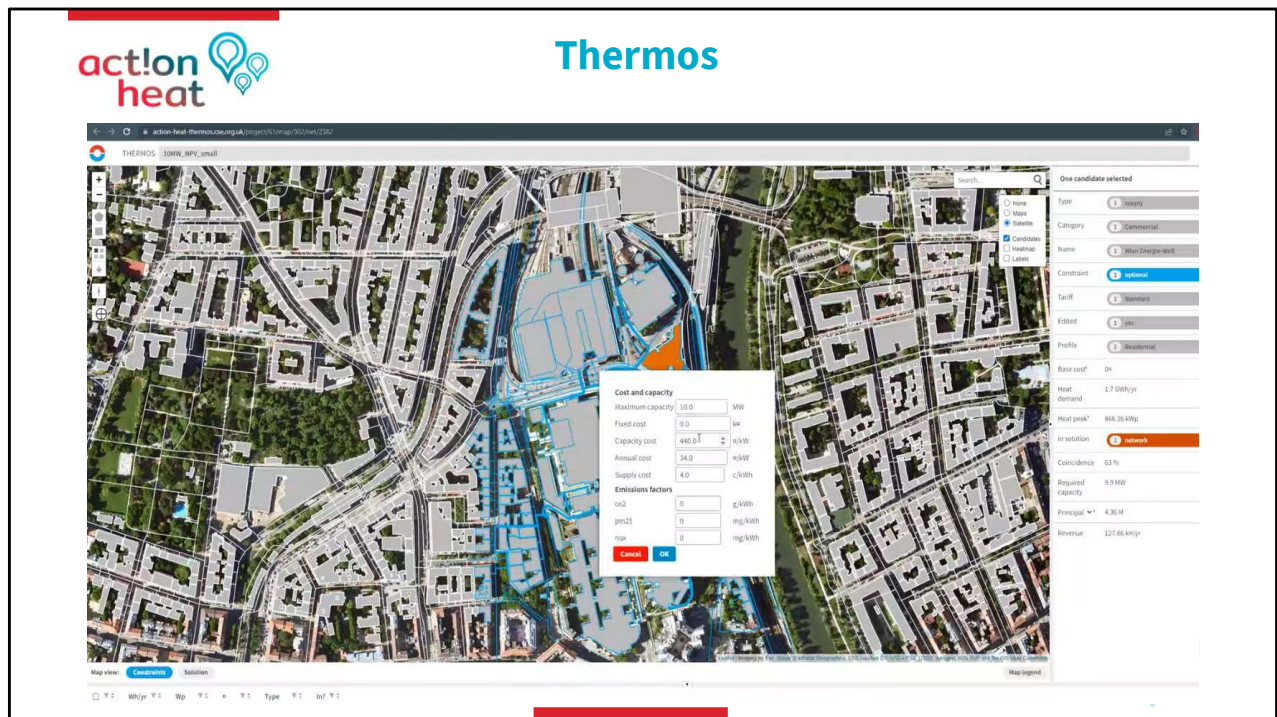
Tools for analysing the use of Excess Heat

THERMOS is a tool used for the support facility 2

- Allows to design a Network for the source to the surrounding buildings
- Has two parts, one is supply and the other is distribution to the networks

EMB3RS has the main focus to analyse Excess Heat projects,

- The platform matches sources and sinks
- It is more focused on the Excess Heat matching than on the distribution



Tool for the district heating network planning

THERMOS was not only developed for integrating Excess Heat into a district heating network but can also be effectively used for this purpose.

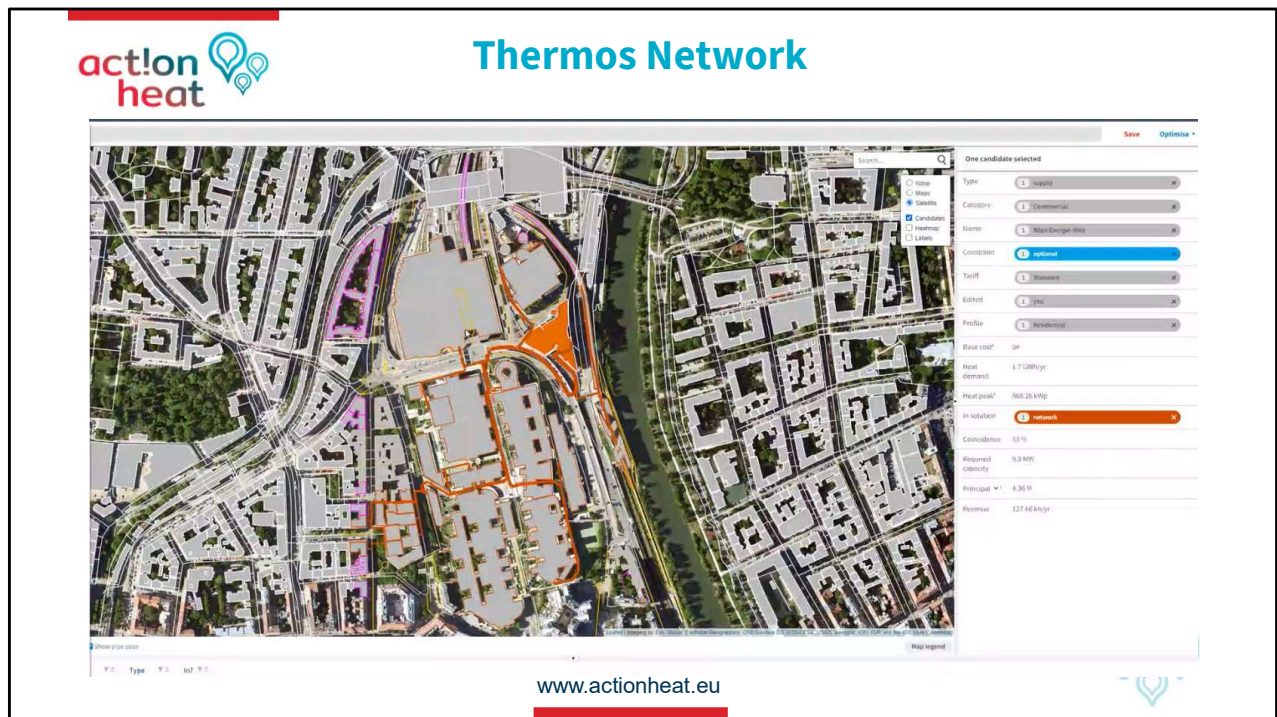
An example was presented to demonstrate the identification of optimal networks for Excess Heat supply:

THERMOS includes default data for demand and various pipe options, facilitating the construction of a regional network.

The example illustrates the creation of a network utilizing excess heat from a waste incineration plant in Vienna.

The incineration plant is represented in orange, along with its internal data, such as capacity, supply costs, and demand.

The blue lines indicate potential candidates that could benefit from the heat source through the construction of a network.



Running the module provides a visual solution

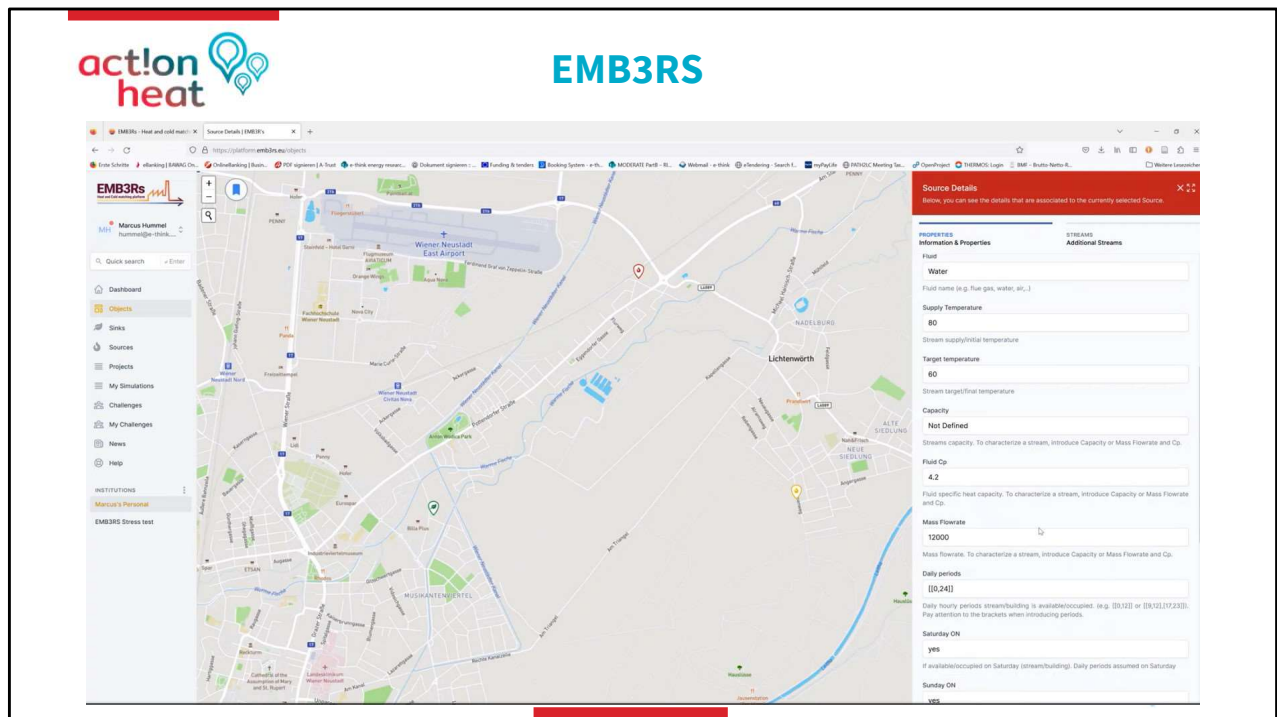
Buildings displayed in orange represent the connected buildings optimized for supply by the source.

In the window on the right side, detailed network information can be viewed based on the solution results.

It is also possible to download a summary of the solution, including the NPV and connection points.

Using preliminary data, the tool offers a preview of how your network could look with the available sources in the region. However, if specific demand and supply data are provided, the network design will be more accurate and detailed.

This tool can also be helpful for policymakers.



EMB3RS is a map-based tool

You need to define your project, territory, and the sources and sinks.

In contrast to Thermos, where buildings are not part of the background, you need to manually enter or upload all your supply and demand points.

The example shows three sources and one sink, and the platform provides options to define the sources and sinks in the template.

The Source Detail allows you to specify the capacity and availability of each source, with the option to define multiple streams per source.

The Sink Detail allows you to set the desired temperature, based on the starting temperature for the district heating system.

Discussion – Q&A

Part II - Assess Excess Heat potential exploitation



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Thank you for your attention!

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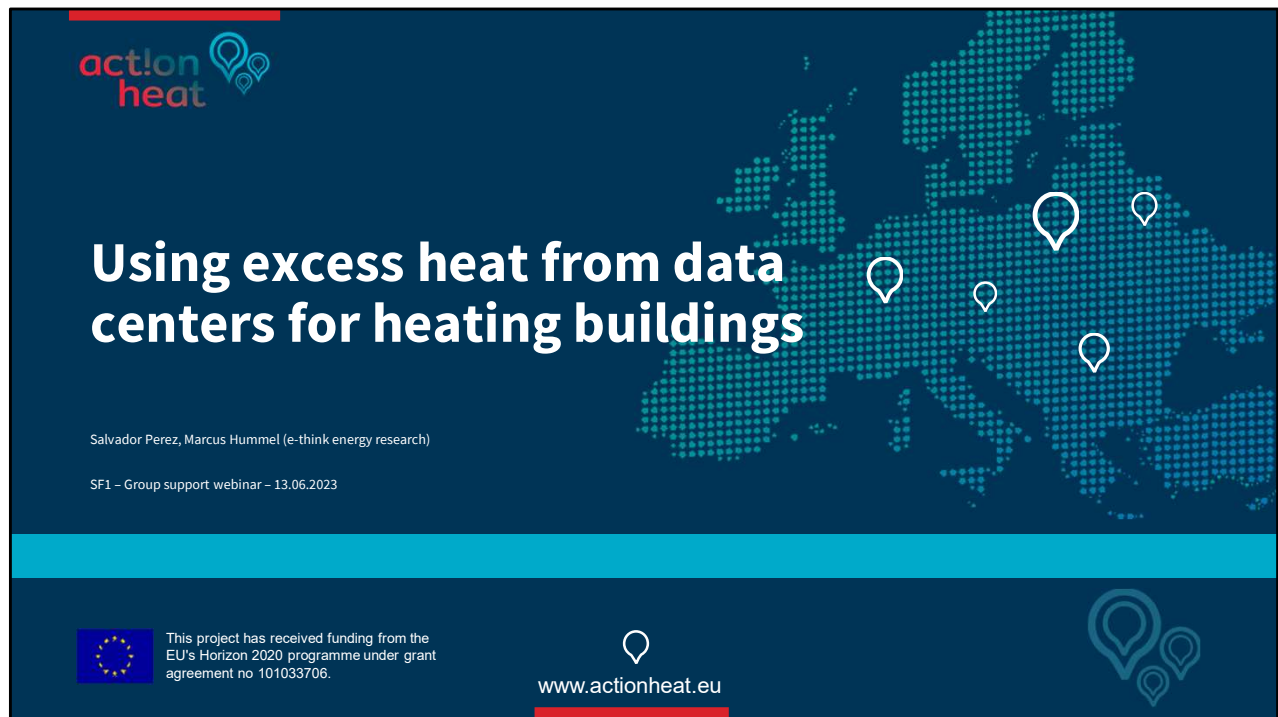
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Webinar 5: Using excess heat from data centers for heating bulidings

Act!onHeat SF1

Time: 1 h 11 min

- Serial 2:
 - Webinar 5
 - Strategical Heating & Cooling planning
 - Group support for municipalities and stakeholders
- Presented by:
 - e-think / Austria
 - TU-Wien / Austria

Part I: Datacenter Excess Heat: Introduction

- Theoretical physical background (15')
- Political landscape (15')
- Discussion, Q&A (5')

Part II: How to reuse Datacenter Excess Heat

- Overview of technologies and concepts that can be used (20')
- Best practice examples (Technical and economic data) (15')
- Discussion, Q&A (10')



Theoretical physical background



Part I - Datacenter Excess Heat: Introduction



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Datacenter background

Datacentre Excess Heat (EH) is the heat generated by the IT and HVAC equipment operating continuously without stopping nearly every day, consuming huge energy and producing very high thermal loads

- **Data centers** (DTC) will use almost **5% of global produced electricity** by 2025 (Andrae A, 2015) M0
- **DTC operates 24-7** and needs to be cooled because heat is generated by many different components
- The **annual growth** of DTC is projected to be in the range of **12-14%** per year (Cushman & Wakefield, 2023)
- It is estimated that **68% of the excess heat in DTC can be recovered** (Huang et.al,2019) M1

Source: Andrae A., and Edler t. (2015) *On Global Electricity Usage of Communication Technology*
Cushman & Wakefield (2023) *Global Data Center Market Comparison Report*
Huang et. al., „ (2019) *A Review of Data Centers as Prosumers in District Energy Systems*

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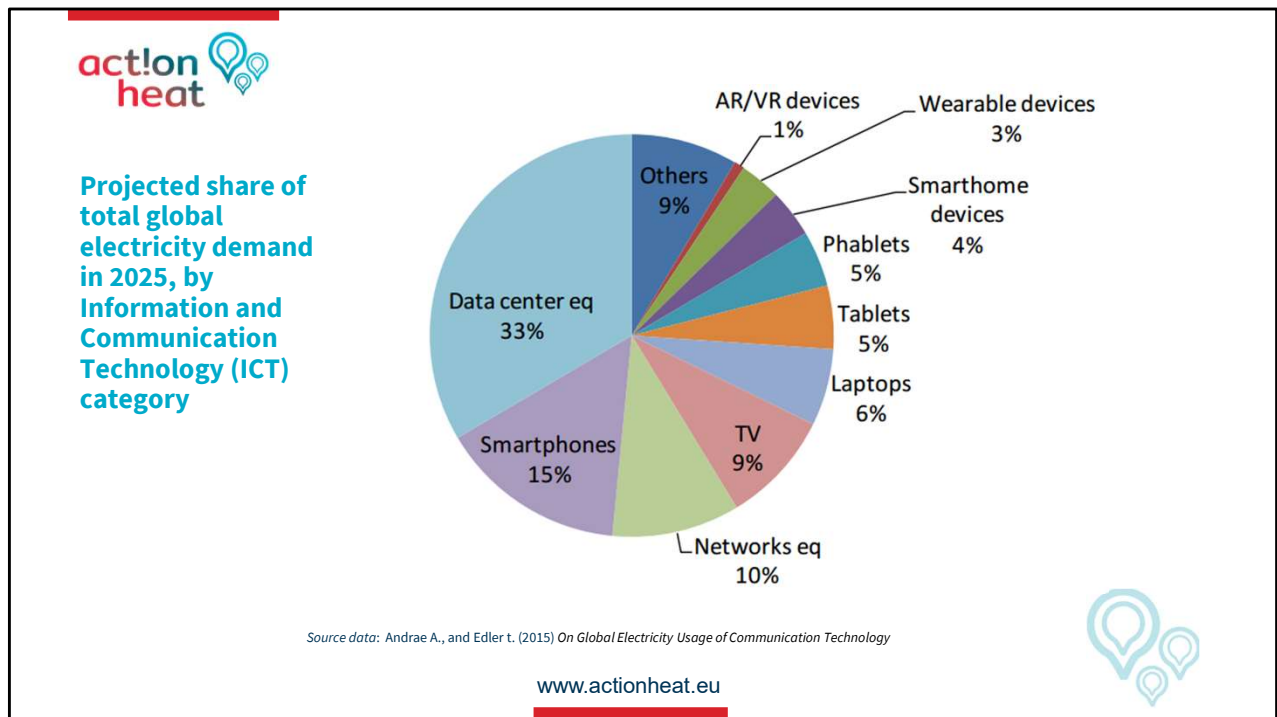


Why reuse the Excess Heat from Data Centers?

- Data centers will continue growing exponentially.
- The Data centers produce Excess Heat day and Night
- The Heat can be increased and reused for District Heating

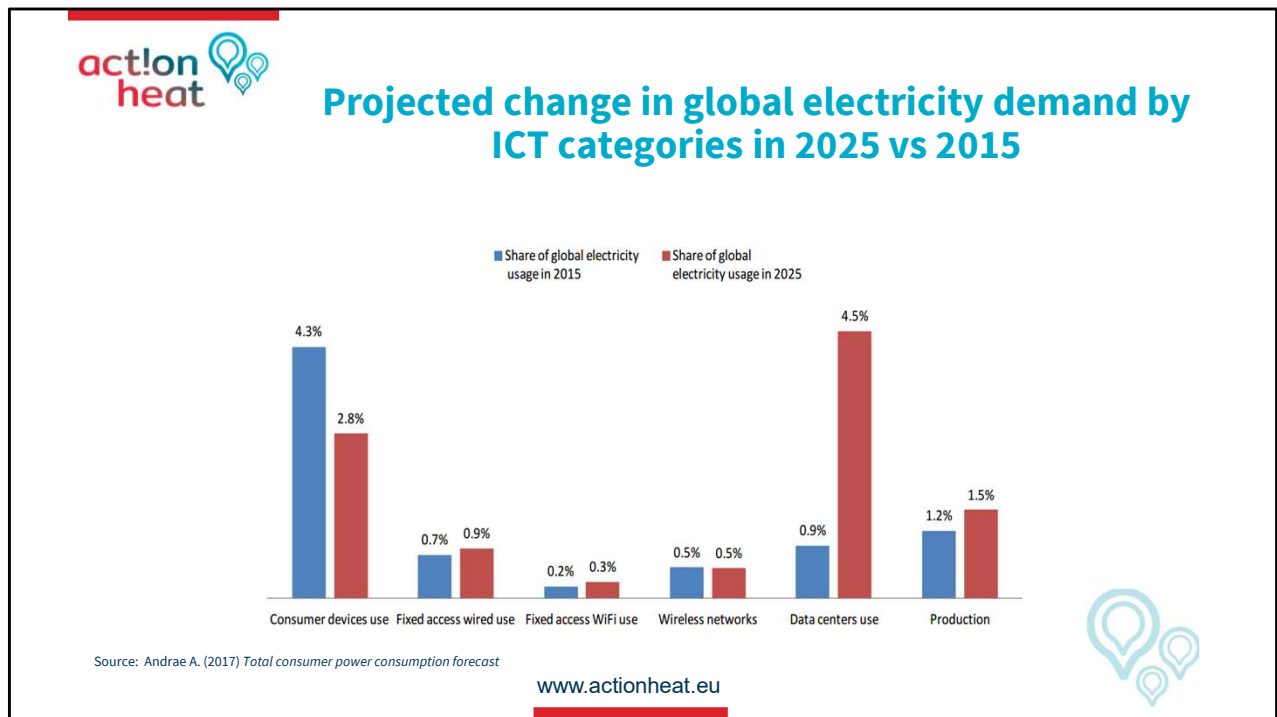
Folie 4

- M0** Source needed
Autor; 2023-06-09T12:40:32.908
- M1** What do other sources state?
Autor; 2023-06-09T12:51:22.471
- M1 0** And: what are the restrictions that are taken into account in this estimation?
Autor; 2023-06-09T12:51:43.839



Datacenter DTC energetical demand by 2025

- Data centers are projected to consume 1/3 of all Information and Communication (ICT) global electricity demand by 2025
- ICT Information and Communications technology
- AR (Augmented reality) real-world and VR (Virtual reality) is entirely virtual.



Comparative projection of energetical demand in ICT

Information and Communications technology ICT comparative electricity demand by sectors

Global electricity demand by data centers is projected to increase +400% by 2025 (vs 2015)

- The blue lines represented the consumption by sector in 2015
- The red lines represent what the consumption will be by each sector in 2025

Data Center heat production: Standard vs High-performance Servers

Component	Temperature	Proportion of total heat	Component	Temperature	Proportion of total heat
Microprocessors	85 °C	30%	Disk drives	45 °C	6%
DC/DC conversion	50 °C	10%	Motherboard	40 °C	3%
I/O processor	40 °C	3%	Microprocessors	85 °C	53%
AC/DC conversion	55 °C	25%	DC/DC conversion	115 °C	13%
Memory chips	70 °C	11%	I/O processor	100 °C	10%
Fans	30 °C	9%	Memory chips	40 °C	14%

Source: ASHRAE whitepaper (2011). Gaseous and particulate contamination guidelines for data centers

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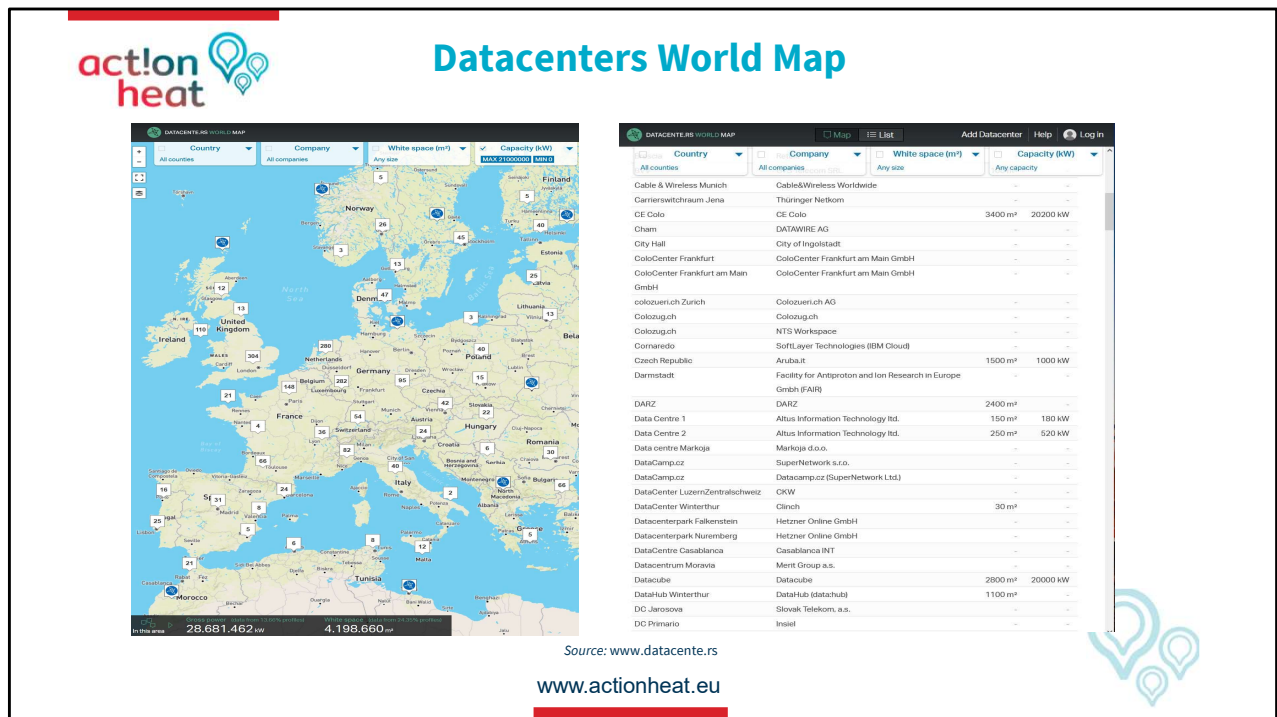


Heat demand temperature for different DTC components

- The IT server racks have dif. temperature. Between Elect. Comp. (Dsk, MB, Mic)
- Consequently, the heat dissipation rates btw those Elec. Divs are different.
- The table summarizes the heat and temp. distribution of different components in standard and high-performance servers.
- Different types of servers dissipate dif. proportions of temp. and H densities
- Conventional DCs have Heat Dissipation Rates (HDR) in the range of 400 and 900 W/m², cubic meter
- With the development of compact and high-power modules in new DC the HDR has increased 10 times in ranges from 6,000 to 11,000 W/m²
- The heat dissipated inside the DC should be removed by Cool. Sist.
- Therefore for dif. dissipation rates. Different Cool Sist and Tec. had been developed to reuse the EH from DTC

Folie 7

M0 Total of heat shares sums up to more than 100% --> why is this the case?
What exactly does the proportion of heat mean
Autor; 2023-06-09T12:35:00.452



Some DTC localization and information

The World Map of Datacenters internet site shows some Information about the company like:

- Name of the Datacenter
- Size of different data centers
- Capacity of different DTC around the EU

For the participants of the Webinar, it will be possible to find one in their regions.

Political Landscape



Part I - Datacenter Excess Heat: Introduction



This project has received funding from the EU's Horizon 2020 programme under grant agreement no 101033706.



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- According to the revisions of the EED and RED:
 - DTC with more than 1 MW total rated energy input will need a cost-benefit analysis of using the Excess Heat. M0 (EED)
 - The use of Excess Heat for district heating will need to increase from 1% to 2.1% per year (RED)
- Advantages of using excess heat from DTC:
 - Most DTC infrastructures are located near urban areas (Oró et.al, 2019).
 - The excess heat of data centers can be used to heat buildings.

Source: EED Energy Efficiency Directive recast proposal by the COM 2023 – Article 24, paragraph 4
RED Renewable Energy Directive. Package "Fit for 55", directive 2018/2001/EU Article 24, 9b
Oró, Taddeo, und Salom, (2019) Waste Heat Recovery from Urban Air Cooled Data Centres to Increase Energy Efficiency of District Heating Networks

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According to the revision of the Energy Efficiency Directive EED and the Renewable Energy Directive a RED for the 'Fit for 55' package, two legislative policies will affect data centers and their excess heat recovery and may indirectly promote heat recovery for DC.

One of the revisions requires that DTC with more than 1 MW total rated energy input need to do a cost-benefit analysis of using the Excess Heat,

Unless they can prove that it is not technically or economically possible, this proposal will be mandatory for the future construction of data centers.

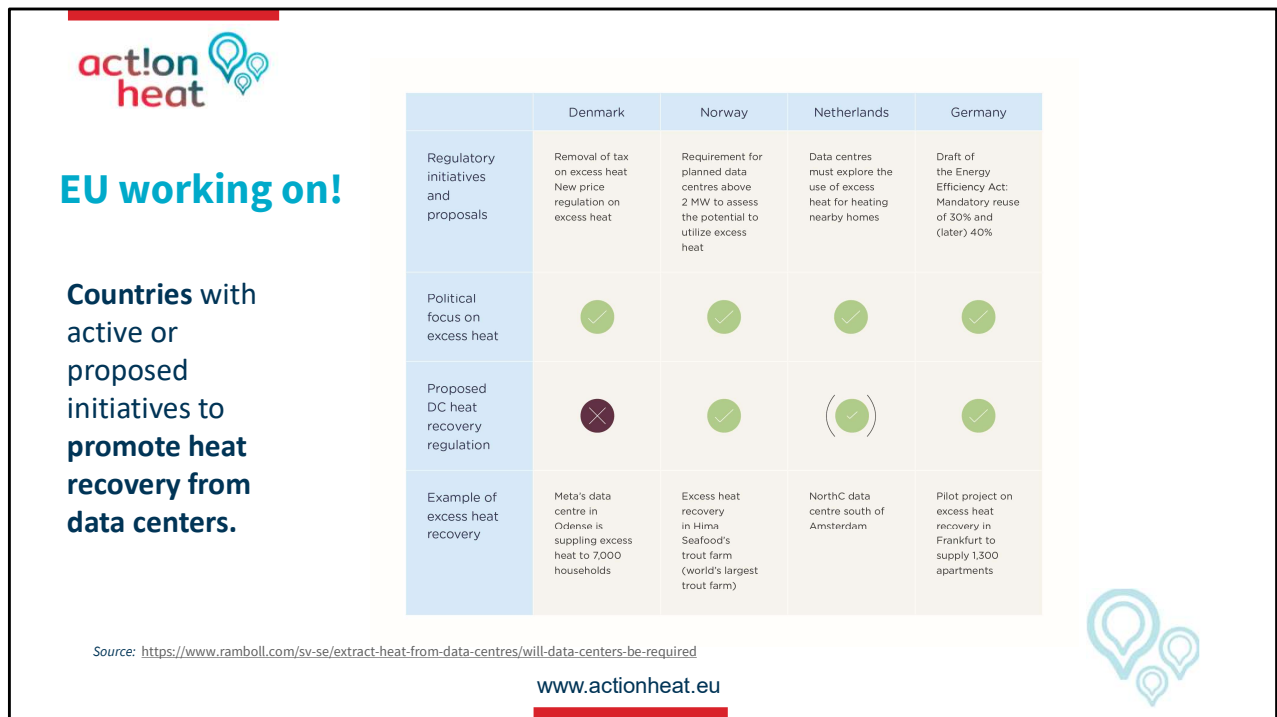
Additionally, the proportion of excess heat in district heating and cooling should increase from 1% to 2.1% per year, pushing district heating companies to look for additional excess heat sources.

In September 2022, the European Parliament adopted the two revisions, and the European Council is still considering both. It is expected that adoption by the EC will happen by the end of this year. Once the EU has adopted them, a deadline will be set by which each member state must have incorporated the directives into national law.

Folie 10

M0

Would be interesting to see the exact formulation of the paragraph in the EED recast --> also cite article
Autor; 2023-06-09T13:09:09.422



European political initiatives by country

Denmark removed taxes on EH from electrical processes to promote the recovery of EH from DTC and other electrical-based industries. Furthermore, a new price regulation on EH removes taxes to supply it to DH networks. Nevertheless, there are not yet any requirements in Danish law to recover the EH from DTC.

Norway is processing a law to require DTC with more than 2 MW capacity to reuse its EH for DH unless they prove it is not technically or economically possible. Additionally, the government has created a map of distribution stations to assist DTC in finding a spot to connect its EH to the DH network.

Netherlands developed new policy measures that required DC to explore using EH for heating nearby homes. At the beginning of 2022, the government announced it is working on new rules to control the construction by area of new hyper-scale DC.

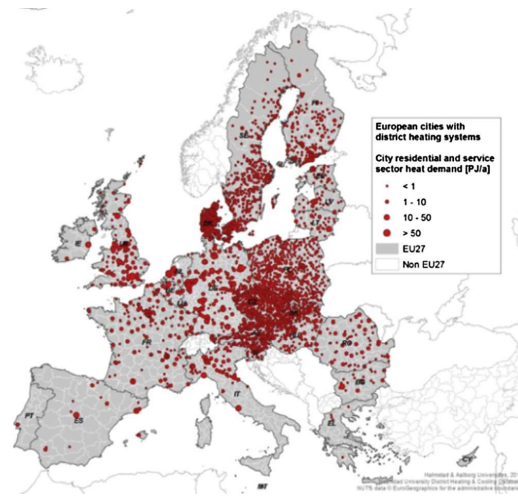
German government drafted a legal framework in 2023 for DC, which, in addition to strict demands on energy consumption, includes mandatory reuse of EH. It is specified that 30% of the EH from DC that starts operations in January 2025 and 40% that starts operations in January 2027 must be reused.

District heating networks

Country	Supply Temperature [°C]	Return Temperature [°C]
Denmark	70	40
Finland	70	40
Germany	80	60
Spain	90	70

Examples from the International Energy Agency of standard operational temperatures in European district heating networks (Skagestad & Mildenstein, 2018)

M0



Source: Oró, Taddeo, und Salom, (2019) *Waste Heat Recovery from Urban Air Cooled Data Centres to Increase Energy Efficiency of District Heating Networks*

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Existing H&C networks to connect data centers

Actually, it is a trend to develop low-temperature DH networks. Nevertheless, the most common DH networks are “high-temperature”.

- On the left side, the table shows the standard temperature operation of some DH networks in Europe. Explain
- On the right side, the map shows that DH systems are widely spread around Europe.

Folie 12

M0

Link does not work

Autor; 2023-06-09T13:12:11.403

DTC in Act!on

Examples of locations using excess heat from data centers to heat buildings and homes, through district heating networks

Company	Year	Location	Excess heat reuse?
Tieto	2011	Espoo, Finland	1 500 detached houses
Telecity Group	2013	Helsinki, Finland	4 500 apartments
Yandex	2015	Mäntsälä, Finland	1 000 private houses
Ericsson	2016	Kirkkonummi, Finland	1 000 single homes
Facebook	2019	Odense, Denmark	7 000 homes
Veolia	2019	Braunschweig, Germany	600 households
Telia Company	2022	Helsinki, Finland	20 000 single homes
Bahnhof	2030	Stockholm, Sweden	30 000 households

Sources: Huang u. a., (2019) *A Review of Data Centers as Prosumers in District Energy Systems*
Wahlroos u. a., (2018) *Future Views on Waste Heat Utilization – Case of Data Centers in Northern Europe*

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Datcenters supplying buildings

The table shows successful examples of data centers supplying buildings and households with their Excess Heat around Europe.

Over the last ten years, data centers have increased in capacity and size. Therefore, the potential to distribute excess heat for district heating has increased by more than 100 per year, as can be seen in the table.

Discussion, Q&A



Part I - Datacenter Excess Heat: Introduction



This project has received funding from the EU's Horizon 2020 programme under grant agreement no 101033706.



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Overview of technologies



Part II - How to reuse Datacenters Excess Heat



This project has received funding from the EU's Horizon 2020 programme under grant agreement no 101033706.



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M1



Overview of technologies that can be used

To increase temperature level and distribute excess heat

- **Heat Pumps**
- District heating network

To cool and recover heat

- **CRAH**^{M0} - 45% of excess heat
- **Chiller** recovers 55% of excess heat
- **CRAH + Chiller** recover 60% of excess heat

• **CRAH** Computer room air handler units

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The EH from data centers requires a heat pump.

Heat pumps are the best solution to reuse the low temperature of EH for district heating, increasing the low water temperature to be distributed in the DH network.

Now speaking about heat recovery, the best place to recover EH in DTC is after or before the cooling system. CRAH and Chiller are the most common cooling systems.

For example (CRAH) or Computer room air handler units are primarily used in medium-big size data centers (>100 kW).

Nevertheless, the absorption chiller is the most promising passive cooling technique for recovering heat.

Folie 16

M0 Abbreviation needs to be written / introduced somewhere

Autor; 2023-06-09T13:18:19.231

M1 Re fre
Ger ator

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M1 0 Cooling system

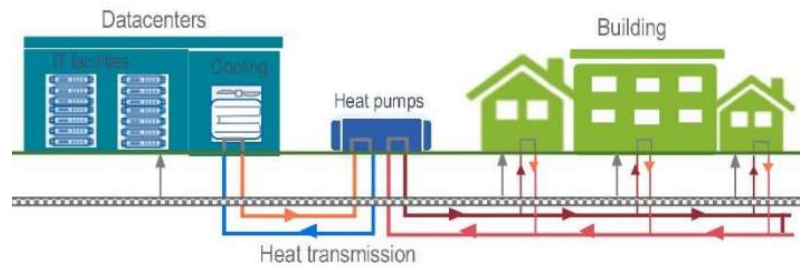
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Heat Pumps

The **low-grade Excess Heat** recovery in the DTC is fed **into the heat pump**, heated to the supply temperature, and then delivered directly to **district heating** end-users.

Datacenters use advanced cooling systems to cool the IT facilities and produce waste heat

The waste heat in datacenters is used in multiple fields, e.g. as a heat source for district heating.



Source: Huang u., a., „ (2019) A Review of Data Centers as Prosumers in District Energy Systems

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Heat pumps are the best solution to reuse the Excess Heat for district heating because heat pumps are made to work with low- temperatures rates. Therefore, we do not recommend another technic to reuse the Heat for building use.

DTC-to-district heating network system

In **return/supply** District Heating connection, the water is **withdrawn from the return line**, heated to the appropriate temperature, and **fed back into the supply line**.

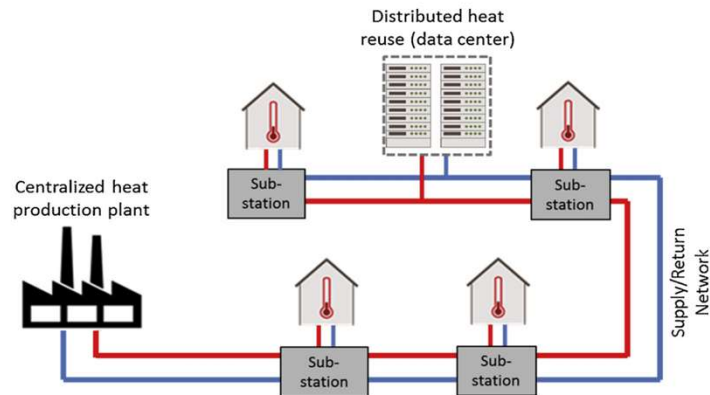


Fig. 2. Simplified scheme of the Return/Supply feed-in configuration in a DH network.

Source: Oró, Taddeo, und Salom, (2019) *Waste Heat Recovery from Urban Air Cooled Data Centres to Increase Energy Efficiency of District Heating Networks*

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Different connections to district heating

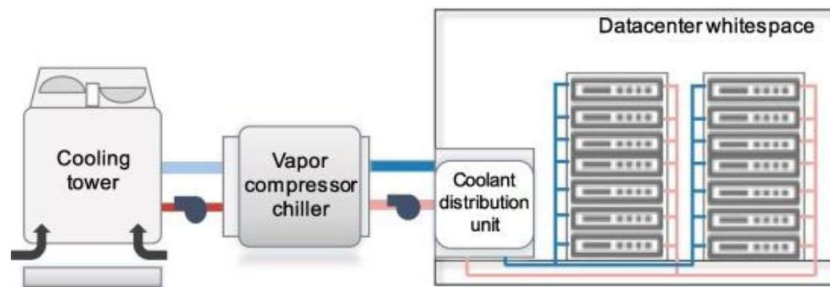
Exist four different ways to connect and distribute heat reuse from data centers to a DH network (i) return/supply, (ii) return/return, (iii) supply/return, and (iv) supply/supply.

The most beneficial system for DTC is the return/supply solution.

In this configuration, the water is withdrawn from the return line, heated to the set temperature, and fed back into the supply line. This feed-in configuration does not affect the return line temperature.

In addition, supplying the DTC excess heat close to the consumers reduces the heat loss in both lines due to the lower mass flow rate circulating in the entire loop. This is reflected in reducing the heat power requirement from the heat pump and, therefore, the distribution prices in the hold network.

In **water-cooled systems**, the temperature of water is at the highest when exiting server racks (**75–80 °C** maximum). Thus, the optimal location to recover excess heat is **where the water exits the server racks**. This can be done by adding a water-to-water heat exchanger.



Source: Huang u. a., „ (2019) A Review of Data Centers as Prosumers in District Energy Systems

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Water cooler system for DTC

In water-cooled systems, the water temperature is at the highest on the exit for the server rack (75–80 °C maximum). So, there is the optimal location to recover excess heat. This can be done by adding a water-to-water heat exchanger.

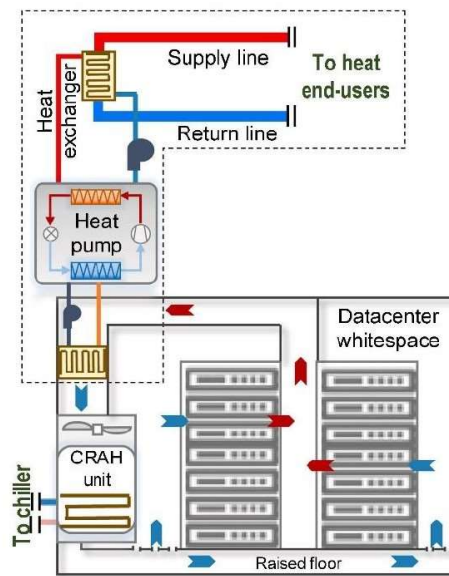
It is essential to mention that most of the existing DTCs have air cooling systems because of installation costs.

The water cooling systems are costly because the water needs to flow close to the electronic components.

This system is best for small DCs.

Excess Heat recovers from CRAH

In **air-cooled** systems, the **optimal location** to capture excess heat is at the **rack room exit (35–45 °C)**, before mixing with room temperature air



Source: Huang u. a., „ (2019) A Review of Data Centers as Prosumers in District Energy Systems

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Air cooler system

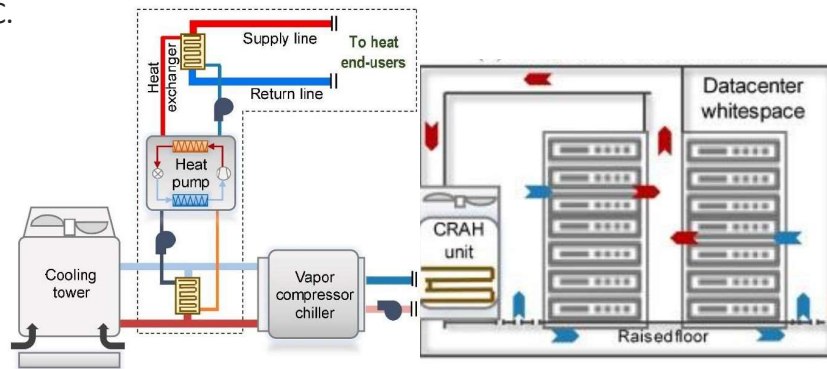
The optimal location to capture EH in air-cooled systems is at the exit point of the rack room (35–45 °C). In the diagram, this is at the top-left point. Here is where to connect the HP before mixing with room air temperature to prevent energy loss.

At this point, a water-to-air heat exchanger must be installed.

In the heat exchanger, the low-grade water is fed into a heat pump, where the water temperature is upgraded to the required level for use by the DH network.

Excess Heat recovery from Chiller

In air-cooled systems, it is also possible for heat recovery following the **chiller condenser** systems, using a water-to-refrigerant heat exchange installed in parallel with the condenser (or dry cooler) of the chiller. The temperature can reach up to 50 °C.



Source: Huang u. a., „ (2019) A Review of Data Centers as Prosumers in District Energy Systems

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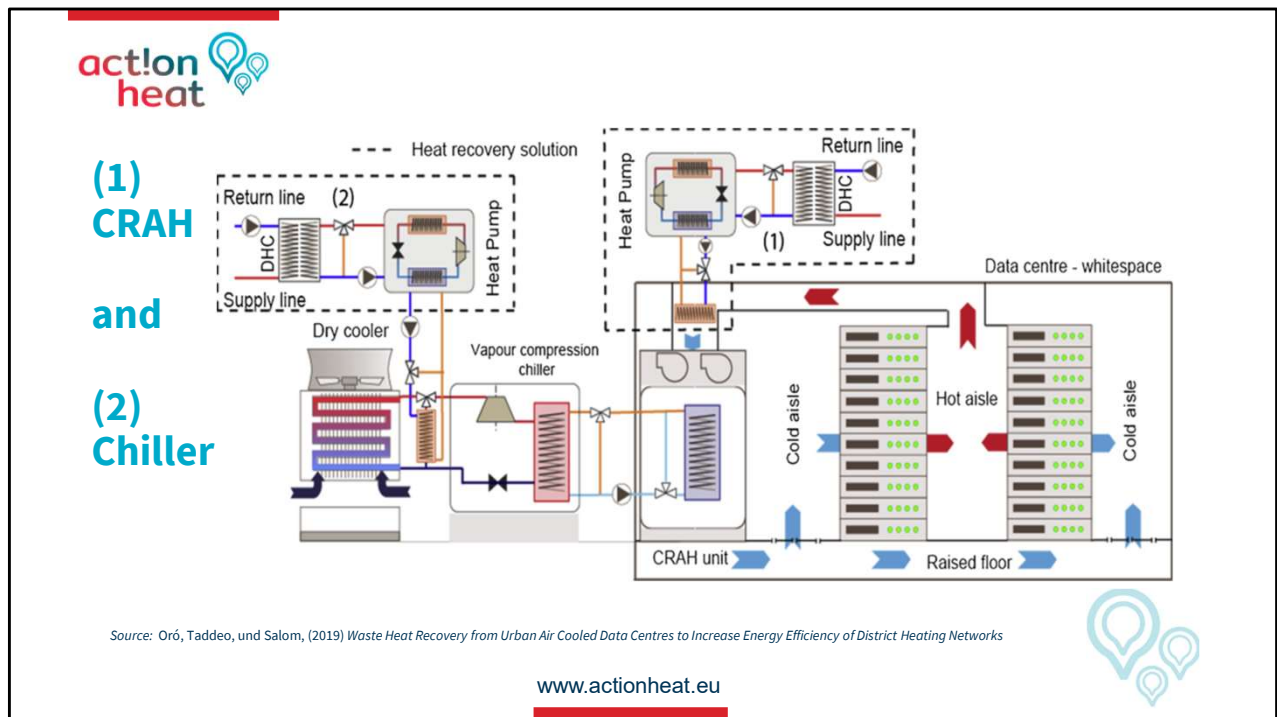
Air cooler to water

Another option to recover excess heat is the chiller condenser, which applies to air and water-cooled systems.

For heat recovery from the chiller, a water-to-refrigerant heat exchange is installed in parallel with the chiller's condenser (or dry cooler).

Part of the heat produced by the chiller passes into the surrounding environment, and the remaining heat is captured by a secondary water circuit. The temperature can reach up to 50 °C.

Here, the low-grade water from the chiller is fed into a heat pump, where the water temperature is upgraded to the required level for use by the DH network.

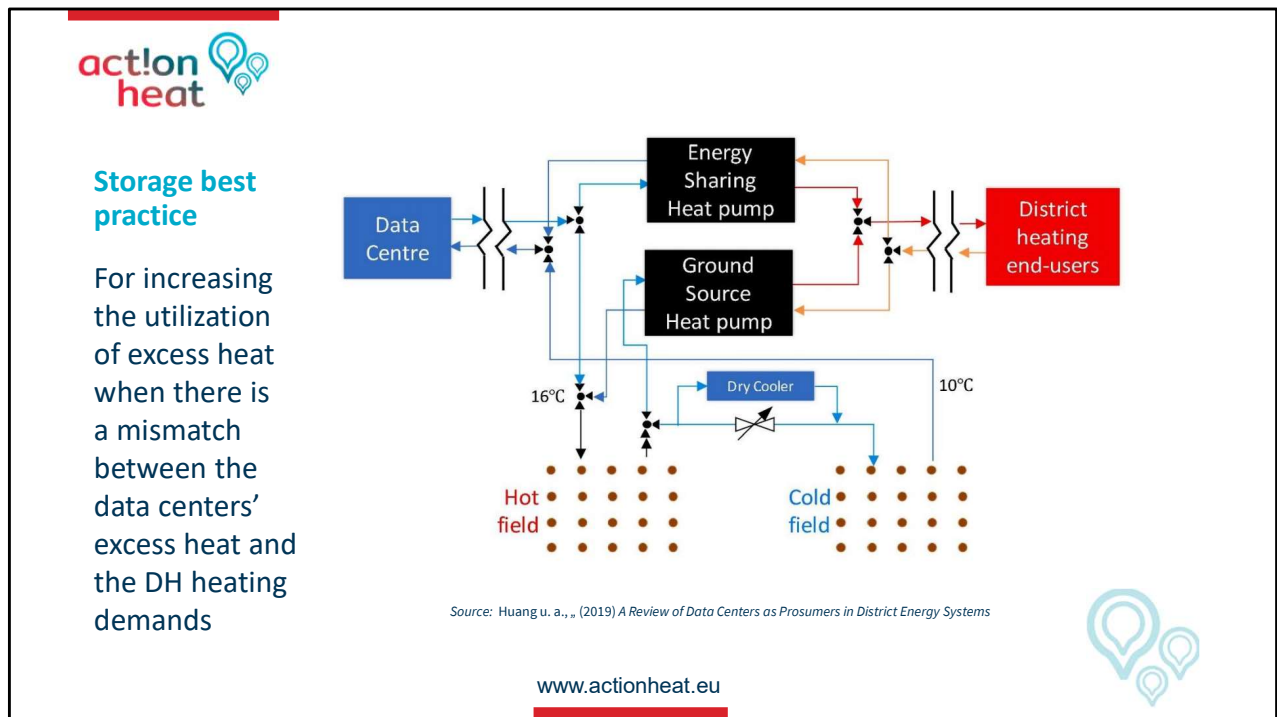


Combination of cooling systems

Air-cooled systems are the most common cooling systems in existing data centers.

They typically arrange server racks into cold areas and hot areas. The cooled areas carry cool air to each server, while the hot air exits the servers in the hot aisled area.

In general, the best option to optimize the use of excess heat in this system is to use two Heat pumps, one at the rack room exit point and the other after the condenser of the vapor-compression chiller.



Possible extra adaptations to the cooling system

To increase excess heat utilization when there is a mismatch between the DC excess and the DH demands, a ground source heat pump and a bore field can be integrated into the system.

In this case, the ground source heat pump will operate in cooling/heating mode to control the temperature. The bore field acts as a large thermal energy storage to alleviate the mismatch. Typically, more than one heat pump is required to manage temperatures between all system parts. Therefore, it is recommended to install two heat pumps.

Finally, to improve the ground source heat pump heating efficiency and provide free cooling for the DTC, an additional bore field can be added. In that case, one bore field acts as a 'hot' thermal storage, and the other as a cold thermal storage.

Best practice examples



Part II - How to reuse Datacenters Excess Heat



This project has received funding from the EU's Horizon 2020 programme under grant agreement no 101033706.



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Excess heat recovery in DTC in Act!on

Company	Location	IT load capacity	Cooling technology	Excess heat reuse	Estimated excess heat reused / recovered	Nr. Of buildings supplied by the excess heat
Telecity Group (5 locations)	Helsinki, Finland	7 MW (2 MW with excess heat reuse)	District cooling	District heating	unknown	4 500 apartments 500 detached houses
Telia Company	Helsinki, Finland	24 MW	Unknown	District heating	200 GWh/a	Unknown
Bahnhof (3 locations in operation, 1 under construction)	Stockholm, Sweden	3 MW (21 MW under construction)	Heat pumps	District heating	600 kW (Pionen) 500 kW (St Erick) 1 500 kW (Thule)	Unknown
Tieto	Espoo, Finland	2 MW	Heat pumps	District heating	30 GWh/a	1500 detached houses
Yandex	Mäntsälä Finland	10 MW	Free cooling	District heating	20 GWh/a	1 000 detached houses
Meta	Odense Denmark	Unknown	Heat pumps free cooling	District heating	25 MW, 100 GWh/a	6 900 homes

Sources: Huang u. a., (2019) *A Review of Data Centers as Prosumers in District Energy Systems*.
Wahlroos u. a., (2018) *Future Views on Waste Heat Utilization – Case of Data Centers in Northern Europe*.

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When analyzing the table, it is important to consider several factors:

IT capacity refers not only to the computing power of the systems and the support staff but also to the capacity designed in the plan, which may not always be fully utilized.

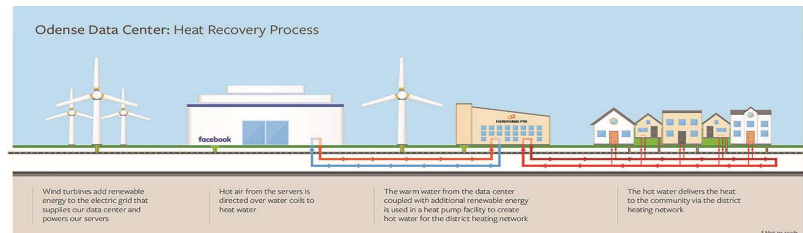
If excess heat from a Data Center (DTC) is used for district heating, the temperature needs to be increased using a heat pump. The efficiency of this process is determined by the Coefficient of Performance (COP) of the heat pump.

In the table, the 20 MW supplied to the network does not indicate that the entire amount is solely from excess heat. Due to the heat pump, the actual amount of usable heat will be lower, as the heat pump efficiency reduces the output.

Additionally, when evaluating examples of heat pumps used in district heating systems, it's important to recognize that the COP can vary, especially if the heat pump is also used for cooling the network.



- Organisations involved:
 - Data center operator: Meta (Facebook) – supply of excess heat for free
 - DH operator: Fjernvarme Fyn – took all investment
- Heat recovery:
 - 176 cooling units on the roof of the data center
 - Water is heated from hot air in the coils
- Reused heat:
 - Up to 25 MW
 - 100 GWh/a
- Start of operation: 2023



Source: <https://tech.facebook.com/engineering/2020/7/odense-data-center-2/>
<https://www.datacenterdynamics.com/en/news/metafacebook-to-expand-odense-data-center-campus-in-denmark/>

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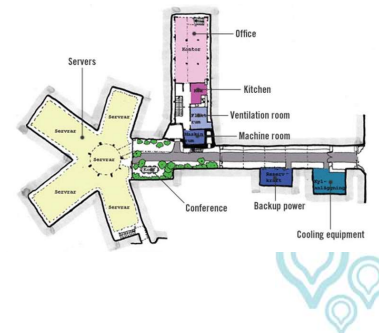
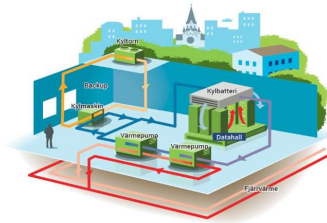
A recent example of heating reuse

The business model there is that the operator takes all the investment, and Facebook does not receive anything from the income of the use of Excess Heat for district heating.

The reuse of the energy in the system works with heat exchangers on the top of the roof in the building through recovery metal pipes and sent to the Heat Pumps to be increased and sent to the district heating network.

Banhof Thule – Stockholm, Sweden

- Organisations involved:
 - Data center operator: Banhof Thule
 - DH operator: Fortum Värme AB
- Installed capacity:
 - Cooling: 1.2 MW
 - Heating: 1.6 MW
- Temperatures:
 - District cooling delivered at approx. 5.5°C
 - District heating delivered at approx. 68°C
- Investment costs:
 - 0.53 MEUR for the cooling system (3 heat pumps, pipe installation, electrical work and control equipment, data collection and construction)
 - 0.26 MEUR for expansion of DH grid
- Start of operation: 2014



Source: <https://www.euroheat.org/resource/open-district-heating-in-stockholm-sweden.html>
www.offenforvarme.se
 Wahlroos u. a., (2018) Future Views on Waste Heat Utilization – Case of Data Centers in Northern Europe.

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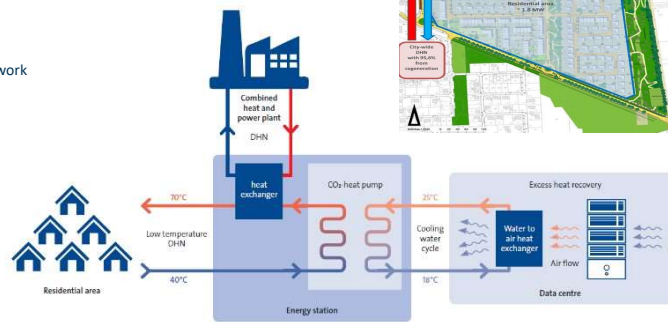
Data center added to existing DH network

The Bahnhof Thule data center is one of several DTC the Stockholm heating and cooling network has. because they have an open network, and it is possible to be integrated into the grid by advice and discussion with the operator.

With 3 heat pumps deliver district heating with almost 70 degrees. The installation cost is also divided between heating and cooling, where the first investment cost is more because the pumps and then a second expansion phase to the network was added to the grid and started to work in 2014.

- Organisations involved:
 - Data center operator: ??
 - DH operator: Veolia Deutschland / BS | Energy
- Local district heating network:
 - New network for newly constructed buildings
 - Excess heat from data centers to supply base load
 - Peak load supplied by existing high temperature network
 - Heat storage of 6 m³
 - Peak load 1.8 MW
- Temperatures:
 - DH system: 70/40°C flow/return
 - Data center excess heat: 25/18°C before/after HP
- Excess heat recovery:
 - 1.75 GWh/yr
 - Supply for 600 housing units
 - COP Heat pump 3.6
- Start of operation: 2019

Source: <https://www.euroheat.org/resource/excess-heat-recovery-from-data-centre-in-braunschweig-germany.html>
ReUseHeat – Excess heat recovery from data centre in Braunschweig, Germany – Project Factsheet



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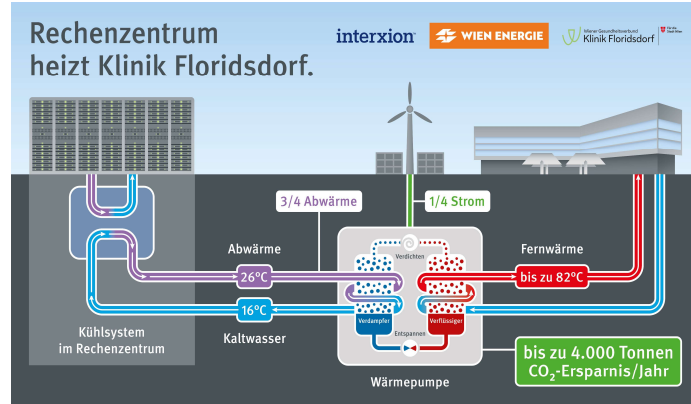
The data center was built, and nearby construction of houses was built.

The district heating operation operates the complete district heating in Braunschweig, with a high-temperature district heating.

Therefore they built a separate district heating network with low-temperatures to supply the house with storage capacity.

Interxion – Wien, Austria

- Organization involved:
 - Data center operator: Interxion
 - DH operator: Wien Energie
- Installed capacity:
 - Cooling: 2.1 MW; around 120 k Servers
 - Heating: 3 MW; 50-70% of heat demand of the hospital should be supplied by the excess heat from the data center
- Temperatures:
 - DH systems: up to 82°C flow temperature
 - Date center excess heat: 25/18°C before/after HP
- Investment costs:
 - 3.5 MEUR
- Start of operation: 2023



Source: <https://klinik-floridsdorf.gesundheitsverbund.at/rechenzentrum-heizt-ab-2023-die-klinik-floridsdorf/>
<https://wien.orf.at/stories/3153437/>

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Example of Vienna

- The data center is only connected with a Hospital.
- It is a small project that supplies 70 percent of the hospital.
- The system heat and cool the hospital; therefore, the COP is high.
- Is in the final face of construction and will operate soon.

Discussion, Q&A



Part II - How to reuse Datacenters Excess Heat

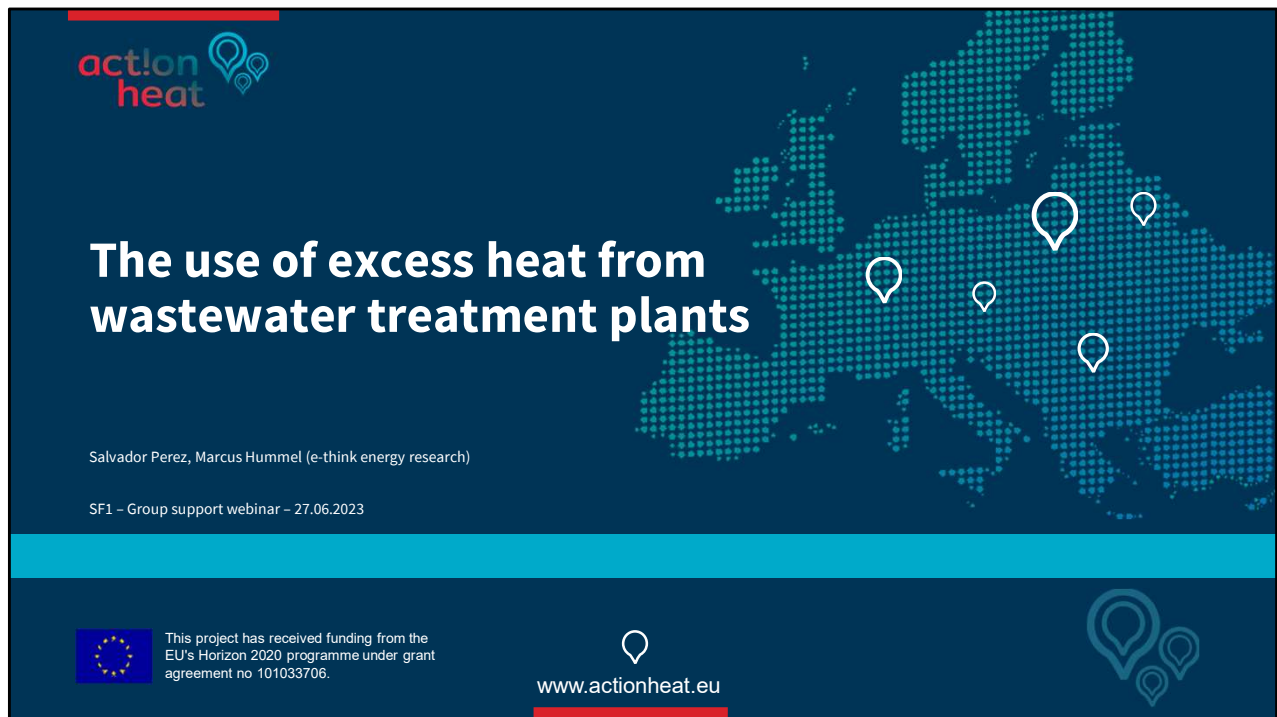


This project has received funding from the EU's
Horizon 2020 programme under grant
agreement no 101033706.



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Webinar 6: The use of excess heat from wastewater treatment plants

Act!onHeat SF1

Time: 1 h 11 min

- Serial 2:
 - Webinar 6
 - Strategical Heating & Cooling planning
 - Group support for municipalities and stakeholders
- Presented by:
 - e-think / Austria
 - TU-Wien / Austria

Part I: Potentials and technologies

- Overview of WWTP and options for energetic use (15')
- Characteristics of excess heat and considerations for the implementation of HPs (10')
- The Hotmaps database on excess heat potentials from WWTPs (10')
- Discussion, Q&A (10')

Part II: Practice examples

- Successful use of excess heat from wastewater treatment plants (20')
- Discussion, Q&A (10')



Use of Excess Heat (EH) from WWTP

Waste Water Treatment Plants WWTP

- First part
 - What kind of energy potential does WWTP have?
 - Use the EH with Heat Pumps for District Heating
- Second part
 - Existing WWTPs and the characteristics of these plants.

Overview of WWTP and options for energetic use



Part I - Introduction to Excess Heat from WWTP

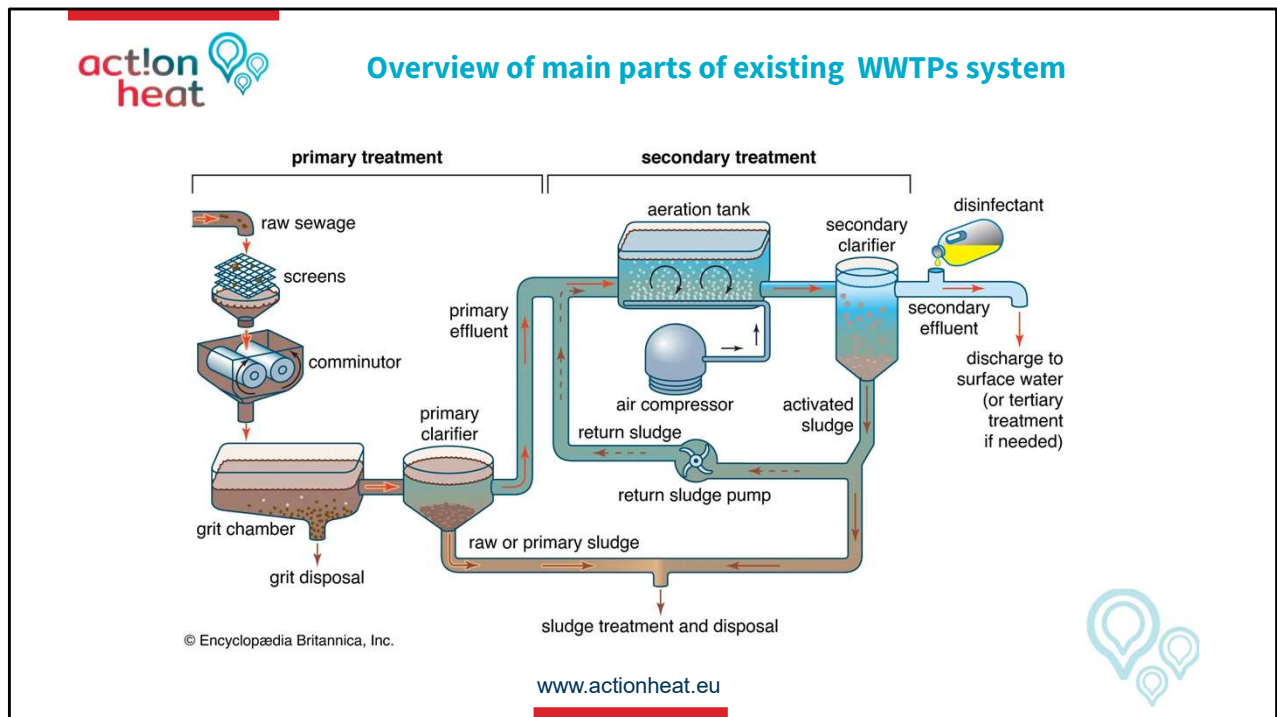


This project has received funding from the EU's Horizon 2020 programme under grant agreement no 101033706.



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Components of a WWTP

Common parts of a treatment plant for district wastewater, not for industrial sites:

Primary Treatment:

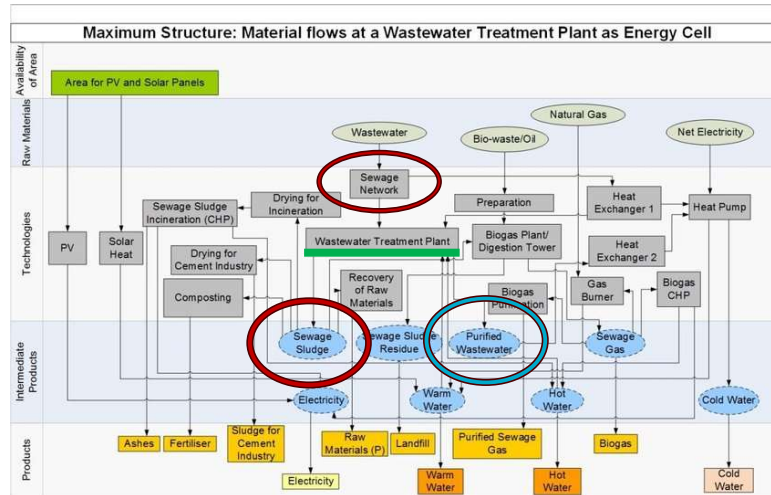
- Raw sewage enters the plant.
- During primary treatment, solid materials are extracted and separated.

Secondary Treatment:

- This is typically a biological treatment using aerobic and anaerobic processes.
- Effluent (clean water) is discharged from the plant.

The webinar does not focus on the overall operations within the plant but rather on specific stages, such as raw sewage water, the sludge produced during the process, and the effluent from which clean water is discharged.

Potential reuse of products from WWTP



Kindermann, H., Kollmann, R. (2015) *Optimisation of regional energy systems centred on wastewater treatment plants.*

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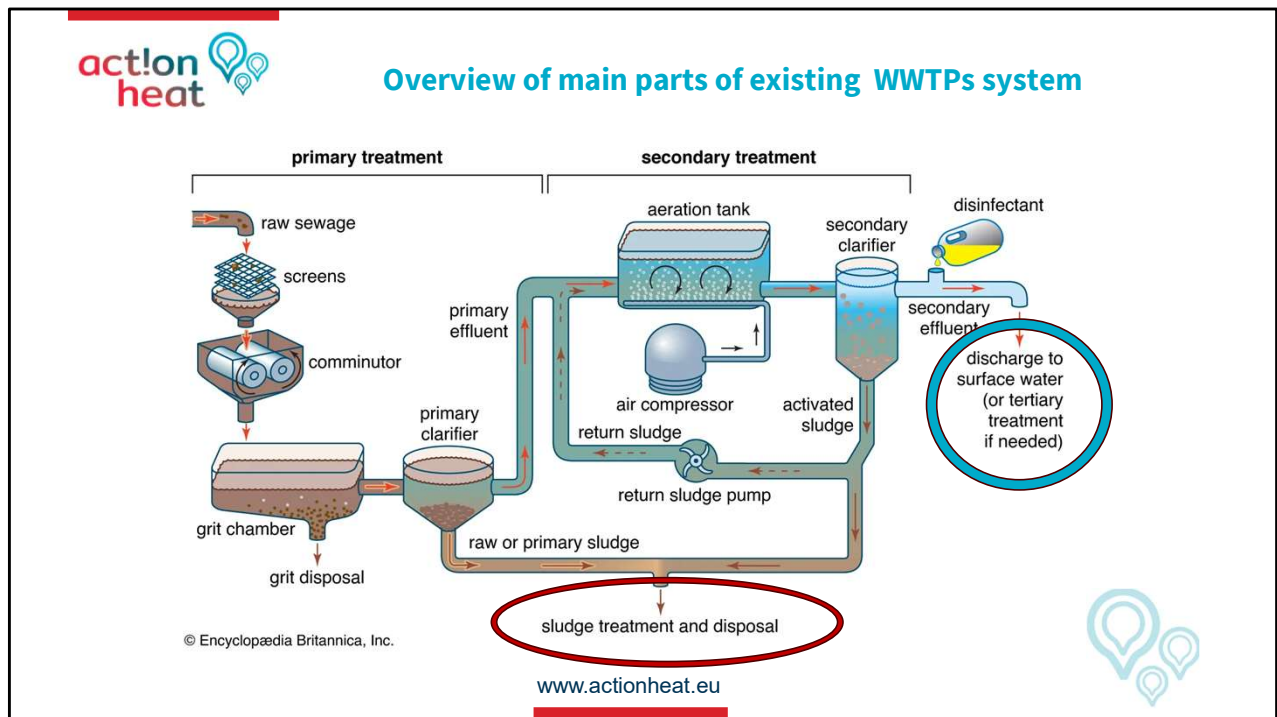
Different parts and their energy products

The table shows different process stages from the WWTP process and the possibilities of transforming the results into energetical products.

Through a sewage network, wastewater enters the plant to be treated, resulting in:

- Sewage sludge
- Purified water

The table shows the different process stages of the WWTP and the possibilities for transforming the results into energy products.

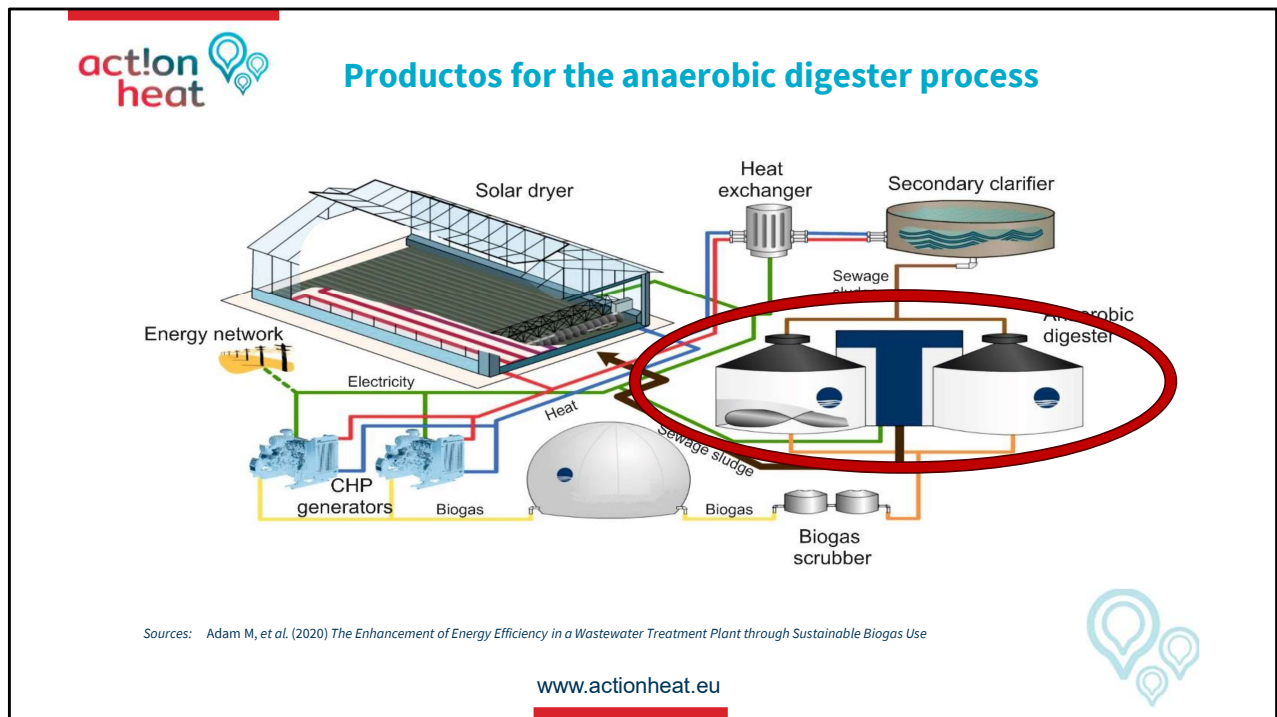


Two results and their place in the process

Sludge and clean water are some of the results of the treatment process, among others.

The graphic aims to clarify where these results occur within the process.

Identifying these two results on the graphic will help understand their energy reuse potential in the following example.



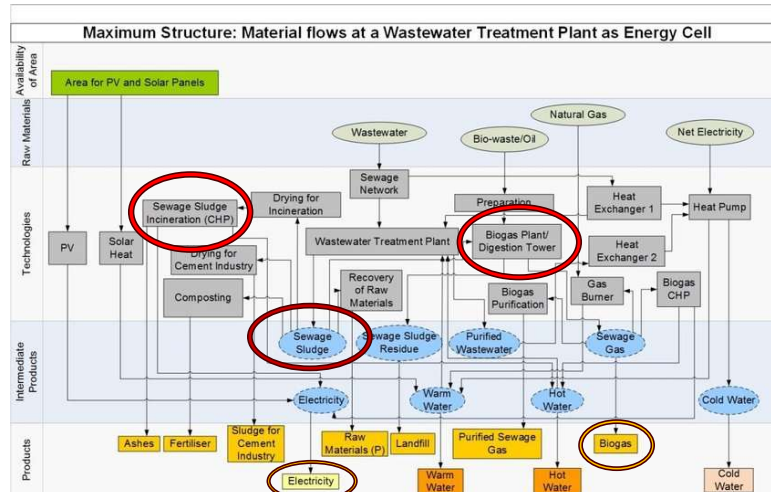
Examples of energy products from sludge

The sludge waste undergoes an anaerobic digestion process, and a scrubber is used to generate biogas.

The biogas is then used in CHP (Combined Heat and Power) generators to produce electricity.

The electricity can be used internally within the plant or externally for private use.

Potential reuse of products from WWTP



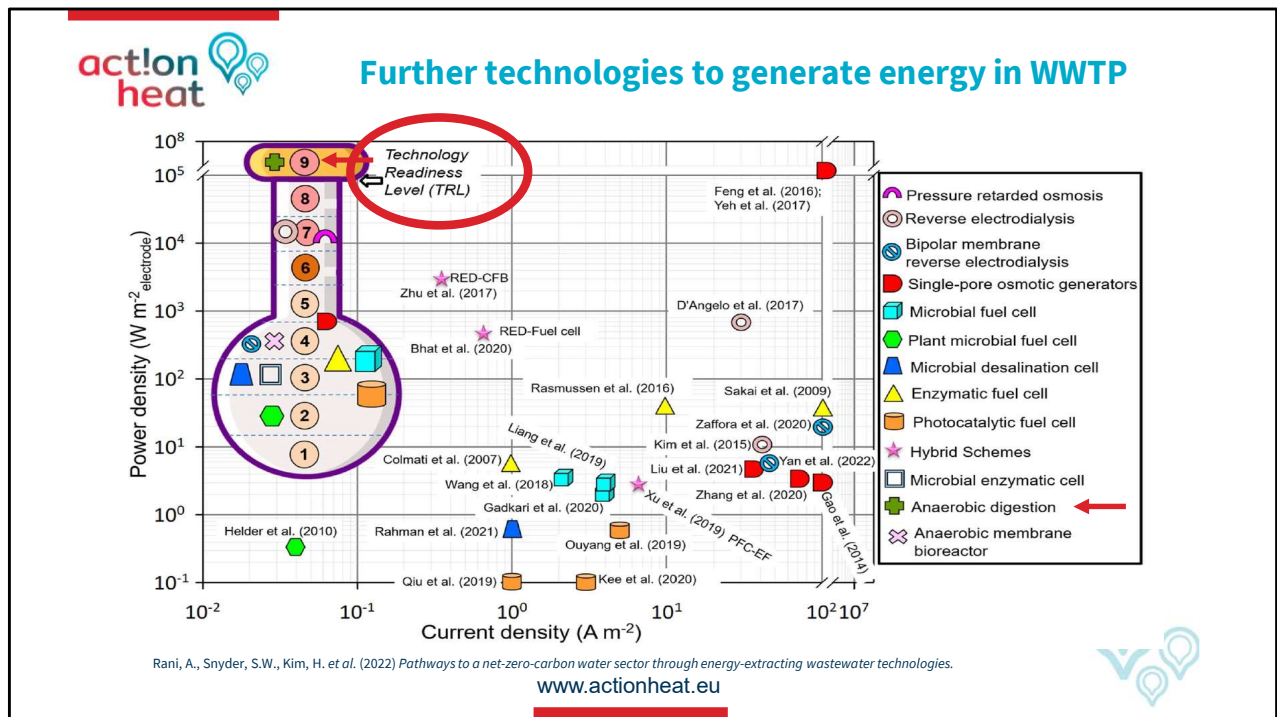
Kindermann, H., Kollmann, R. (2015) *Optimisation of regional energy systems centred on wastewater treatment plants.*

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Resulting products from sewage sludge

- Biogas from the sludge
- Electricity when you burn the biogas

These are just two examples of the energy and environmental advantages of WWTPs over others. The table presents additional energy products. However, the webinar will focus more on potential alternatives for reusing excess heat from the treatment plants in heating and cooling processes.

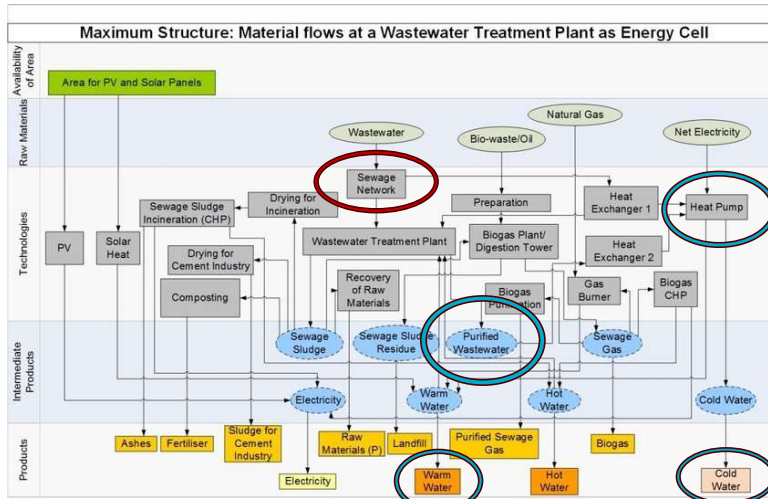


Potential electricity generation

There are a lot of other WWTP processes that produce energy out of the sludge depending on technological desition from needs.

The table shows different forms of generated electricity depending on the technology used for flouting and interaction with the particles in the process.

The anaerobic digestion that generated biogas which can be used to produce electricity, is the only technology in level 9 on this comparative graphic from 2022.



Kindermann, H., Kollmann, R. (2015) *Optimisation of regional energy systems centred on wastewater treatment plants.*

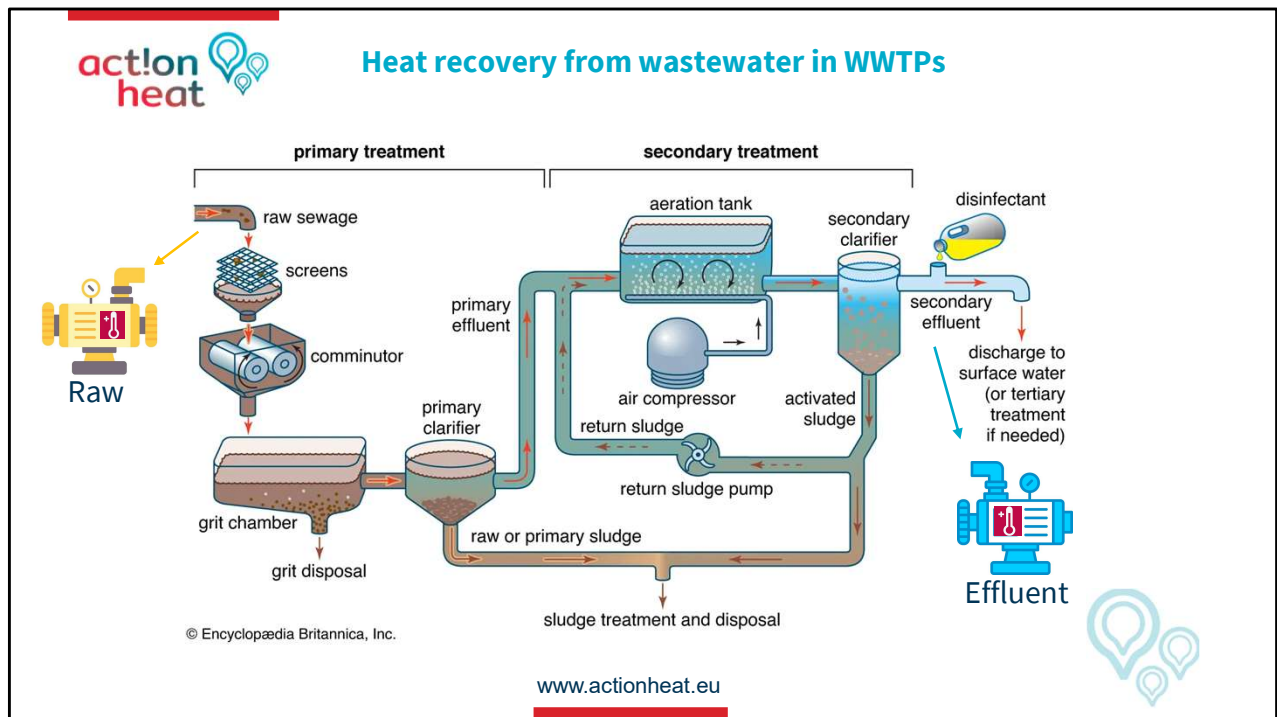
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Excess Heat reuse from District Heating

There are two ways to extract low-energy heat from a WWTP, which can then be connected to a heat pump for reuse in district heating:

1. Before the treatment process, in the sewage network.
2. After the purified water process.

In both locations, when connected to a heat pump, it is possible to generate both hot and cold water.



Installation of Heat Pumps on the plant

The design pretends to illustrate where it is possible to install Heat Pumps HP

- Raw wastewater (Before the process)
- Effluent purified water (After the process)

Each connection has different characteristics.

Heat recovery from wastewater

	Advantages	Disadvantages
In-hose	<ul style="list-style-type: none"> • High water temperature • Short heat transport (Low losses) • Producers – Consumers • No impact from supplement water 	<ul style="list-style-type: none"> • High fluctuations • Difficult to match peak demand • Decentralized system, high operative expenses
From sewer line	<ul style="list-style-type: none"> • Large amounts of WW • Relatively short heat transport • Moderate WW temperature – potentially retrieves otherwise lost heat along sewer 	<ul style="list-style-type: none"> • Dependant on sewage network • Potentially impacts WWTP processes • Untreated WW inside equipment, higher downtime and equipment costs
From treated water	<ul style="list-style-type: none"> • No impact on WWTP processes • Large effluent flow rate – large heat supply • Clean water through equipment • Cools WW deposited to environment 	<ul style="list-style-type: none"> • Plants not close to consumers • Low WW temperature

Source: Ola Vestberg, (2017) Heat recovery from untreated wastewater

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Advantages and disadvantages of the connections

- It is also possible to connect a heat pump (HP) outside of houses or buildings, but we will not provide examples of these connections.
- From the sewer line or raw wastewater, it is possible to obtain return heat or cooling water near the users, but filters are required to clean the water used by the heat pumps.
- From treated or purified effluent, you can take advantage of the environmental temperature of the return water, and the heat pump does not require filters. However, WWTPs are typically located far from consumers.

Characteristics of excess heat and considerations for the implementation of HPs



Part I - Introduction to Excess Heat from WWTP



This project has received funding from the EU's Horizon 2020 programme under grant agreement no 101033706.



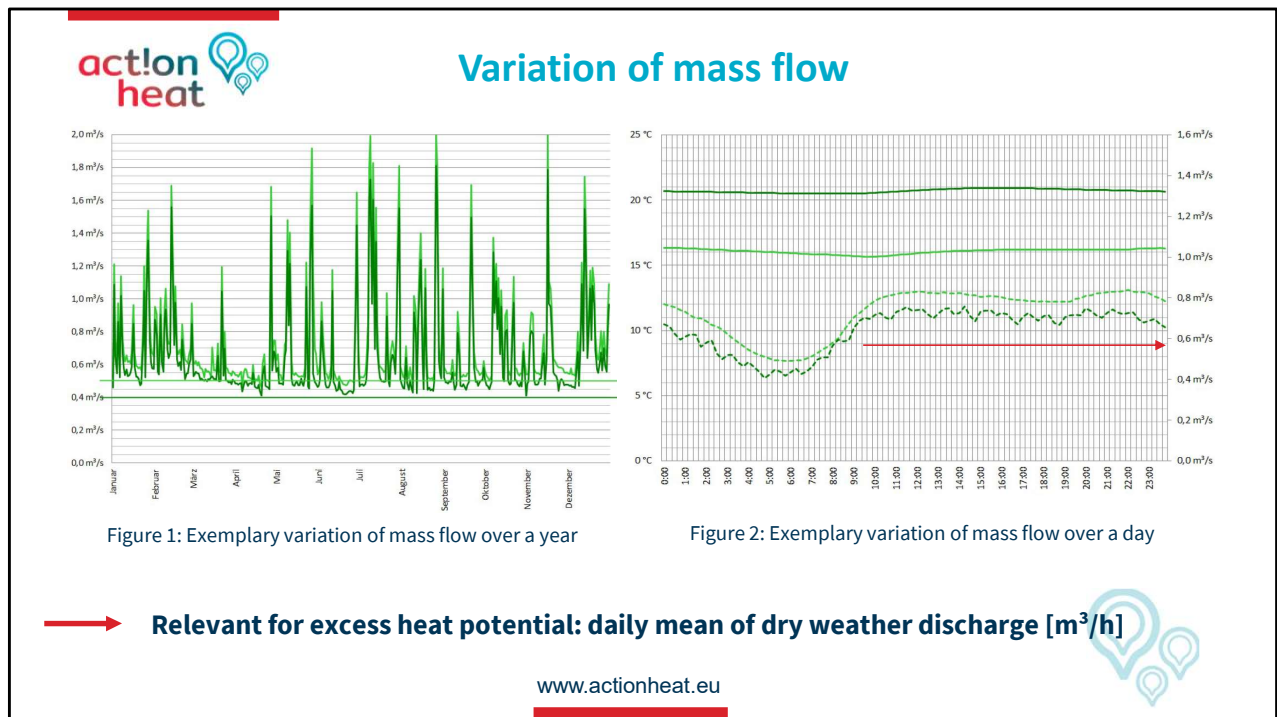
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Overview of characteristics

- Mass flow
- Temperatures
- Legal aspects
- Economic aspects





Graphics of mass flow in a plant in Germany

Left side: Variation over the year

Right side: Variation over the day

- The graphics display temperatures and mass flows, showing variations in inlet and outlet flows.
- What is shown is the variation over the year, with high and low flows due to the rainy season, where rainy days experience higher fluctuations.
- The temperature flow remains constant during the day and is lower and irregular at night. Therefore, the day flow is used to dimension the potential needed for the heat pump.

Variation of temperature

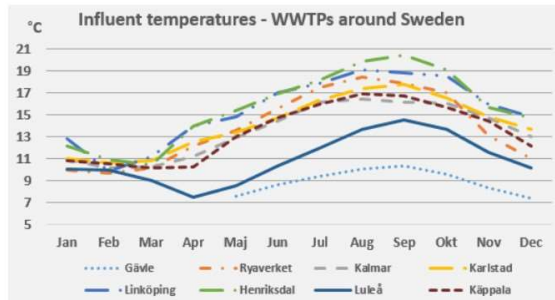


Figure 1: Exemplary variation of temperatures of inflow in WWTPs in Sweden over a year



Figure 2: Exemplary temperature profile of in- and outflow in DE

Remarkable variation over the year, not high variations over day (except wet weather)

Inflow temperature usually lower than outflow temperature

Especially outflow usable all over the year



WWTP temperatures over the year

- On the left side is the raw water temperature before it enters the treatment plant in different cities in Sweden.
- On the right side, the inflow and outflow temperatures of a plant in Germany, showing variations over the year.

The effluent temperature variation between summer and winter is lower, usually due to biological processes. Therefore, excess heat can also be used during the winter.

- Requirements for the operational safety of the WWTP or sewer channel
- Restrictions in the extractions of heat from the outflow
 - usually regulated in local / regional water law
 - Can be defined very different from region to region
- Potential amendment of the water law permit of the WWTP necessary
- Potentially legal expert assessments are needed
 - e.g. on how much the effluent can be cooled down to not harm the environment



Local political regulation

- From the sewer channel, there are specific operational requirements because it stays below the surfaces.
- From the Outflow, extraction restrictions exist because of the temperature introduced into the river.

The WWTP also needs to enter into negotiations in the outflow case because they usually have a legal regulation on this aspect.

- Investment costs
 - Remarkable economies of scale (see tables below)
 - Around 50% for HP, 20% connection to heat source, Rest for construction, electric connection and planning
 - In many countries funding schemes exist
- Running costs:
 - Reduction of running costs possible for using nearby electricity sources (e.g. run off river plant, wind park, ...) → lower taxes and grid charges

City	HP capacity	Investment costs	Specific investment costs [Mio. EUR ₂₀₂₀ /MW _{th}]	HP in outflow of WWTP
Austria, Vienna	110 MW _{th}	70 Mio. EUR	0.5 – 1 MWth	1.23 – 1.91
Austria, Kapfenberg	165 kW _{th}	189 tsd. EUR	1 – 4 MWth	0.72 – 1.23
Denmark, Kalundborg	10 MW _{th}	7.5 Mio. EUR	4 – 10 MWth	0.62 – 0.72

Sources: AGFW (2020), Praxisleitfaden Grosswärmepumpen, Frankfurt am Main
<https://www.wienenergie.at/pressrelease/gruene-waerme-fuer-wien-klaerwasser-heizt-kuenftig-mehr-als-100-000-haushalte/>
 Florian K, Bernd H, Georg N and Gernot S. (2021) Wastewater Treatment Plants as Local Thermal Power Stations
<https://www.euroheat.org/resource/waste-water-as-heat-source-in-kalundborg.html>
www.actionheat.eu



Guidelines for the Use of Heat Pumps in Germany

Using heat pumps to extract heat from the effluent or outflow of the WWTP is cost-effective if the supply distances are short.

In Norway, where plants are located far from the users, heat pumps are connected to the wastewater network.

There is also a reduction in costs if electricity is generated locally, avoiding grid charges.

The Hotmaps database on excess heat potentials from WWTPs



Part I - Introduction to Excess Heat from WWTP

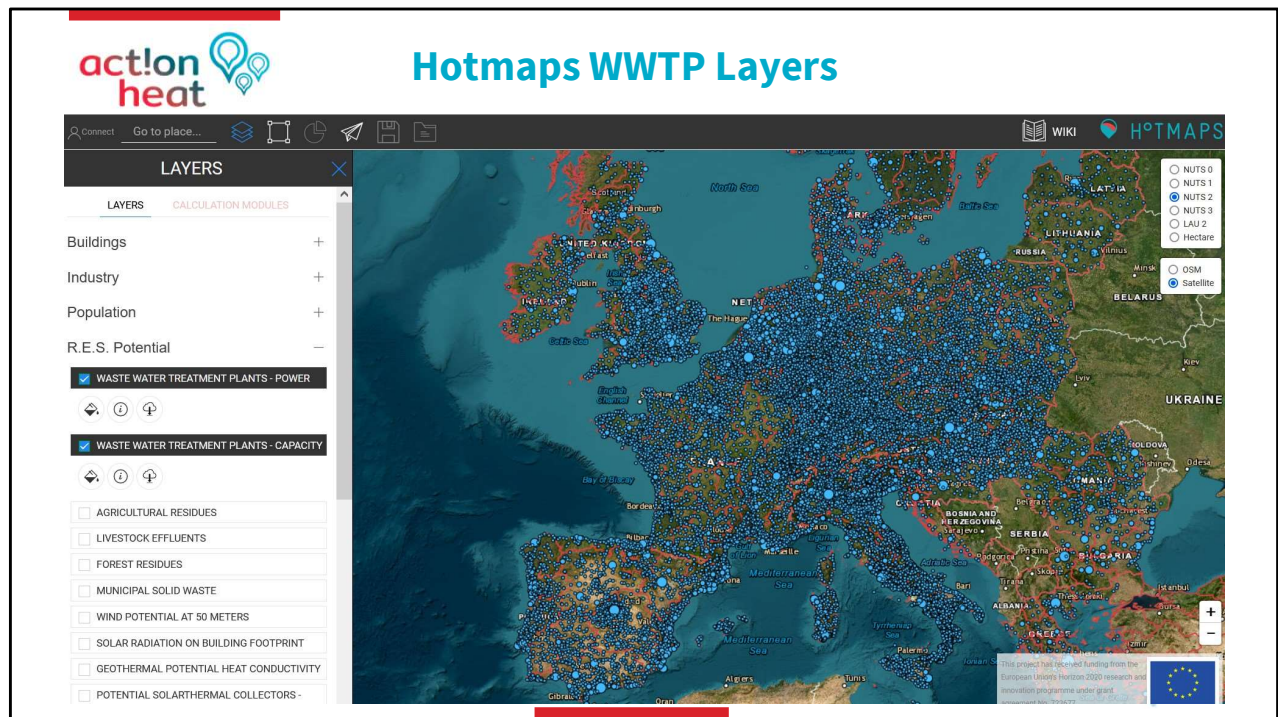


This project has received funding from the EU's Horizon 2020 programme under grant agreement no 101033706.



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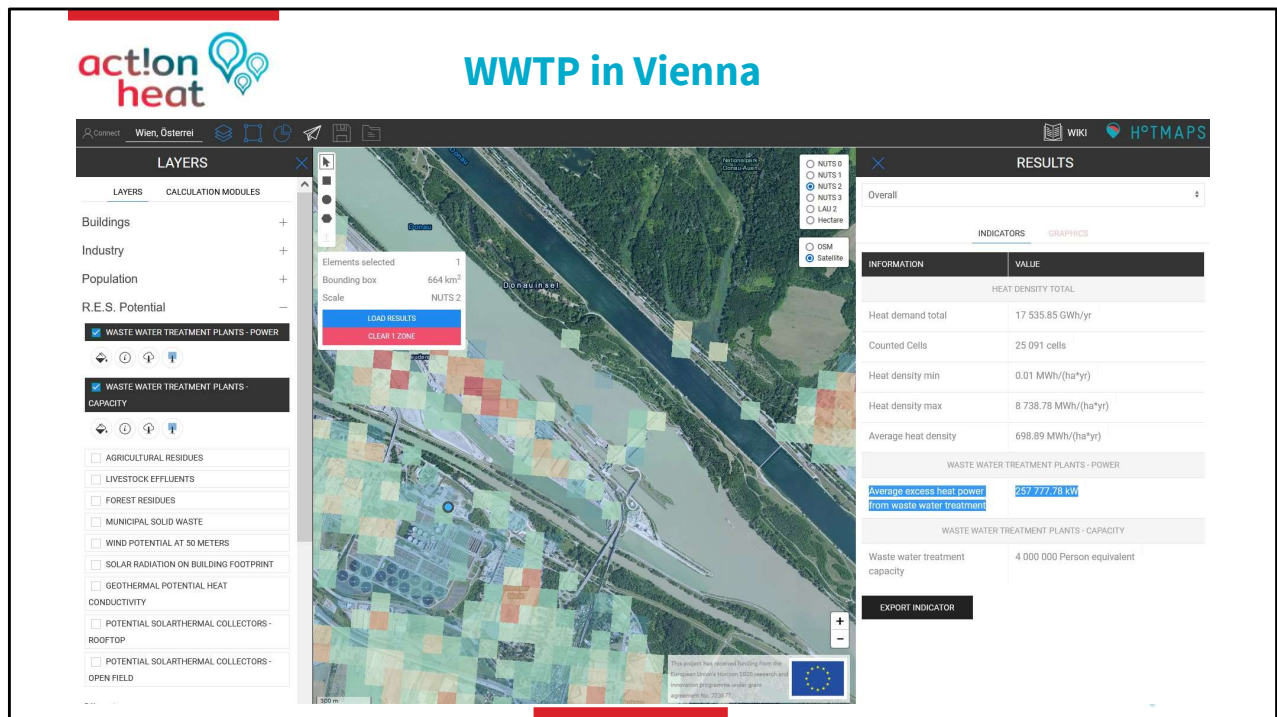


WWTP Layers option on Hotmaps.

Two layers exist for wastewater treatment plants WWTP:

- WASTE WATER TREATMENT PLANT - POWER
- WASTE WATER TREATMENT PLANT - CAPACITY

Which has an extensive data base for Europe.

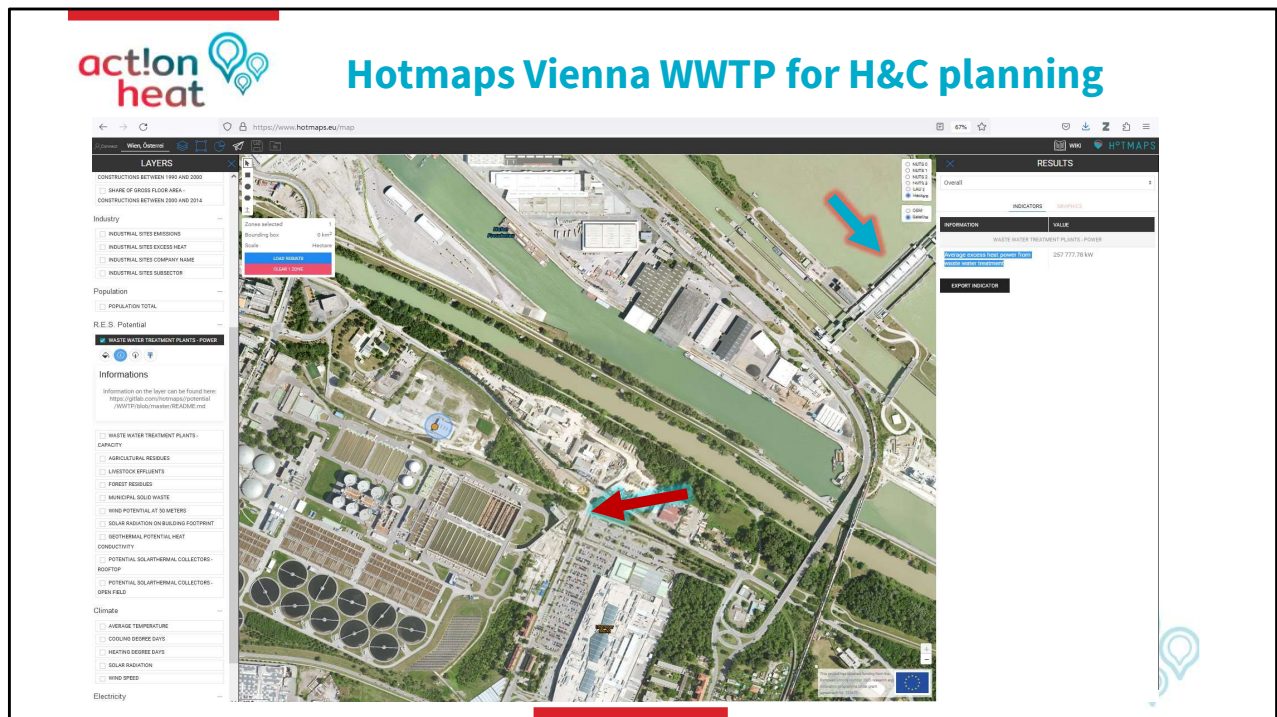


The WWTP for the city of Vienna

Capacity is given in person equivalents, which is typically the dimension of the plant.

The average excess heat power from the WWTP is determined by the amount of clean water flowing through the plant per person capacity and the temperature difference that can be utilized.

Note: The parameters are estimations. For more information, click on the pictograms of the layers to view the parameters assumed for the calculations.



Reuse for WWTP Excess heat for DH in Vienna

In red, the heat pumps will be connected near the outflow or effluent areas, not far from the Danube.

In blue is the hydroelectric power plant upstream of the Danube River, which will supply the electricity needed for the heat pumps to increase the water temperature for district heating (DH).

Discussion, Q&A



Part I - Introduction to Excess Heat from WWTP



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Successful use of excess heat from WWTP



Part II: Practice examples



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Horizon 2020 programme under grant
agreement no 101033706.



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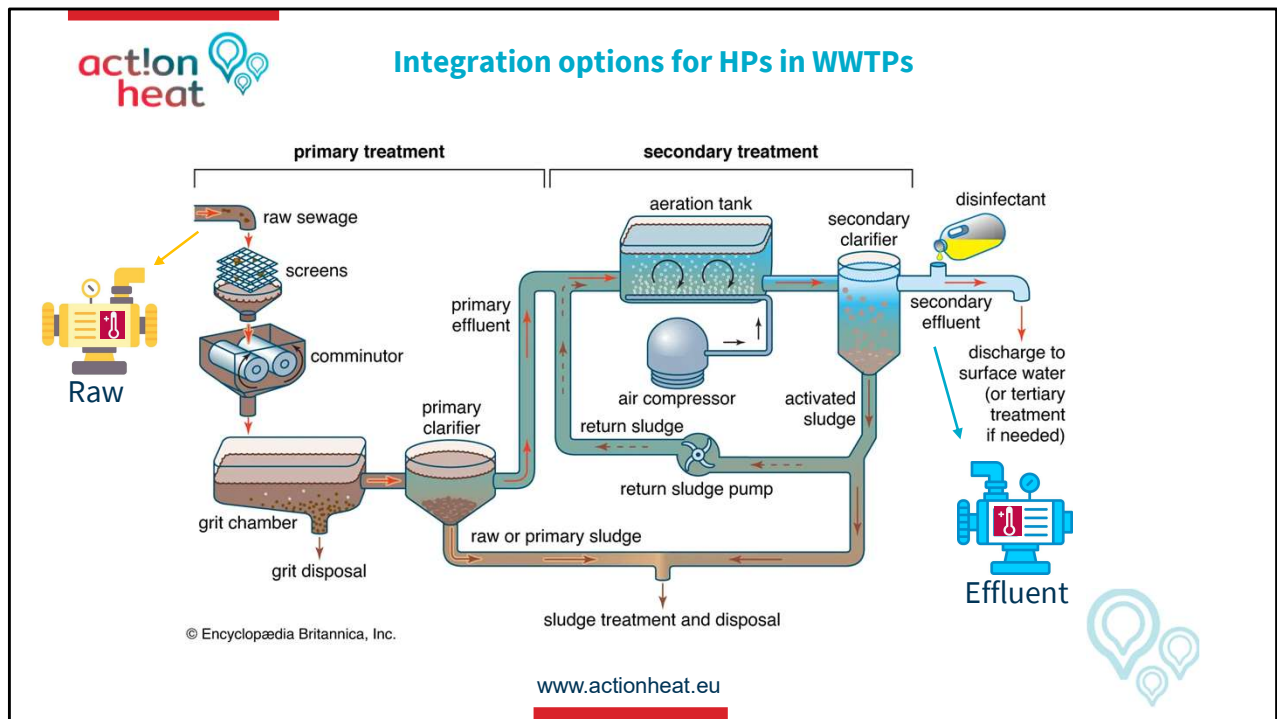
Overview of examples

- Heat Pump (HP) connections
- Table of successful HP used for WW
- HP before the WWTP using raw sewage
- HP after the WWTP using cleaned effluent



The second part of the Webinar

During this part of the presentation, it was possible to see different European examples for the use of Excess Heat coming from WWTP connections in Row or Outflow.



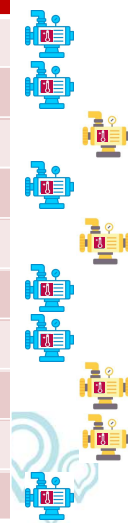
Connection places of Heat Pumps

The infographic shows the locations where heat pumps are typically connected to reuse excess heat from wastewater treatment plants.

Examples of the use of excess heat from WW

Sources: Lokietek T., et al. (2022) Heat Recovery from a Wastewater Treatment Process—Case Study

Year	Country / City	System Supplier	HP Capacity COP	HOTMAPS		Purpose	Arrangement
				WWTP / PE Capacity	EH Power WWTP / MW		
1984 (2003)	Sweden, Lund	Lund Energi	1 x 13 MW + 2 x 40 MW, COP 3.3	97 006	6.25	Heating/HW 80 to 90 °C + Cooling, R-134a	8 to 16 °C Effluent
1986– 1991– 1997	Sweden Hammarby, Stockholm	Fortum Energi	5 HP total 131 MW, COP 3.0	1 197 006	77.14	Heating + Hot water (HW)	Effluent
1998 (2008)	Norway Sandvika, Oslo	Friotherm AG	2 x 6.5 MW + 2 x 4.5 MW, COP 3.10	700 000	45.11	Heating 68 °C + Cooling, R 134a	10 °C Raw wastewater
2002	Poland Grudziadz	Unknow	2 HP Total 82.6 kW, COP 4.0	198 000	12.76	Heating + Hot water	Treated sewage
2005 (2008)	Norway Skøyen Vest, Oslo	Hafslund Fjernvarme AS	28 MW, COP 2.8	300 000	19.33	Heating 90 °C R 134a	10 °C Raw wastewater
2006	Finland Katri Vala, Helsinki	Friotherm AG	3 x 30 MW + 2 x 30 MW, COP 3.5	-----	-----	Heating/HW 88 °C + Cooling, R 134a,	10 °C Effluent
2006	Finland Kakola, Turku	Friotherm AG	2 x 10 MW + 2 x 30 MW, COP 3.3	-----	-----	Heating/HW 78 °C + Cooling, R 134a	10 °C Effluent
2014	Hungary, Budapest Military Hospital,	Thermowatt Ltd.	3.8 + 3.9 MW COP 6-7	3 553 266	17.84	Heating/Cooling	Raw wastewater,
2018	Switzerland Dietikon (Zürich),	Huber, Tec. ThermWin	4.0 MW COP 5,5	3 664 933	236.18	Heating + HW 40 °C NH3	Raw wastewater,
2023 2027	Austria Wien	Johnson	3 x 20 MW 4 x 15 MW, COP 3.5	4 000 000	257.78	Heating/HW 90 °C + Cooling	13 to 17 °C Effluent



Heat pumps use for District Heating.

The table shows the year of installation for different heat pumps used to reuse excess heat from WWTPs.

The blue heat pumps represent connections to the effluent or outflow from the treatment plant.

The yellow heat pumps are connected to the wastewater after the treatment plant.

The first cases of heat pump installations for district heating using wastewater began in northern European countries. In recent years, central European countries have started to reuse this type of low-temperature excess heat.

The data from Hotmaps help with the heat pump comparison in the table, as they provide an estimation of the system size, which can be applied to the outgoing treated water cases.

Oslo, Sandvika (Norway)

Raw connection.

Short case description:

- Heat pumps connected to the **600 km** piped network.
- Total city district heating supplies: **7.8 %**

Date for the case:

- Installed HP capacity: **22 MW_{th}**
- 2HP x **4.5 MW_{th}**, 2HP **6.5 MW_{th}**
- COP of the HP: **3.1**
- DH network: **13,000 apartments**
- WWTP: **6 °C** supply temp of HP: **78 °C**



Skoyen HPs and Sandvika HPs connected to a 600 km piped network.

Source: Pietrucha B., Burkhalter F., FRIOTERM AG, (2011) *District Heating and Cooling with Large Centrifugal Chiller – Heat Pumps*

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Two different HP connections in Oslo

Two complexes of heat pumps are installed on the wastewater return line to reuse excess heat and supply heating and cooling water to different parts of Oslo.

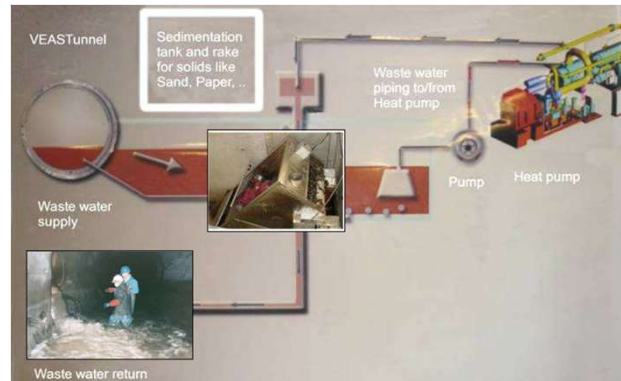
Raw connection.

Short case description:

- **300m** inside the rockface under the residential area
- Pump force of **3,800 m³** of sewage per hour.

Data for the case:

- Installed HP capacity: **28 MW_{th}**
- 1HP **18 MW_{th}**, 1HP **10 MW_{th}**
- COP of the HP : **2.8**
- DH network: **13,000 apartments**
- WWTP: **6 °C** supply temp of HP: **90 °C**



Raw wastewater pumping into the HP

Source: <https://www.klimaoslo.no/2019/10/16/district-heating-from-sewage/>
https://www.lsta.it/files/events/21_bailer.pdf

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The second connection to the return line

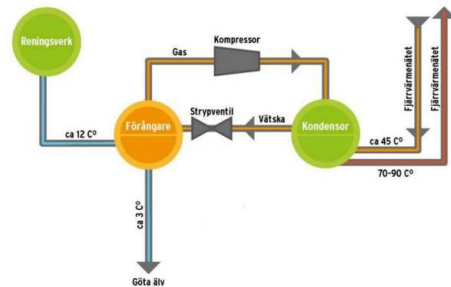
The connection from where it took the low temperature is almost 300 meters under the city, and from there are connected the pumps used to feed the surrounding area of Skoyen with cool and hot water.

Short case description:

- WWTP has been used with heat pumps since **1985**.
- HP is supplied with electricity from a hydro and a nuclear power plant
- 10 °C effluent water pumped into an evaporator of HP

Data for the case:

- Total installed HP capacity: **160 MW_{th}**
- Divided in **4 HP** (2 x **30 MW_{th}** and 2 x **50 MW_{th}**)
- DH temperature lift is from **12 to 75-85 °C**
- HPs **12,000** operating hours (3,000 per HP on average)
- Producing annually **440 GWh** heating.



Source: Ola Vestberg, (2017) Heat recovery from untreated wastewater
<https://www.euroheat.org/resource/heat-pumps-using-waste-water-in-gothenburg-sweden.html>

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Example of the Effluent connection

Gothenburg, Sweden, is home to one of the oldest and largest connections from a wastewater treatment plant to a district heating system in Europe.

It is the oldest in terms of construction time and the largest in terms of heat pump capacity.

Short case description:

- Hammarbyverket is the world's largest heat pump plant that extracts district heating and cooling from purified wastewater.

Data for the case:

- WWTP: Treated from Henriksdals
- Total installed **7HP** capacity: **225 MW_{th}**
- HP: R234a and R22 as refrigerant
- DH temperature lift from **10-19 to 60-90 °C**
- DH temp. season decrease **0.5 to 11 °C**
- Producing annually **900 GWh** heating.



Source: Ola Vestberg, (2017) *Heat recovery from untreated wastewater*
<https://heatpumpingtechnologies.org/annex47/wp-content/uploads/sites/54/2018/12/annex-47hammarbyverket.pdf>

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Biggest connection from WWTP

Hammarbyverket in Sweden has the largest system connection from a WWTP in Europe.

Seven heat pumps are fed by the treated water.

The treated water is stored in two large cylinders.

A system of pipes inside the cylinders extracts the low temperature from the water.

The low-temperature water is then fed into the heat pumps.

The pumps increase the temperature of the water.

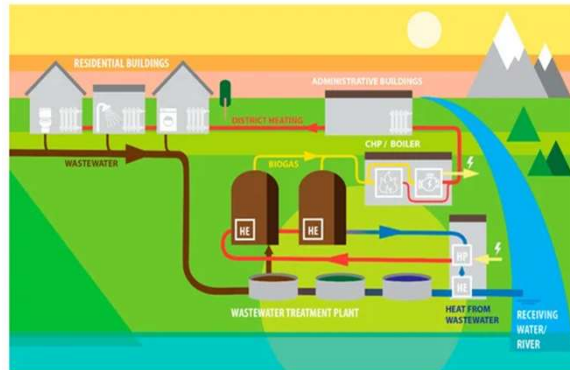
Hot or cold water is then pumped into the district heating network.

Short case description:

- Anaerobic digestion using the sewage sludge to produce biogas
- Biogas is converted into electricity and heat and provided to the DH network
- A HP uses the excess heat of the WWTP outflow to supply heat for the anaerobic digestion as well as for the office buildings at the WWTP site

Data for the case:

- Installed **CHP** power of **124 kW_{el}** and **165 kW_{th}**
- Thermal output of the **HP 200 kW_{th}**
- WWTP treatment capacity of **49,000** population equivalents
- Investment costs: **189 tsd. EUR**



Source: Florian K, Bernd H, Georg N and Gernot S. (2021) Wastewater Treatment Plants as Local Thermal Power Stations

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Not connected to district heating

The biogas from the sludge is used to produce electricity and preheat the water through gas boilers.

In contrast to other cases, the heat is reused for heating office buildings but is not introduced into the district heating network.

Short case description:

- Organic content used for biogas production
- Higher temperatures to accelerate biological processes
- Heat pump (HP) to supply district heating (DH)

Data for the case:

- Installed HP capacity: **10 MW_{th}**
- DH network: **5010 consumers**
- WWTP temperature between **20-25 °C**
- **COP** of the HP is between **3.6 and 4**
- HP worked **8000 hours** in the first 2 years
- Investment costs: **7.5 Mio EUR**

General data from Hotmaps:

- Heat demand in the city: around **190 GWh/yr**
- Average excess heat power from WWTP: **3.5 MW**



Source: <https://www.euroheat.org/resource/waste-water-as-heat-source-in-kalundborg.html>

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Comparative data from Hotmaps

On the left side are data coming from Hotmaps showing the heat demand in the city and the estimation of the excess heat power generated from the wastewater treatment plant.

Note: The data for Hotmaps represent the energy for the water that can be used for the Outflow or Effluent

Short case description:

- Heat pump to be installed at the outflow of the WWTP
- Replacement of the coal-fired thermal power plant

Data for the case:

- Installed storages: **60 MW_{th}** in 2025
- Four Heat Pumps: **15 MW_{th}**
- **450,000 m³**/day of wastewater treated in the plant
- HP expected to supply **39,000** residential units with heat



Visualisation: Hamburg plans to build a 60-MW heat pump at the Dradenau wastewater treatment plant. Image by Hamburg Wasser.

Source: <https://renewablesnow.com/news/hamburg-to-power-district-heating-with-60-mw-wastewater-heat-pump-799005/>
<https://www.aquapublica.eu/article/members-activities/hamburg-wasser-launches-concept-recover-energy-waste-water>

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Decision According to Planning

Hamburg, Germany, planned to construct a larger system for Köhlbrand with a capacity of almost 100 MW to reuse excess heat from the WWTP for the city.

However, based on the results of case studies, it was decided to install a 60 MW heat pump system instead.

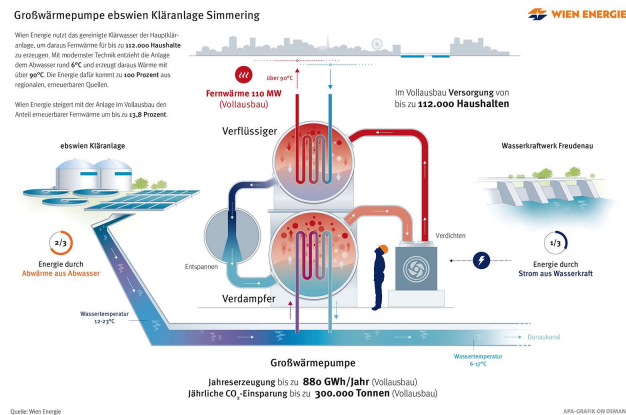
Therefore, it is essential to understand the needs and conditions of the municipality at the start of project planning. Nevertheless, sometimes it may be necessary to adapt the project to gain approval from local authorities.

• Short case description:

- One large WWTP for the entire wastewater of Wien
- Several HPs installed at the outflow of the WWTP
- HPs will be supplied with electricity from a nearby run-off-river plant (Danube)
- Site is currently under construction

• Data for the case:

- Installed **3HP** capacity: **55 MW_{th}** in 2023
- Final **7HP** capacity: **110 MW_{th}** in 2027
- Total DH network currently **440,000 households** (HH), HP in 2027 for 112,000 HH
- WWTP: **6 °C** supply temp of HP: **90 °C**
- Annual generation: **880 GWh**
- Annual **CO₂** savings: **300.000 tons**



Vienna has different construction phases

The final project will have a capacity of 110 MW to supply the district heating network in Vienna.

During the first phase, three heat pumps were installed, which began operating in the winter of 2023.

In the second phase, another four pumps will be installed, with the goal of fully feeding the network with 110 MW by the end of 2027.

Discussion, Q&A



Part II: Best practice examples



This project has received funding from the EU's Horizon 2020 programme under grant agreement no 101033706.



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SF1 Group Support Webinar 7: Geothermal in District Heating

Presented by: Kai Zosseder, TUM

Organized by: TUW, e-think

13.03.2024



This project has received funding from the EU's Horizon 2020 programme under grant agreement no 101033706.



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Webinar 7: Geothermal in District Heating

Act!onHeat SF1

- Serial 3:
 - Webinar 7
 - Strategical Heating & Cooling planning
 - Group support for municipalities and stakeholders
- Organized by:
 - e-think / Austria
 - TU-Wien / Austria

Act!onHeat:
SF1 - Geothermal in District Heating

Scenarios to integrate Geothermal into District
Heating and Cooling Networks

Group Support Webinar 7

Kai Zosseder / 13.03.2024

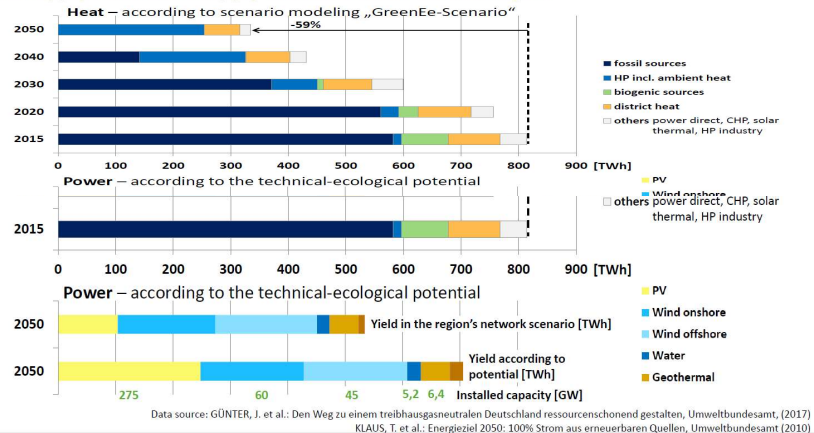
- The presentation provides an overview of the Scenarios to integrate Geothermal into District Heating and Cooling Networks.
- The work was carried out within the SAPHEA project and presented by Dr. Kai Zosseder.

Motivation:

- Decarbonisation to reach climate goals
- Security of energy supply

3 HEAT SUPPLY BECOMES RENEWABLE — UBA MODEL CALCULATIONS AND SCENARIOS

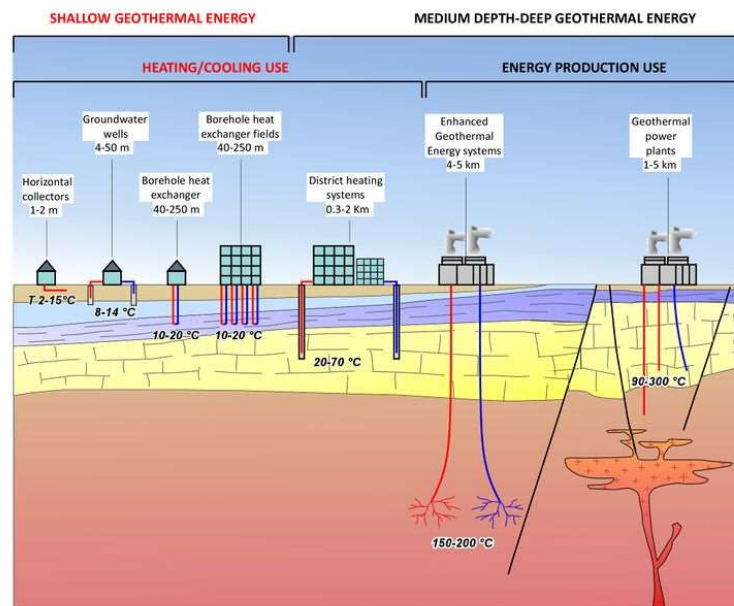
Heat Supply and Power Supply with Low-carbon Technologies



The motivations for using geothermal in district heating are:

- Achieving decarbonization targets
- Security of supply
- Ambient heat could contribute to a major portion of the supply shares in the future

Geothermal Systems



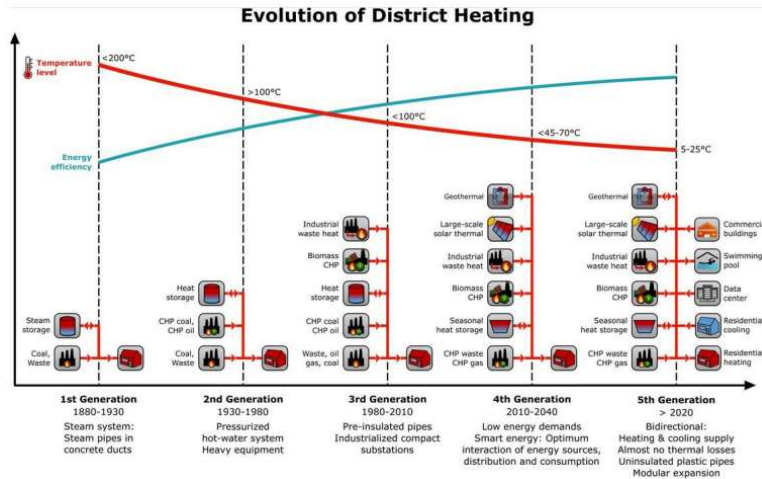
SAPHEA
INTEGRATING GEOTHERMAL HEATING
AND COOLING NETWORKS IN EUROPE

Dr. Kai Zosseder / GA / 05/12/2023

Page 4

- Overview of geothermal systems, including shallow and deep geothermal sources.
- Emphasis on geothermal energy as a stable, low-emission heat source.
- Details on technical aspects such as:
 - Depth of wells.
 - Heat extraction methods.
 - Suitable temperature ranges for different applications in district heating and cooling.

Heating - Cooling Grids

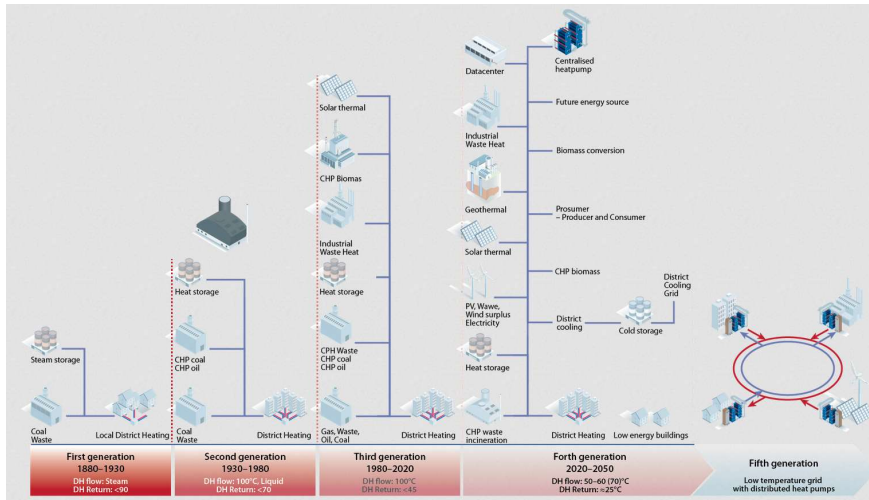


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Adopted from Lund et al. (2018) and Wirtz et al. (2020)

Page 5

- Focus on heating and cooling grids and their integration with geothermal systems.
- Highlights the role of geothermal energy in creating efficient and flexible heating and cooling grids, facilitating energy transfer between sources and users.
- Emphasizes how newer generations, including 4th and 5th, enhance energy efficiency and integrate renewable sources like geothermal energy more effectively.



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Page 6

- This slide contains visual content without specific text or detailed information.
- Likely serves as a transition or visual representation of geothermal systems or district heating concepts.
- Could be used to emphasize the shift towards geothermal energy in heating and cooling networks.

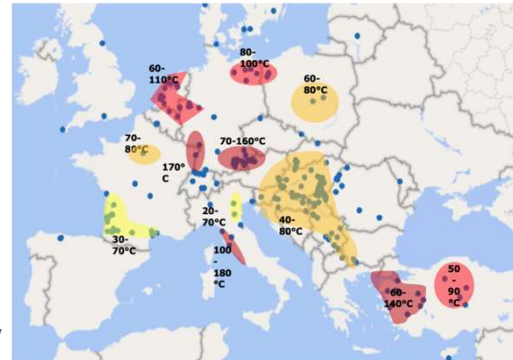
„Geothermal“ Networks distributed in Europe

Table 1: Statistical KPIs of direct geothermal energy used in heating networks in Europe as for 2019 based on the EGECC Geothermal Market report 2020 (data source: European Geothermal Energy Council).

KPI	Sample Size	P50	P75
Installed capacity (MW)	341	7	14
Temperature of production well (°C)	179	72	80
Capacity factor (gross heat / installed capacity (kh/yr)	234	2,59	3,98

Source: Goetzl et al., 2022

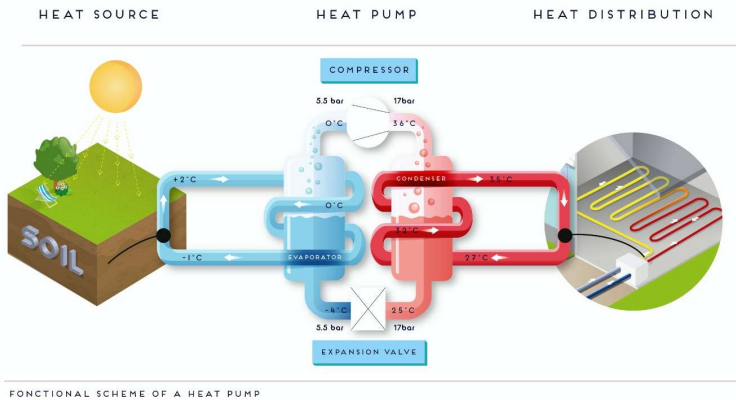
- **364 direct use geothermal DH networks** in Europe ~ 5.6 GW capacity
- **Approx. >100 5G networks** in Europe linked to geothermal technologies



Source: EGECC Geothermal Market Report 2021

- Overview of 364 geothermal district heating networks in Europe, providing around 5.6 GW capacity, with over 100 emerging 5th generation (5G) networks.
- 5G networks support flexible energy systems and better integration with renewables like solar and wind.
- Expanding geothermal can reduce fossil fuel dependency, support EU climate goals, and improve energy resilience year-round.

Flexibilisation

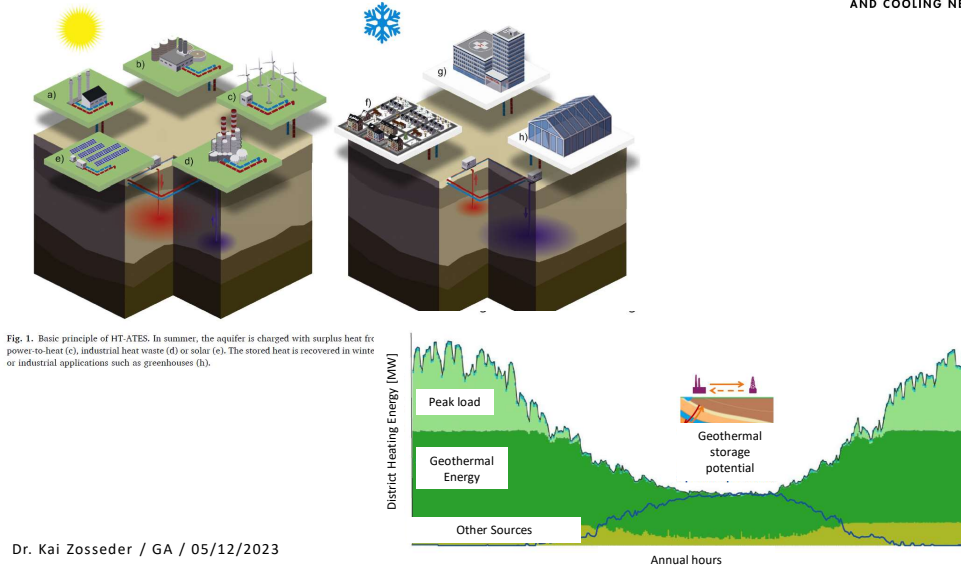


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Page 8

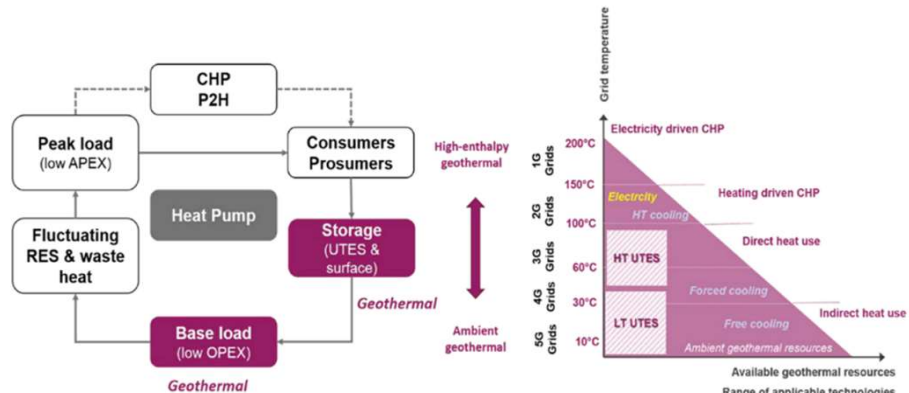
- Focus on the concept of "flexibilization" in district heating, emphasizing the role of geothermal energy in balancing supply and demand.
- Highlights how geothermal can be used alongside other energy sources to manage peak loads and optimize system efficiency.
- Flexibilization is crucial for adapting to varying energy demands and integrating renewable sources, ensuring a stable energy supply throughout the year.

Flexibilisation



- Discusses the potential of geothermal energy storage to enhance system flexibility in district heating.
- Illustrates how geothermal can handle peak loads by storing excess heat and using it when demand is high.
- Emphasizes the integration of geothermal with other renewable sources to maintain a consistent energy supply, optimizing district heating efficiency throughout different seasons.

Combination with Geothermal Sources



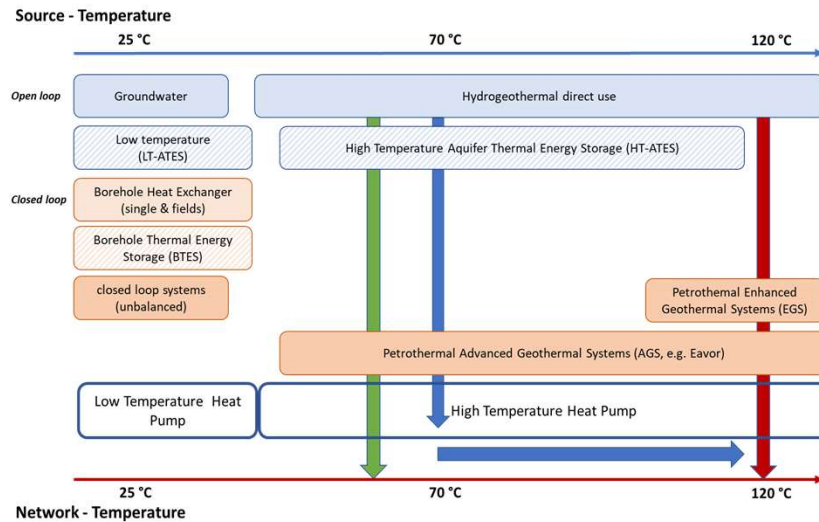
Goetzl et al. (2020)

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Page 10

- Explores the combination of geothermal energy with other heat sources to enhance district heating systems.
- Highlights the potential benefits of hybrid systems that integrate geothermal with technologies like heat pumps and thermal storage.
- Such combinations allow for greater adaptability and improved efficiency in meeting varying heating demands.

Geothermal Sources + HP + Storage + Networks → Scenarios



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Page 11

- Presents scenarios combining geothermal energy with heat pumps, storage solutions, and district heating networks.
- Emphasizes the need for strategic planning to optimize the mix of technologies for different regional contexts.
- Highlights the potential of these combinations to enhance the flexibility and sustainability of district heating systems.

Scenarios for Integrating Geothermal into DHC-Networks



- **Basic Scenarios:** Basic scenarios are simpler in design and are already commonly used throughout Europe or in single countries.
- **Complex Scenarios:** Complex scenarios consist of a combination of different technologies such as storage scenarios or scenarios using a HTHP, and are already installed in some places.
- **Future Developments:** Future scenarios are based on technology that is not yet market-ready. These are especially scenarios using enhanced or advanced geothermal systems (EGS, AGS) or uncommon combinations.

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- **Basic Scenarios:** These are simpler, commonly used configurations across Europe, involving standard geothermal integration.
- **Complex Scenarios:** These involve a combination of technologies such as heat pumps, storage systems, and high-temperature heat pumps (HTHP), already in use in some areas.
- **Future Scenarios:** Based on advanced geothermal systems (EGS/AGS) and emerging technologies that are not yet market-ready but hold potential for broader adoption in the future.

Basic Scenarios

Number	Scenario name	Type	SourceT [°C]	Aquifer/ ground	GridT [°C]
Basic scenarios					
B 01	Shallow geothermal & Free cooling - DC Network	basic	5-25	aquifer/ground	0-15
B 02	Groundwater + decentral LTHP - LT Network	basic	10	aquifer	10-25
B 03	Hydrothermal Direct Use - HT Network	basic	90 <<	aquifer	80 - 120
B 04	Hydrothermal Direct Use - MT Network	basic	40 - 90	aquifer	40 - 60
B 05	Groundwater + central HP - MT/HT Network	basic	10 - 30	aquifer	25- 90
B 06	BHE + central HTHP/BTES - MT/HT Network	basic	-4 - 30	ground	25 - 90
B 07	BHE + decentralized LTHP - LT Network	basic	-4 - 25	ground	10

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- **Basic Scenarios:** These are straightforward, simpler designs already implemented across Europe, focusing primarily on integrating shallow or direct-use geothermal technologies into existing district heating and cooling (DHC) networks.
- **Examples of Basic Scenarios:**
 - Shallow geothermal systems combined with district cooling networks.
 - Direct-use hydrothermal wells extracting groundwater for medium- to high-temperature district heating applications.

Basic scenarios typically involve mature technologies, such as low-temperature heat pumps or direct geothermal use, which offer more accessible entry points for integrating geothermal energy into local networks. These systems often have lower investment costs and can serve as a foundation for future expansion or hybridization with more complex technologies.

Complex Scenarios

Number	Scenario name	Type	SourceT [°C]	Aquifer/ ground	GridT [°C]
Complex scenarios					
C 01	Basic + LT ATEs + LT/MTHP - LT/MT Network	complex	30 >	Aquifer	40 - 60
C 02	Hydrothermal + HTHP - MT/HT Network	complex	30-90	aquifer	60 - 120
C 03	Hydrothermal + Sorption Chiller - DC Network	complex	60 - 100	aquifer	6 - 15

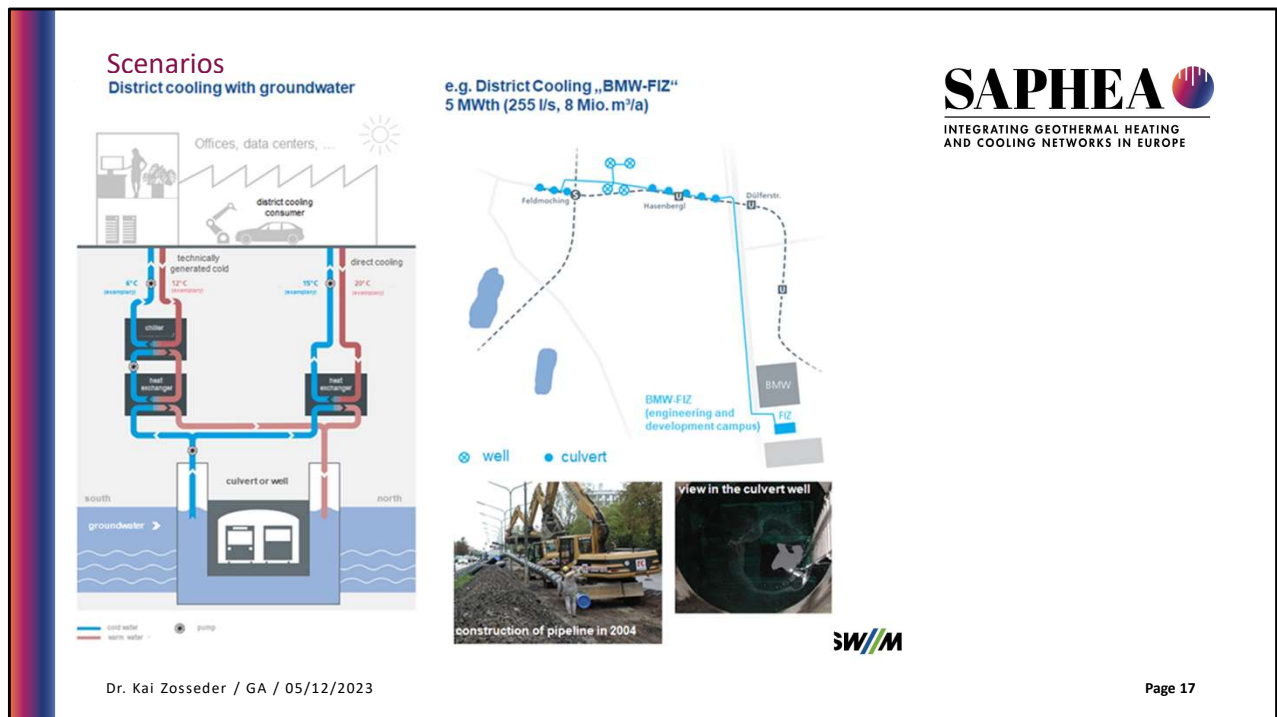
- **Overview:** Combines geothermal with technologies like high-temperature heat pumps (HTHPs) and storage systems.
- **Key Points:**
 - Uses geothermal alongside other energy sources for greater efficiency.
 - Already installed in some European regions, improving heat supply flexibility.

Future Scenarios

Number	Scenario name	Type	SourceT [°C]	Aquifer/ ground	GridT [°C]
Future scenarios					
F 01	Basic + HT-ATES – MT/HT Network	future	90 >>	aquifer	90
F 02	Advanced Geothermal Systems (AGS)	future	90 >>	ground	90
F 03	Enhanced geothermal system (EGS)	future	90 - 120	ground	90
F04	Deep BHE + HTHP – MT/HT Network	future	20 – 50	ground	90

- Focuses on future developments in geothermal integration, especially advanced and enhanced geothermal systems (AGS and EGS).
- **AGS and EGS:** These technologies involve closed-loop systems or enhanced geothermal wells, which are still in development and not widely commercialized.
- Potential for these systems to provide more flexible and scalable geothermal energy, making them applicable in a wider range of geographic and economic contexts.

Basic Scenarios



- Utilizes shallow geothermal energy with groundwater wells to supply cold water for district cooling (DC) networks.
- Cooling is delivered directly via a closed circuit, with supply temperatures typically around 4-8°C and return temperatures of 13-16°C.
- Suitable for systems where free cooling can be used, minimizing energy consumption and eliminating the need for mechanical chillers in many cases.

This setup is cost-effective with low maintenance and running costs, offering a highly efficient solution for district cooling

Scenarios

B 02 Groundwater + decentral LTHP - LT Network			
	T Source [°C]	T Grid [°C]	aquifer
	10	10-25	

Examples **Friedberg, Germany [8]; S**

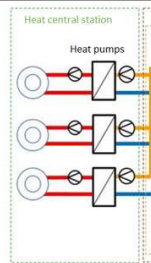


Figure 5: Scheme of



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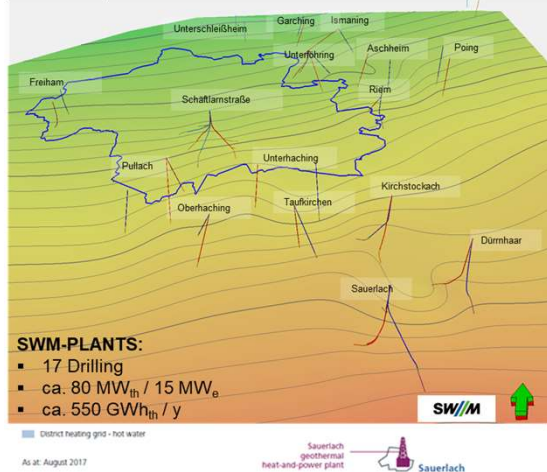
- In this scenario, groundwater wells are used to extract water at a low temperature (around 10°C) for a low-temperature district heating network (10-25°C).
- Each building has a decentralized low-temperature heat pump (LTHP) that raises the temperature to meet the required heating level for the building.
- This system, often referred to as a 5th Generation District Heating and Cooling (5GDHC) network, primarily serves as a provider of low-temperature ambient heat.
- It is particularly efficient for areas where low-temperature heating or cooling is needed, with minimal heat loss and flexible network operation.

Scenarios

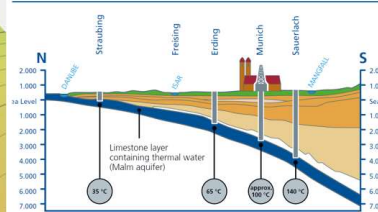
B03

Hydrothermal Direct Use – HT Network

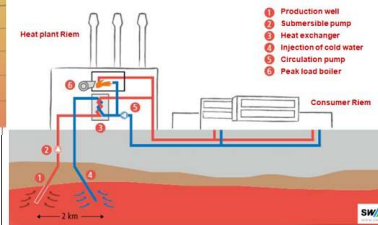
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NORTH/SOUTH CROSS-SECTION OF THE
FOOTHILLS OF THE BAVARIAN ALPS



North/South cross-section of the foothills of the Bavarian Alps



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- Involves hydro geothermal well doublets extracting groundwater at 90-120°C from deep geothermal reservoirs.
- Heat is transferred directly to high-temperature district heating networks (90-120°C).
- Suitable for high-temperature district heating systems (2nd and 3rd generation).
- Example of implementation: Munich, Germany, where this system is used to supply district heating.

Scenarios

B 04 Hydrothermal Direct Use – MT Network



Lendava, Slovenia [10]

Local community Lendava covers 123 km² in the Pomurje region. In Lendava there is one of the few Slovenian geothermal district heating systems. Production borehole Le-2g was drilled in 1994 and reinjection borehole Le-3g in 2007. At a district heating system with a length of about 3200 m school, kindergarten and multi-dwelling houses are connected. The installed capacity is about 2.7 MW_{th}. The production temperature of the well is 74°C and the operation temperature of the network is about 40-66 °C.

Mórahalom, Hungary [10]

Mórahalom has 6 100 inhabitants A geothermal cascade system was developed to reduce dependency on natural gas by using a renewable heat source. This system consists of two drilled wells, a 1.26 km-deep outflow well and a 0.9 km injection well. Within the project a new district heating system of 2.85 km was established to supply public buildings. The GHG emission is now reduced by 80%. A capacity of 1.5 MW_{th} is produced by the three production wells. The operating temperature of the district heating network is about 69-40°C. The maximum production temperature of the wells is about 70°C.

Trnava Sered, Slovakia [10]: about 6 MW_{th}, about 3760 apartments, Production Temperature 66°C; Operating District Heating temperature: 65°C; combined with natural gas



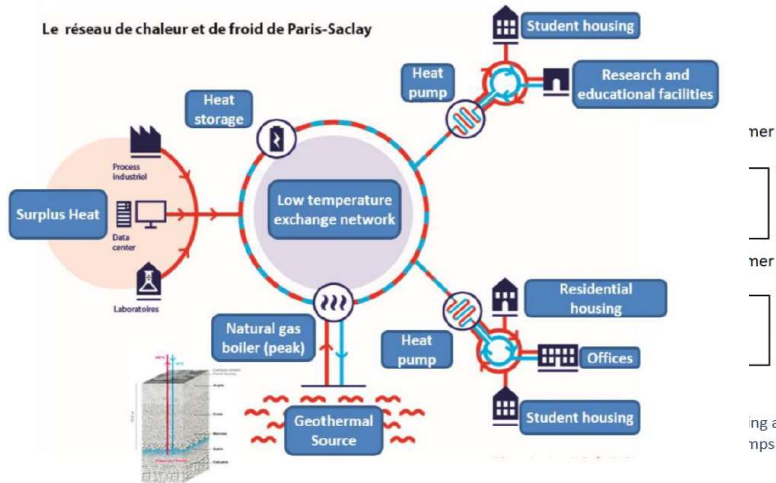
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- Hydrothermal well doublets extract groundwater at 40-90°C from geothermal reservoirs at depths of approximately 1,500 meters and below.
- Heat is transferred via heat exchangers to district heating networks, supplying hot water at 40-60°C to end users.
- This scenario is suitable for medium-temperature networks (2nd and 3rd generation DHC systems).
- Examples include the Lendava system in Slovenia and Mórahalom in Hungary, where geothermal heating systems operate with moderate temperatures to meet local demand.

Scenarios

B 05 Groundwater + central HP – MT/HT Network



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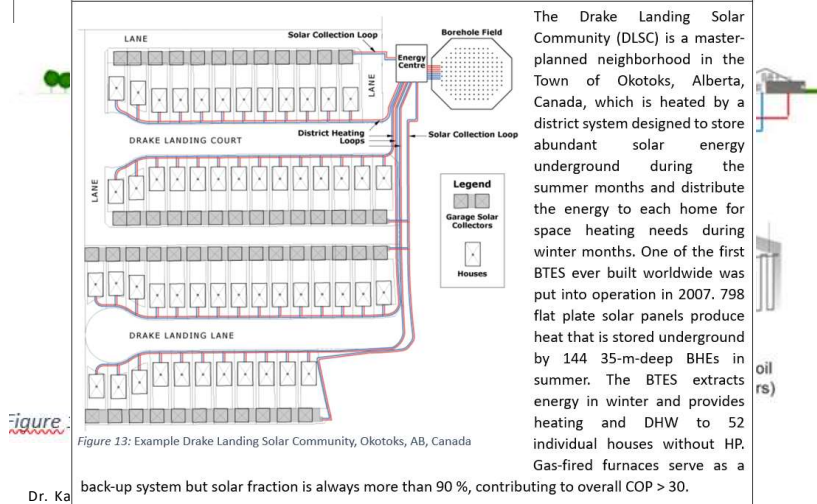
- Groundwater wells at shallow depths (10-30°C) combined with central large heat pumps to increase the temperature for district heating.
- The scenario typically serves medium- and high-temperature networks (25-90°C), covering the base load of the heat demand.
- Often integrated with other sources like combined heat and power (CHP) for added flexibility and efficiency in district heating networks.

This scenario is suitable for 4th generation district heating (4G DH) systems, offering flexibility in temperature adjustment to meet diverse energy demands across different regions.

Scenarios

B 06 BHE + central HTHP/BTES - MT/HT Network

Drake Landing Solar Community, Okotoks, AB, Canada [18]



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- Borehole heat exchangers (BHE) are used in combination with high-temperature heat pumps (HTHP) and borehole thermal energy storage (BTES) systems.
- BHEs are installed at depths of 50-200 meters to deliver energy year-round, providing either heating or cooling depending on the season.
- During summer, heat is collected via solar panels or waste heat and stored in shallow BHEs (<50 m), while in winter, heat is extracted from deeper BHEs and delivered to the grid for heating.
- Short-term storage tanks (50-100 m³) improve system efficiency by acting as an intermediary between the BTES and the heating grid.

Scenarios

B 07

BHE + decentralized LTHP - LT Network

Silkeborg. Denmark

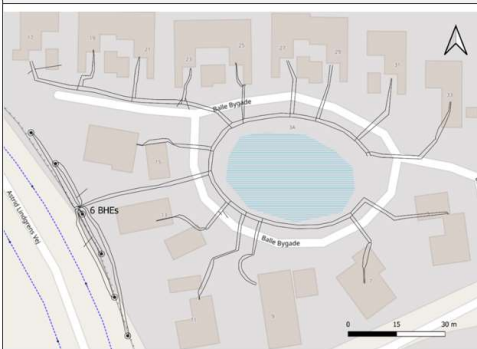
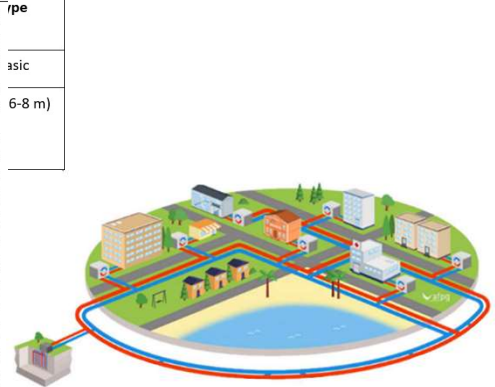


Figure 18: The thermonet at Balle Bygade in Silkeborg with 15 connected consumers. Balle Bygade no. 9 is the existing house built in 1979 (lower center of figure).

The 5GDH grid/thermonet consists of ca. 1340 m uninsulated PE forward and return pipes including the consumer connections with dimensions Ø40, Ø50, Ø63 and Ø90 mm. The thermonet connects six 120 m long borehole heat exchangers (BHE) with single-U Ø40 mm SDR probes, and a drilled diameter of 15.2 cm, to individual brine-to-water heat pumps in 15 (14 6kW and 1 10 kW) family houses. The annual heating consumption amounts to approximately 167 MWh and SCOP is 3.3 at the system level.



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- Borehole heat exchangers (BHEs) are used to exchange thermal energy with a low-temperature district heating network.
- Each user is equipped with a decentralized low-temperature heat pump (LTHP) that adjusts the temperature of the heat from the BHE for space heating or cooling.
- The system can operate in both heating and cooling modes, depending on seasonal demand, with energy being extracted or injected into the ground.
- Suitable for 5th generation district heating and cooling (5GDHC) networks, this setup optimizes energy efficiency with minimal heat losses.

Complex Scenarios

Scenarios

C 01

Basic + LT ATES + LT/MTHP – LT/MT Network

Rostock, Germany [24]

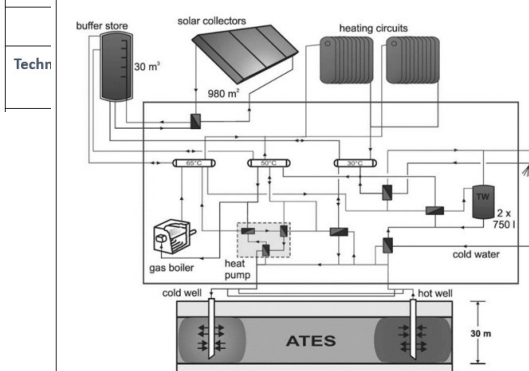
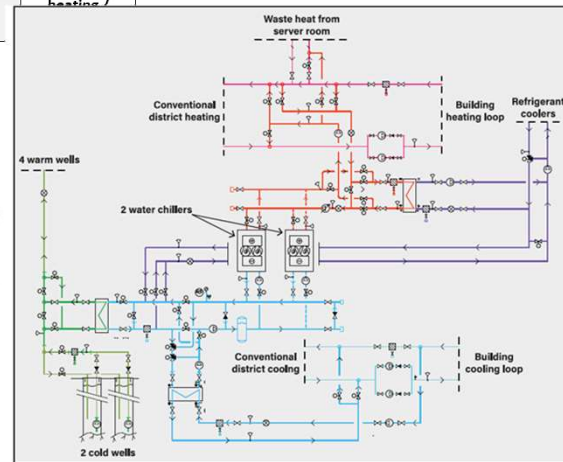


Figure 21: Hydraulic scheme of the installation in Rostock.



Hästskon, Sweden

- The scenario uses Aquifer Thermal Energy Storage (ATES) systems to provide low-temperature (LT) and medium-temperature (MT) heating for district heating networks.
- Groundwater is extracted from aquifers and stored for later use, supporting efficient heating in buildings, with temperatures ranging from 30°C in the aquifer to 40-60°C in the grid.
- The system enables cooling during summer by utilizing cold groundwater stored in the previous winter season and reinjecting excess heat from cooling processes into the warm well for winter heating.

Scenarios

C 02 Hydrothermal + HTHP - MT/HT Network

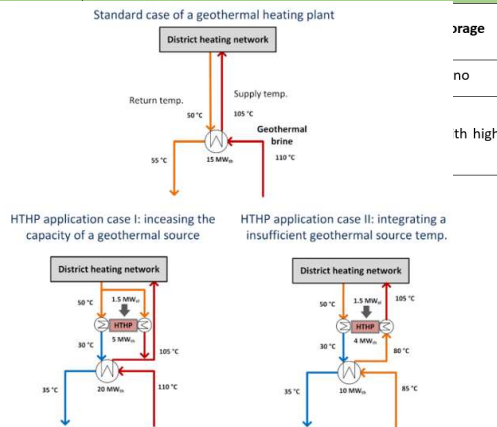


Figure 23: Application scenarios for HTHPs within geothermal heating plants.

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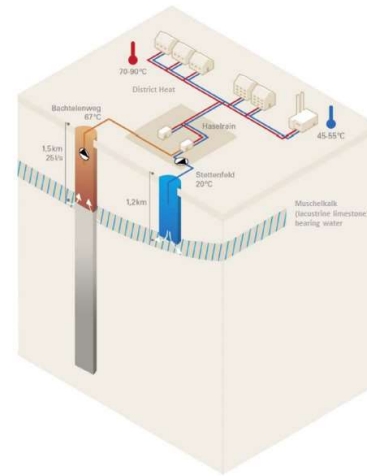


Figure 24: Example of Riehen, Switzerland (Source: [29])

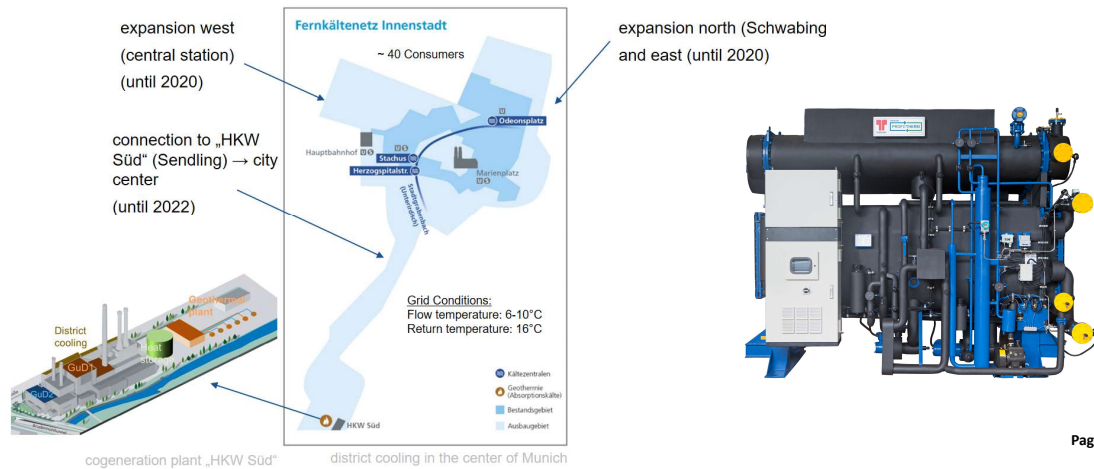
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- Demonstrates the use of hydrothermal well doublets combined with high-temperature heat pumps (HTHP) to supply medium- to high-temperature district heating networks.
- The scenario shows how lower-temperature geothermal sources (30-90°C) are lifted by HTHPs to match the heating grid requirements of 60-120°C.
- This setup increases the efficiency and flexibility of district heating systems, enabling better use of lower temperature geothermal resources in regions that require higher network temperatures.

Scenarios

C 03 Hydrothermal + Sorption Chiller - DC Network

Expansion of district cooling



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- Hydrothermal well doublets extract geothermal heat (60-100°C), which is used to drive sorption chillers for district cooling networks.
- The cooling network operates with supply temperatures around 6-10°C and return temperatures of 15-17°C.
- This scenario is suitable for larger commercial and industrial buildings, where sorption chillers offer a lower electricity demand compared to traditional vapor compression cycles.

Future Scenarios

Scenarios

f 01 Basic + HT-ATES – MT/HT Network

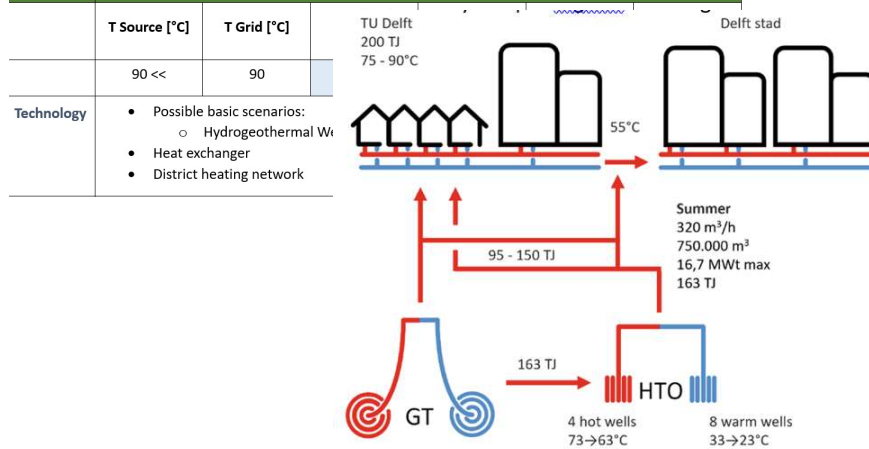


Figure 29: HT-ATES Scheme of Delft, The Netherlands.

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- The scenario demonstrates the use of high-temperature Aquifer Thermal Energy Storage (HT-ATES) systems to provide heat to medium- and high-temperature district heating networks.
- Aquifers serve as storage mediums, with stored temperatures reaching up to 90°C at depths between 300 and 3,000 meters.
- Heat is extracted from the aquifer using well doublets and transferred via heat exchangers to district heating networks, ensuring consistent heat supply.

Scenarios

f 02 Advanced Geothermal Systems

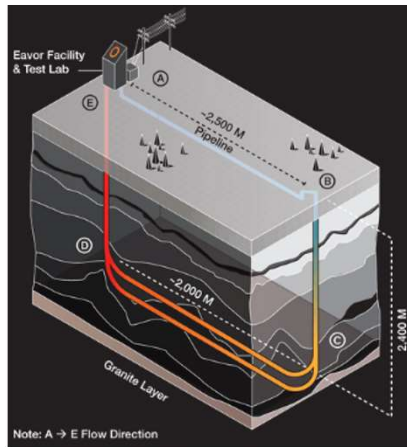


Figure 30 Eavor-Lite (Prototype)

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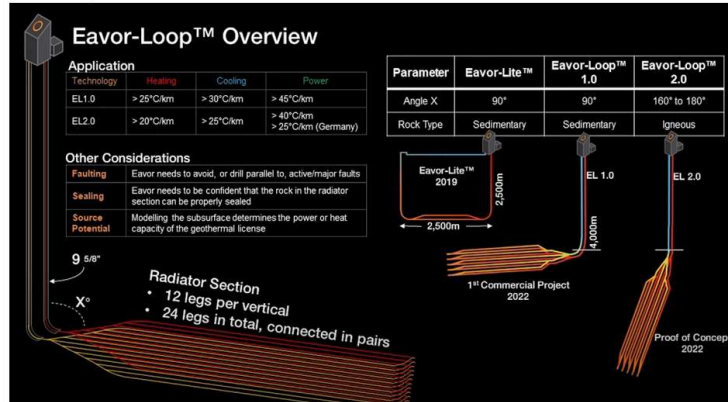


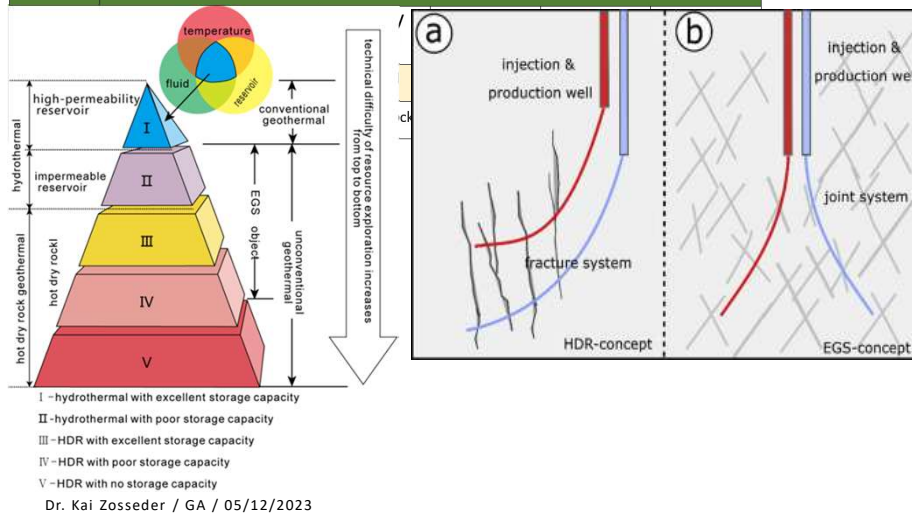
Figure 31: Eavor-Loop™

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- This scenario focuses on **closed-loop geothermal systems** like **Eavor-Loop™** and **GreenLoop**, where no fluids are extracted from the Earth.
- Fluids circulate in sealed pipes deep underground, picking up heat by conduction, and carry it to the surface for heating or electricity generation.
- These systems reduce risks such as seismic activity and water consumption and can be implemented in a variety of locations due to their scalability.
- Suitable for future developments in both heating and power generation applications.

Scenarios

f 03 Enhanced geothermal system (EGS)

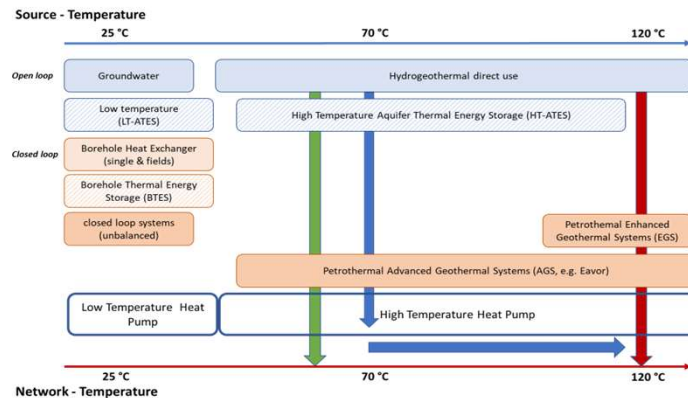


- The Enhanced Geothermal System (EGS) harnesses geothermal heat from deep underground (3-6 km), utilizing low-permeability rocks.
- EGS involves creating a large subterranean heat exchanger by injecting pressurized water into the rock to widen existing cracks, enhancing the flow of heat.
- EGS systems can provide heat for district heating networks and are capable of operating at temperatures between 90-120°C, offering potential for high-efficiency, high-temperature heating solutions in the future.

Conclusion

- Several Opportunities to integrate Geothermal into DHC Networks
- All depending on the local situation at the surface and the subsurface:

Which sources are available, which heat/cool demand must be covered



- Several opportunities exist to integrate geothermal energy into district heating and cooling (DHC) networks, contingent upon local surface and subsurface conditions.
- The availability of geothermal sources and the specific heating and cooling demands that need to be met will dictate the most effective integration approach.
- Strategic planning and assessments are essential for optimizing the mix of technologies tailored to local circumstances.

Thank you!

Get in contact with us:
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Webinar 8: Space Cooling

Act!onHeat SF1

- Serial 3:
 - Webinar 8
 - Strategical Heating & Cooling planning
 - Group support for municipalities and stakeholders
- Presented by:
 - e-think / Austria
 - TU-Wien / Austria

This webinar focuses on space cooling, covering increasing demand, reduction potential, and sustainable supply opportunities. The presentation is delivered by Aadit Malla from TU Wien, highlighting strategies to address cooling challenges in the context

of rising demand and EU policy frameworks.

Contents

- Part 1: Existing and projected demands and EU policy landscape
 - Space cooling demands in Europe, reasons for increasing space cooling demands
 - EU regulations related to space cooling, requirements within the Comprehensive Assessment in the EED Art. 25
- Part 2: Opportunities for reduction and sustainable supply
 - Reduction potential from passive measures
 - Identifying Sustainable Supply technologies - Central and Decentral
 - Impact of occupant behavior on cooling demand



Part 1: Existing and projected demands and EU policy landscape

- ☐ Space cooling in Europe
- ☐ Cooling demand: Data scarcity and Modelling
- ☐ EU cooling policy and framework



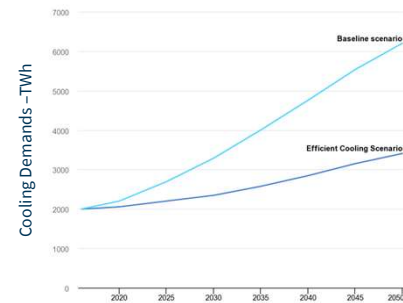
Space Cooling

“the process of cooling indoor air by removing heat from the air and providing buildings' occupants with thermal comfort”

Why cooling in Europe?

- Global temperature rises
- Higher affordability (increased GDP & reduced technology costs) for cooling technologies → resulting in higher diffusion rates
- Increasing living standards, improved comfort levels
- Focus on the heating season only when improving buildings' envelope and neglecting the chance to improve buildings' performance under winter and summer conditions
- Increasing window-wall-ratio

Global Increasing Cooling Demands (IEA,2019)



www.actionheat.eu

- The presentation focuses solely on space cooling, which refers to cooling aimed at maintaining indoor comfort for occupants. Process cooling is excluded from the scope.
- Global cooling demand is rising due to factors such as higher affordability, improved living standards, and increased comfort expectations.
- Innovative approaches offer opportunities to control demand growth and transition towards sustainable cooling supply solutions.
- A shift in building improvement strategies is needed to address performance during both summer and winter, emphasizing holistic climate-responsive designs.

Part 1: Existing and projected demands and EU policy landscape

- ☐ Space cooling in Europe
- ☐ Cooling demand: Data scarcity and Modelling
- ☐ EU Cooling policy and framework

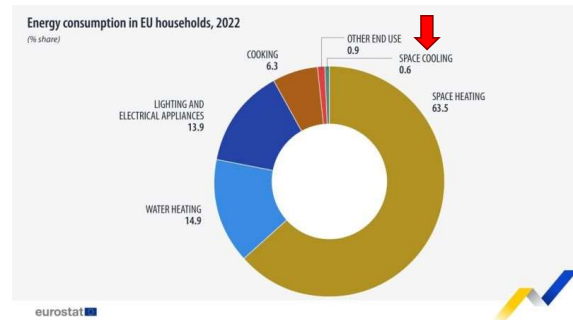
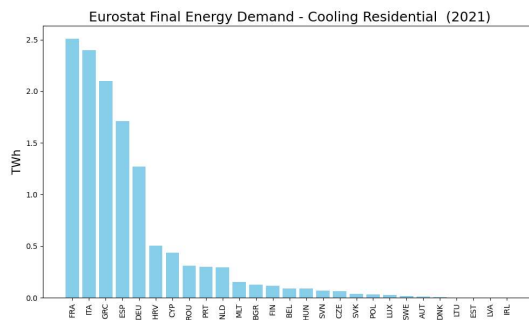


Scarcity of Cooling data

- Historical focus on heating
- Regional variability in data collection practice
- Cooling demand is coupled with electricity demand
- Until recent years there has been no/limited emphasis on cooling
- Finding a proxy to estimate the cooling demands

- The scarcity of reliable data complicates the prediction and modeling of cooling demand across Europe.
- Cooling demand has traditionally been overlooked, with more focus placed on heating data collection and analysis.
- Cooling Degree Days (CDD) provide a straightforward yet simplistic method for estimating cooling demand.
- Improved data collection practices and proxies are necessary for more accurate demand assessments, especially given regional variability.

Space Cooling in EU-residential



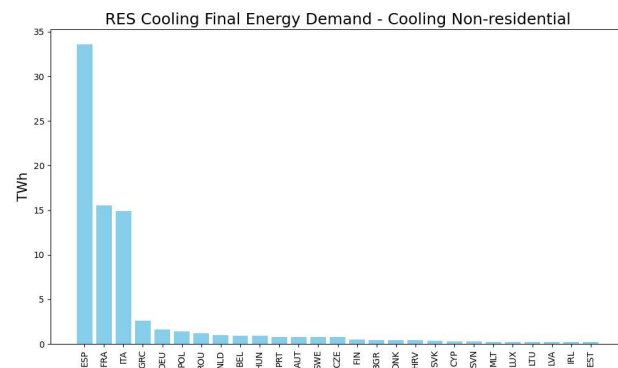
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Source: Eurostat, 2022

- Space cooling represents a minimal portion of the total energy demand in the EU residential sector.
- The demand is primarily influenced by external temperatures, building insulation quality, and occupant behavior.
- Increased affordability and diffusion of cooling technologies are gradually driving demand growth in residential buildings.
- Accurate demand modeling for this sector remains challenging due to limited data availability and historical focus on heating needs.

Space Cooling Non-residential

- Scarce Data
- Mostly combined data with process heat



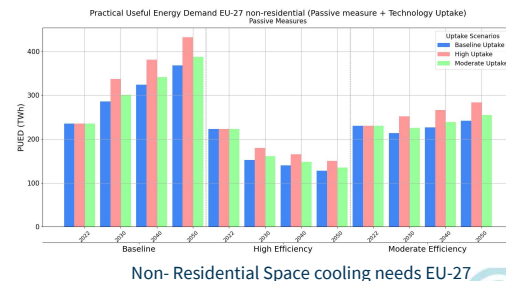
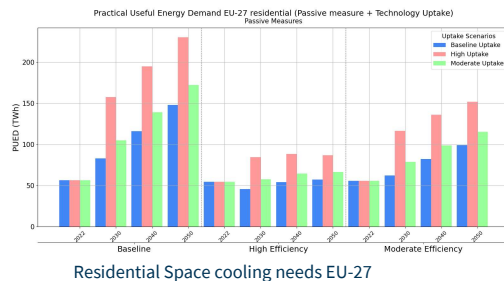
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Source: RES Cooling 2019

- In the non-residential sector, cooling demand data is often combined with process heat data, making it challenging to isolate specific cooling needs.
- The lack of granular data hampers accurate assessments and planning for space cooling in non-residential buildings.
- Non-residential cooling demand is influenced by operational schedules, internal heat loads, and building design
- Improved data segregation and collection methodologies are essential to understand and address the unique cooling requirements of this sector.

Modeling the Space Cooling Demand

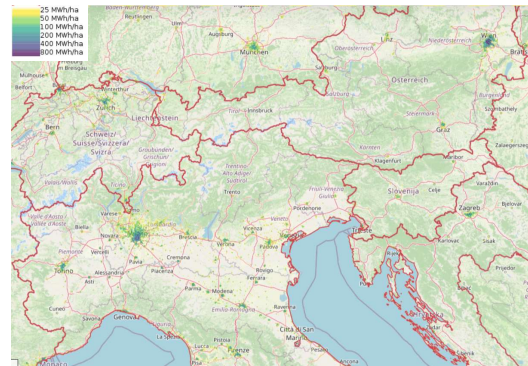
- Baseline: No changes to the technology stock
- High Uptake: Sudden increase in the uptake of the passive measures
- Moderate Uptake: Moderate increase in the uptake of passive cooling measures



- The space cooling demand was modeled under three scenarios, each varying by the rate of uptake of passive cooling measures.
- The adoption rate and efficiency of passive measures significantly influence the potential for demand reduction.
- Large uncertainties exist regarding the future adoption rates of these measures and their real-world effectiveness.
- Passive measures include strategies like shading, advanced window glazing, night ventilation, and adjusting indoor temperature setpoints to reduce cooling needs.
- These scenarios aim to provide insights into how passive measures can contribute to sustainable cooling strategies.

Spatial distribution of the cooling demand density

- Numerical data to spatial distribution helps policymakers, urban planners, and energy providers visualize and address the demand more effectively.
- Available hotmaps layers
- Overview of the demand in major cities across Europe



www.actionheat.eu

Source: Hotmaps

- Spatial data on cooling demand density adds an important dimension to planning and policy-making.
- It helps visualize demand patterns across regions, enabling targeted interventions for cooling infrastructure and energy supply.
- Policymakers, urban planners, and energy providers can use this data to address demand more effectively and equitably.
- Tools like Hotmaps layers can provide an overview of cooling demand in major cities, facilitating region-specific strategies for sustainable cooling.

Occupant Behavior and Cooling Demand

• **Behavioral Influence:** Occupant behaviors, including adjustments to thermostats and preferences for cooler indoor temperatures, significantly dictate cooling energy demand.

• **Comfort Needs:** Comfort perceptions are highly subjective and influenced by personal preferences, lifestyle, and environmental awareness.

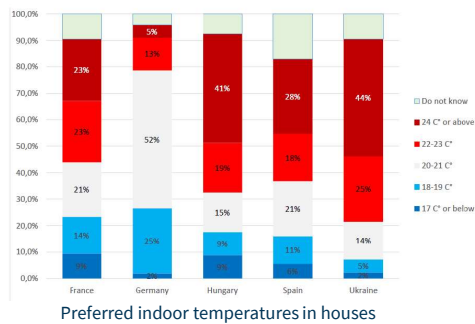
• **Adaptive Comfort:** Occupants adjust their comfort levels through various means, not just mechanical cooling, using strategies like natural ventilation and shading.

• **Socio-Cultural Factors:** Cultural backgrounds and lifestyle choices impact cooling

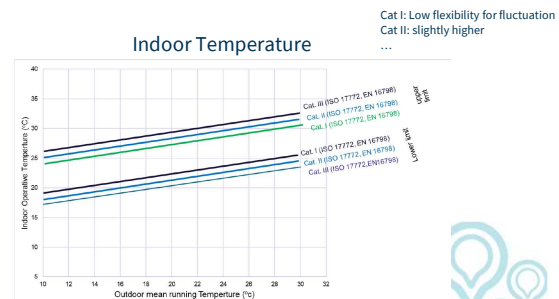


- Occupant behavior significantly influences cooling demand, adding complexity to demand modeling efforts.
- Behavioral aspects, such as thermostat adjustments, preferences for cooler temperatures, and lifestyle habits, must be considered alongside building physics modeling.
- Comfort needs are subjective, influenced by socio-cultural factors, personal preferences, and environmental awareness.
- Incorporating these dynamic and human-centered factors is crucial for developing accurate and comprehensive space cooling demand models.

Comfort Ranges



- People with exposure to air-conditioning at work would also prefer one at home
- Demand is driven by the external temperatures, building insulation, energy prices and user preferences as well as the occupancy behavior (occupancy status)
- Typical thermostat setting found in air-conditioned setting 25-28°C



Source: CoolLIFE, 2023

- The figure on the left illustrates preferred indoor temperatures across various countries, reflecting cultural and climatic differences.
- The bottom figure highlights the relationship between indoor temperatures and outdoor conditions, providing a framework for estimating comfort levels.
- These calculations are essential for architects, urban planners, and energy engineers to design energy-efficient HVAC systems tailored to local climatic variations.
- Properly designed systems can maintain thermal comfort while minimizing energy use, particularly in areas with significant fluctuations in outdoor temperatures.

Part 1

- ☐ Space cooling in Europe
- ☐ Cooling demand: Data scarcity and Modelling
- ☒ EU cooling policy and framework



EU Policy Framework

- Decarbonization targeted in heating and cooling as part of the European Green Deal and Fit for 55 initiatives.
- Renewable Energy Directive (2018/2001) enhances focus on renewable integration in heating and cooling sectors.
- Revised Renewable Energy Directive (2023/2413) strengthens and sets new targets for district heating and cooling.
- New provisions enable better use of waste heat and improve the role of heating and cooling in EU energy systems.



- The European Green Deal and the Fit for 55 package emphasize decarbonizing heating and cooling sectors to achieve climate neutrality by 2050.
- The Renewable Energy Directive (2018/2001) sets a binding overall Union target to reach a share of at least 32% of energy from renewable sources in the Union's gross final consumption of energy by 2030.
- The revised Renewable Energy Directive (2023/2413) strengthens the heating and cooling target (Article 23) and the district heating and cooling target (Article 24). It also extends measures EU countries can take to achieve these targets and includes specific provisions on integrating waste heat and cold.
- These directives aim to enhance the role of heating and cooling in the EU's energy system integration, promoting the use of renewable energy sources and improving energy efficiency.



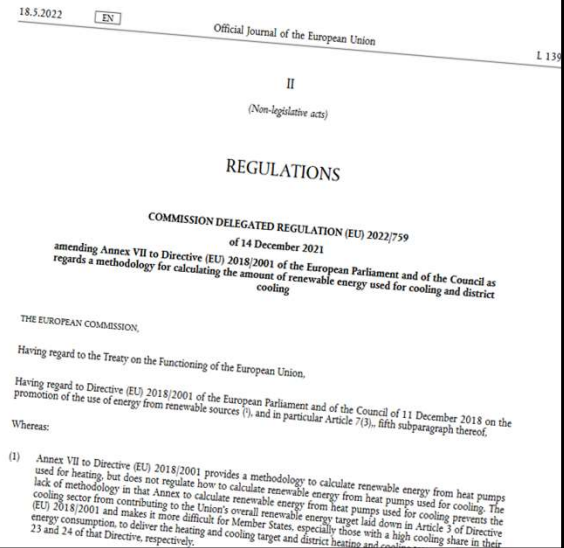
Increasing focus of (EU) policies on cooling- Renewable Cooling – RED

- Share of renewable cooling for calculating RES-HC shares according to the renewable energy directive:

$$E_{RES-C} = (Q_{C_{Source}} - E_{INPUT}) \times S_{SPF_p} = Q_{C_{Supply}} \times S_{SPF_p}$$

Depending on the efficiency (seasonal performance factor) of the cooling system:

- Technological progress
- Use of low-temperature heat sink (cold source)



- EU policies are increasingly prioritizing the integration of renewable cooling within the broader energy transition agenda.
- The Renewable Energy Directive (RED) emphasizes renewable cooling as a key component for achieving energy efficiency and decarbonization targets.
- Renewable cooling is defined based on efficiency thresholds, promoting technologies like heat pumps, free cooling, and waste heat recovery.
- The RED encourages Member States to develop frameworks to support renewable cooling adoption and monitor its contribution to renewable energy targets.
- This focus aligns with the EU's Green Deal and Fit for 55 objectives to transition the heating and cooling sectors to sustainable and energy-efficient solutions.

Requirements of the EED recast- MS Comprehensive Assessment

- **Demand Assessment:** Evaluate current and future cooling needs.
- **Technical Feasibility:** Identify viable cooling technologies.
- **Economic Analysis:** Perform cost-benefit and investment analysis.
- **Environmental Impact:** Estimate energy savings and emissions reductions.
- **Legal Framework:** Review regulatory barriers and incentives.
- **Infrastructure Requirements:** Outline necessary infrastructure for cooling.
- **Market Potential:** Analyze customer base and market size.
- **Best Practices:** Highlight successful case studies.
- **Risk Evaluation:** Identify and assess project risks.



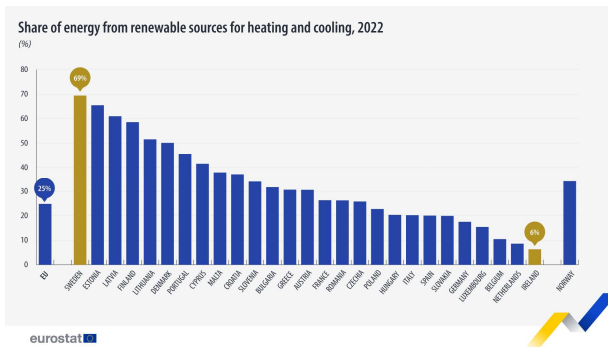
- The EED recast requires member states to assess cooling demand, identify viable technologies, and evaluate economic and environmental impacts.
- It emphasizes addressing regulatory barriers, market potential, and infrastructure needs.
- Risk assessment and best practices are key to advancing sustainable cooling strategies.

Part 2: Opportunities for reduction and sustainable supply

- ☐ Impact of Cooling on Achieving Renewable Energy Targets
- ☐ Overview of Active and Passive Cooling Measures
- ☐ Reduction potential from passive measures
- ☐ Evaluating Central and Decentralized Cooling Technologies



Current Share of renewables in Heating and cooling



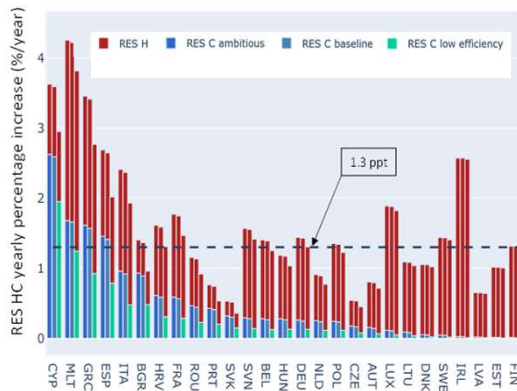
- Data only on cooling is not available
- Considering the delegated act was in place in 2021 this data should include cooling, but needs to be confirmed with MS
- Hard to estimate what percentage of cooling demand is met by renewable

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Source: EUROSTAT, 2022

- Data on the share of renewables specifically for cooling is limited, as current statistics often combine cooling with heating data.
- The Renewable Energy Directive (RED) aims to integrate cooling into renewable energy targets, emphasizing the need for accurate and updated data.
- Member states are encouraged to evaluate and report renewable cooling contributions to better align with EU energy goals.

Potential impact of RES-C share calculation on RES-HC shares and target achievement?



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Source: Mascherbauer, 2024

- Different Scenarios based on renewable accounting:
 - Primary efficiency factor thresholds
 - Development of technology
 - Use of local resources
- Countries with high cooling requirements (southern) experience a substantial boost in RES shares adopting renewable cooling in RES-HC
- The lower the efficiency of cooling devices, the lower the RES-C contribution to the RES-HC targets.
- Thus, in principle, there is an incentive to increase the efficiency of cooling systems.
- Increased emphasis on the cooling sector gives member states the opportunity/incentive to increase their renewable energy share in the heating and cooling sector
- It remains to be seen to what extent this incentive is sufficient to actually trigger improvements in the cooling sector.

- The efficiency of cooling systems significantly influences renewable cooling (RES-C) contributions to renewable heating and cooling (RES-HC) targets.
- High cooling demands in southern regions can substantially boost renewable shares with effective RES-C integration.
- Policies encourage improving system efficiency and adopting renewable technologies to meet EU decarbonization goals.

Part 2: Opportunities for reduction and sustainable supply

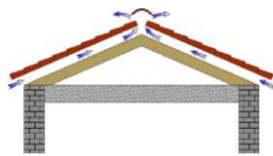
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Reduction Potential from Passive Measures

Passive cooling measures: Cooling measures do not require energy input to provide cooling

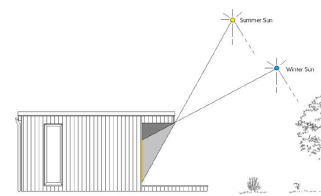
- Well-designed passive cooling measures would reduce the demand in a region
- Commonly Included passive measures include: Ventilation and shading
- Night ventilation is relatively effective



Roof Ventilation
TRL: 7-9
Savings Potential: 5-15%



Shading
TRL: 7-9
Savings Potential: 10-25%



Overhang
TRL: 7-9
Savings Potential: 15-30%
Source: CoolLIFE, 2023

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- Passive cooling measures, such as shading, ventilation, and roof insulation, significantly reduce cooling energy demands, with savings potential ranging from 5% to 30%.
- The **Technology Readiness Level (TRL)** largely defines the cost and savings potential of these measures, impacting their adoption feasibility.
- Some measures are easy to integrate, while others require substantial building design alterations, which can increase costs.
- Prioritizing scalable and cost-effective measures is key to achieving sustainable cooling strategies.

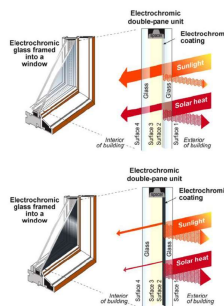
Reduction Potential from Active measures

Active cooling measures: Cooling measures that take energy input

- Automated Glazing
 - Electrochromic glazing
 - Thermochemical glazing
- Rotating shading system
- Folding shading system
- PV shading

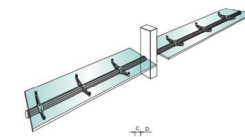


TRL: 6-7
Savings Potential: n.a.



TRL: 6-9
Savings Potential: 80%

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TRL: 6-9
Savings Potential: 15-40%



Source: CoolLIFE, 2023

- Active cooling measures, such as electrochromic glazing, thermochemical glazing, and PV shading, require energy input but offer significant savings potential, ranging from 15% to 80%.
- Advanced technologies provide better energy-saving potential but come at higher costs, requiring a balance between upfront investment and long-term efficiency gains.
- The **Technology Readiness Level (TRL)** for these measures varies, impacting their integration feasibility and market adoption.
- These systems are ideal for projects where high savings justify the cost, but careful evaluation of costs and integration challenges is necessary.

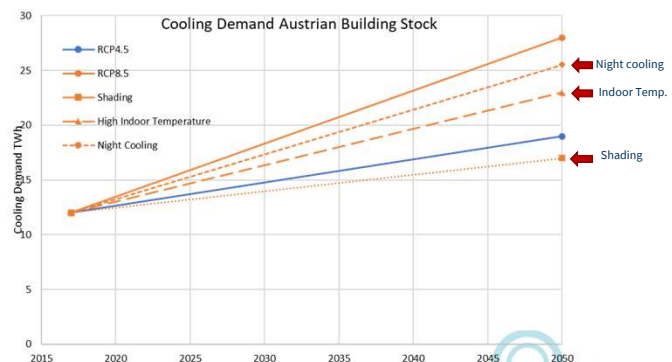
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Modelling the effect of passive cooling measures on future energy needs for the Austrian building stock

- Analyzing the effects of the measures on a country-level
- Impact of passive cooling measures (shading, night ventilation) and sufficiency measures (high indoor temperature)
- 100% technology saturation

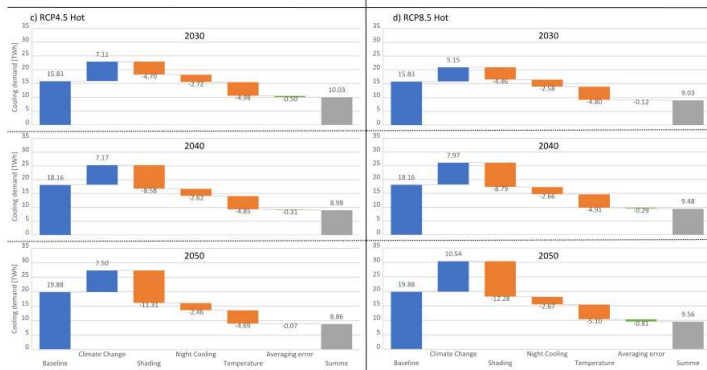


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Source: Mayrhofer, 2023

- The modeling assesses the impact of passive cooling measures, such as shading and night ventilation, on future energy demands for the Austrian building stock under **Representative Concentration Pathways (RCPs)**.
- Under RCP 4.5 (stabilization by 2040) and RCP 8.5 (high GHG emission scenario), cooling demand is projected to increase significantly by 2050.
- Despite these increases, passive measures and sufficiency strategies (e.g., higher indoor temperatures) offer a substantial reduction potential of 68–73% in energy demand.
- The results underscore the importance of incorporating regionally optimized passive cooling strategies into Austria's energy policies to mitigate climate-induced demand increases.

Combined effect of Passive measures



- Findings validate that regional passive cooling strategies can be effectively scaled to the national level across Austria.
- Passive measures play a critical role in managing future energy demands within the building sector.
- It's crucial to embed passive cooling measures within national energy planning and policy frameworks
- Emphasizes the importance of these measures in maintaining sustainable energy use amidst rising temperatures.

- Passive cooling measures, such as shading, night ventilation, and maintaining higher indoor temperatures, have a combined potential to significantly reduce energy demand.
- Modeling for Austria shows these measures can mitigate the impacts of rising temperatures under RCP 4.5 and RCP 8.5 scenarios.
- Scaling passive strategies to the national level is essential for sustainable energy planning and achieving climate resilience.
- These findings highlight the critical role of passive measures in reducing future energy needs while addressing increasing cooling demands driven by climate change.

Part 2: Opportunities for reduction and sustainable supply

- ☐ Impact of Cooling on Achieving Renewable Energy Targets
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Cooling Supply Technologies

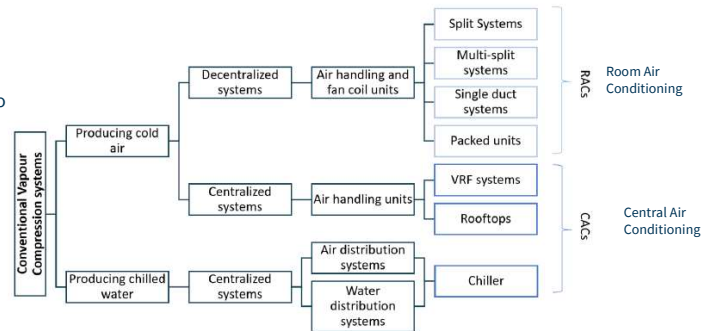
Active cooling technologies: Appliances that require energy input for cooling

- Free cooling sources: the source is free (ambient air, ground, water body) but still requires energy input to transport heat against the direction of its flow

Vapor Compression Units

$$COP_{max} = \left(1 - \frac{T_{cold}}{T_{hot}}\right)^{-1}$$

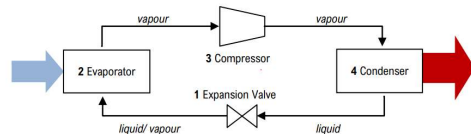
* Theoretical maximum that can be achieved without any losses in the compressor.



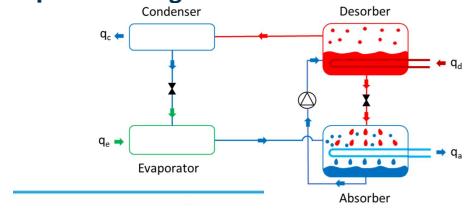
- Cooling supply technologies include active systems like vapor compression units, central air conditioning, and room air conditioning.
- Free cooling sources**, such as ambient air, ground, or water bodies, offer sustainable options but require energy input to transport heat.
- Advanced cooling technologies are essential for achieving higher efficiency and reducing emissions in line with EU climate goals.
- Selection of supply technologies should balance efficiency, cost, and sustainability to address both current and future cooling demands.

Decentral Supply Technologies

Vapour Compression



Absorption Cooling



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Source: Venegas, 2020

- Decentralized cooling technologies, such as vapor compression and absorption systems, offer flexible and localized solutions for cooling needs.
- These technologies are particularly suitable for areas without centralized infrastructure or where retrofitting existing buildings is required.
- While decentralized systems provide adaptability, centralized systems often achieve **higher efficiencies through economies of scale**, making them more energy and cost-effective in dense urban areas.
- Decentralized technologies remain a critical component of a diversified and sustainable cooling strategy.

Commonly Used Cooling Technologies

System Types	Costs (€/Units)	(Typical) SEER
Movables	409	2.49
Small Split (<5 kW)	1,051	4.4
Big Split (>5 kW, inclusive ducted)	1,692	4.17
Variable refrigerant flow systems	19,720	3.96
Rooftop + Packaged	18,135	3.88
Chillers (air-to-water) < 400 kW	20,768	3.51
Chillers (air-to-water) > 400 kW	111,370	3.52
Chillers (water-to-water) < 400 kW	1,676	4.8
Chillers (water-to-water) > 400 kW	88,033	5.8

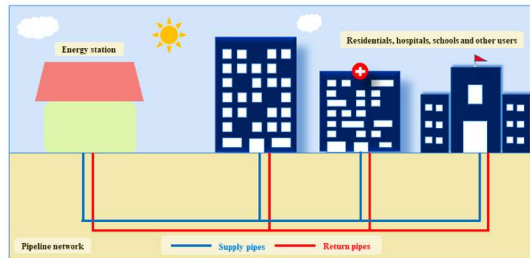
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Source: EURAC, 2021

- Centralized cooling technologies, such as district cooling, achieve **higher efficiencies through economies of scale** and are ideal for dense urban areas.
- Key components include distribution networks, service pipes, and energy transfer systems, ensuring reliable and efficient cooling delivery.
- Seasonal Energy Efficiency Ratios (**SEER**) represent average efficiency values but depend heavily on usage patterns and operational conditions.
- Centralized systems offer environmental and economic advantages, supporting sustainable urban cooling strategies.

Central Supply Technologies



District Cooling

Components of District Cooling Systems:

- Distribution System
 - Transmission Grid
 - Distribution Grid
 - Service Pipes
- Cooling Source
- Energy Transfer System

Important Operating Parameters

- Delta T
- Pipe and pump sizing
- Heat exchangers with longer thermal lengths are used



Source: Xu, 2021

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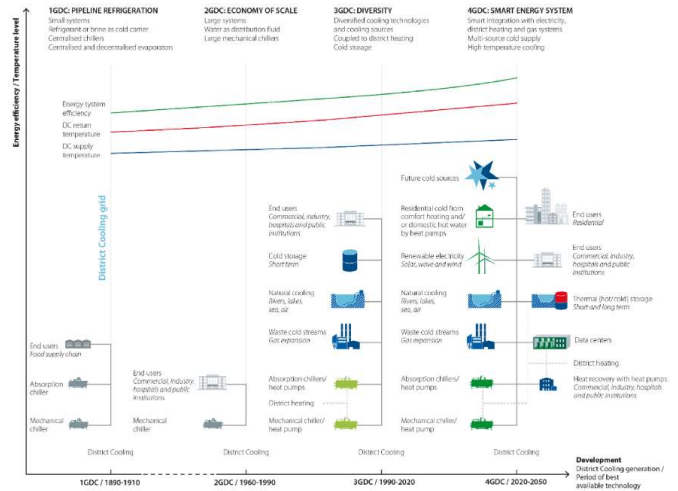
- District cooling has evolved since its inception in the late 19th century, with the first systems developed in the USA and Europe.
- Modern systems are highly efficient, leveraging centralized cooling sources and advanced distribution networks.
- The technology has expanded globally, with over 150 systems in Europe as of 2017, delivering approximately 10 PJ of energy annually.
- Continued development is driven by urbanization, rising cooling demands, and the need for sustainable, large-scale cooling solutions.

Development of District Cooling

History ...

- 1890s.. USA systems with central condenser and distributed evaporator
- 1962.. First DC in the USA
- 1967.. Hamburg
- 1967.. Paris
- ...

150 European Systems delivering 10 PJ energy (2017)



Source: Werner, 2017, Ostergaard, 2022

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- Low-temperature district cooling networks utilize ambient or waste cooling sources to improve energy efficiency and sustainability.
- These systems reduce energy losses during distribution and enable the integration of renewable and free cooling sources, such as groundwater or ambient air.
- Low-temperature networks are a key innovation for modernizing district cooling systems and aligning with decarbonization goals.
- Their implementation supports reduced operational costs and emissions, making them ideal for future-proof urban cooling strategies.

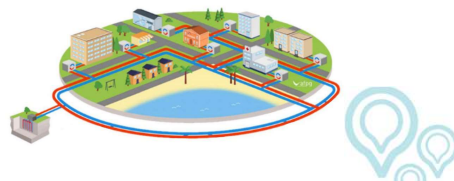
Low-Temperature Networks

B 02	Groundwater + decentral LTHP - LT Network					
	T Source [°C]	T Grid [°C]	aquifer / ground	storage	heating / cooling	type
	10	10-25	Aquifer	no	Heating Cooling	Basic
Technology	<ul style="list-style-type: none"> Groundwater wells Grid to transport water LTHP to lift temperature at end users (decentralized) SG DHC 					

Examples	Friedberg, Germany [8]: Shallow aquifer well doublets, SGDH; only Heating
<p>Figure 5: Scheme of the low temperature network operating with groundwater in Friedberg.</p>	

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B 07	BHE + decentralized LTHP - LT Network					
	T Source [°C]	T Grid [°C]	aquifer / ground	storage	heating / cooling	type
	-4 – 25	10	Ground	yes	Heating Cooling	Basic
Technology	<ul style="list-style-type: none"> Borehole heat exchangers (type: 1-U, 2-U, coaxial; depth: 50-200 m; spacing: 6-8 m) One or several heat pumps for each user SGDHC distribution grid 					



Source: SAPHEA, 2023

- Low-temperature networks enhance energy efficiency by reducing distribution losses and utilizing renewable or free cooling sources like groundwater or ambient air.
- These systems support the integration of decentralized and centralized cooling technologies, enabling greater flexibility and sustainability.
- They align with decarbonization objectives, offering reduced emissions and operational costs compared to traditional high-temperature networks.
- Low-temperature networks are pivotal for modernizing district cooling systems and future-proofing urban cooling solutions.

Identifying District Cooling Feasibility

In a city/region,

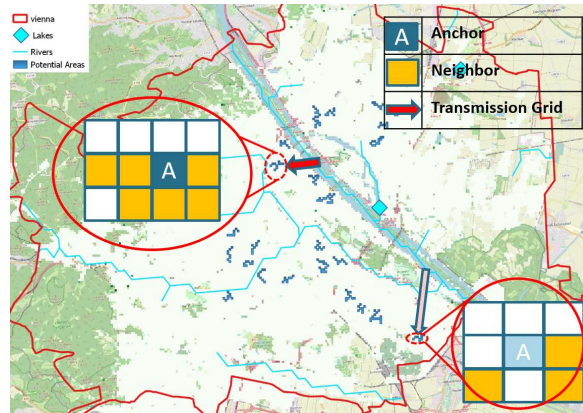
- Which locations show feasibility for investment in DC networks?
- How much demand for cooling can be covered?
- What are the tentative investments?

$$\frac{1}{n} \sum_{n=1}^n L_{G_{an}} \leq LCOC_{ind_{an}}$$

$$LCOC_{DC_e} = L_{G_e} + \frac{crf \cdot (I_{pump} + I_{trans} + I_{supply}) + O_f + ElecP \cdot (O_{v_{pump}} + O_{e_{supply}})}{\sum UED_{act_i}}$$

$$LCOC_{DC_e} \leq LCOC_{ind}$$

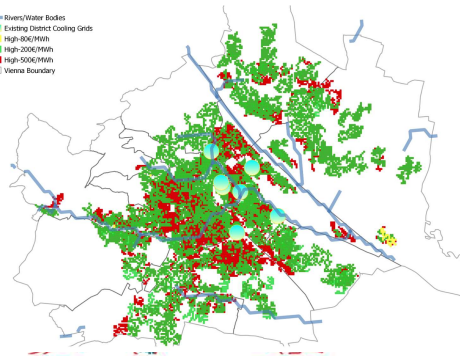
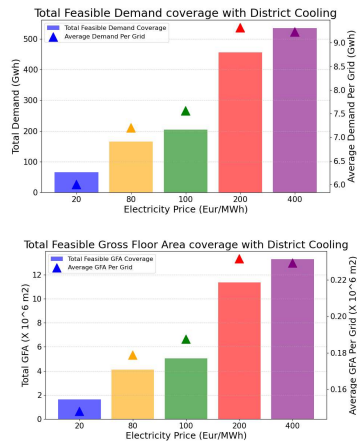
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Source: Malla, 2023

- Feasibility assessments for district cooling focus on identifying locations with sufficient demand density to justify investment in infrastructure.
- Key considerations include the percentage of cooling demand that can be met, initial investment requirements, and operational efficiencies.
- These evaluations guide policymakers, urban planners, and investors in determining where district cooling networks are most viable and impactful.
- Accurate feasibility studies are critical for optimizing resource allocation and maximizing the sustainability benefits of district cooling systems.

District Cooling Potentials in Vienna



- District cooling as a means of sustainable urban cooling solution
- Higher feasibility with increasing electricity prices
- A favorable policy framework and supporting financial incentives needed

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Source: Malla, 2023

- District cooling offers a sustainable solution for Vienna, improving energy efficiency and reducing emissions.
- High upfront costs necessitate **supporting incentives** and policy frameworks to ensure financial viability and encourage adoption.
- Rising electricity prices enhance the economic appeal of district cooling systems, making them a competitive option.
- Scaling district cooling aligns with Vienna's climate and sustainability goals, contributing to long-term urban development plans.

Conclusions

- Increasing demand for space cooling underscores the urgency for sustainable management.
- EU policies, including the Green Deal and Fit for 55, are pivotal in driving the adoption of sustainable cooling solutions.
- Advancements in cooling technologies, both active and passive, are essential for reducing energy consumption.
- User behavior significantly influences cooling demand; targeted education and awareness can promote energy-efficient practices.
- Integrating renewable energy into cooling systems is crucial for achieving EU renewable energy targets.
- A holistic approach combining technical, economic, and policy strategies is necessary to address space cooling challenges.
- Proactive planning and adaptive strategies are required to ensure the cooling sector's resilience and sustainability in the face of climate change.



- Rising cooling demand necessitates urgent action for sustainable management through energy-efficient and renewable solutions. EU policies like the Green Deal and Fit for 55 are key drivers in adopting sustainable cooling technologies and achieving decarbonization targets.
- Advancements in both active and passive cooling measures are critical to reducing energy consumption and emissions.
- User behavior significantly influences cooling demand, highlighting the need for education and awareness to promote energy-efficient practices.
- A holistic, integrated approach combining technical, economic, and policy strategies is essential to address the challenges of space cooling.

Contents

- Part 1: Existing and projected demands and EU policy landscape
 - Space cooling demands in Europe, reasons for increasing space cooling demands
 - EU regulations related to space cooling, requirements within the Comprehensive Assessment in the EED Art. 25
- Part 2: Opportunities for reduction and sustainable supply
 - Reduction potential from passive measures
 - Identifying Sustainable Supply technologies - Central and Decentral
 - Impact of occupant behavior on cooling demand





Thank you.



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Webinar 9: Existing heat planning policies in Europe

Act!onHeat SF1

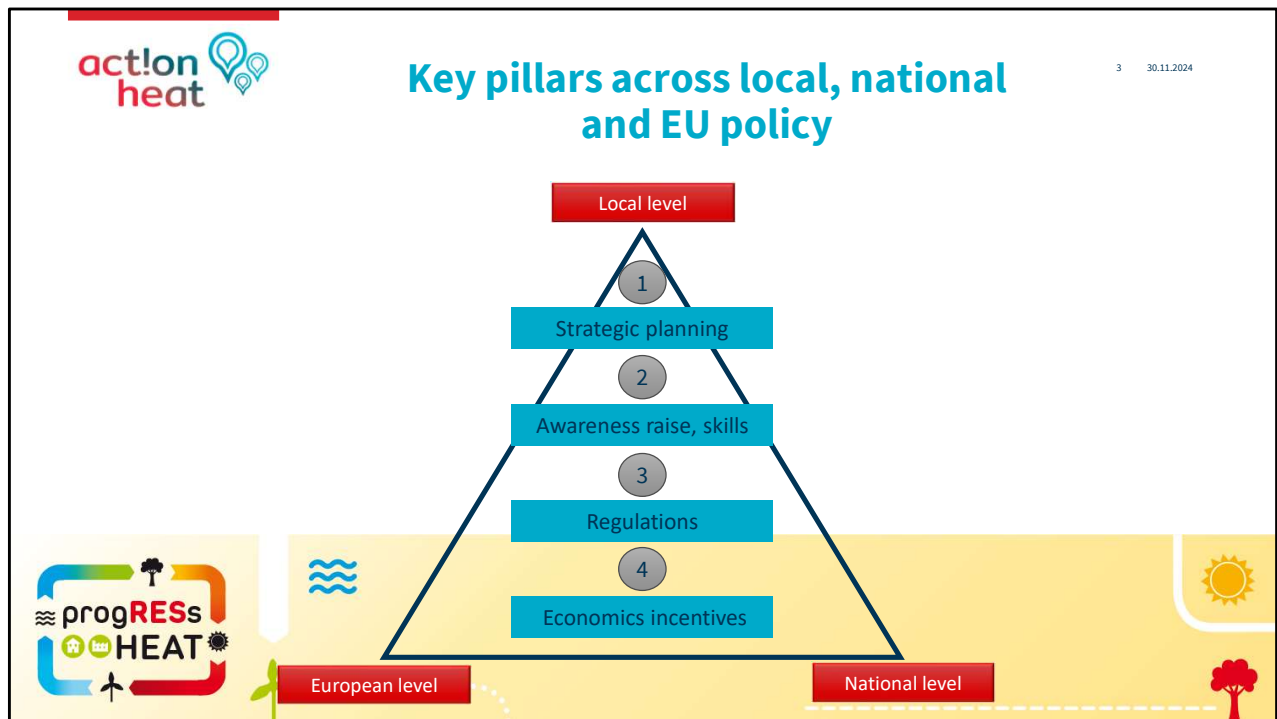
- Serial 3:
 - Webinar 9
 - Strategical Heating & Cooling planning
 - Group support for municipalities and stakeholders
- Presented by:
 - e-think / Austria

The discussion explored current heat planning policies in Europe, with a focus on zoning policies and best practices across various countries. It examined how these practices align with the Energy Efficiency Directive (EED) to support sustainable heating and cooling systems. The webinar was led by Marcus Hummel.

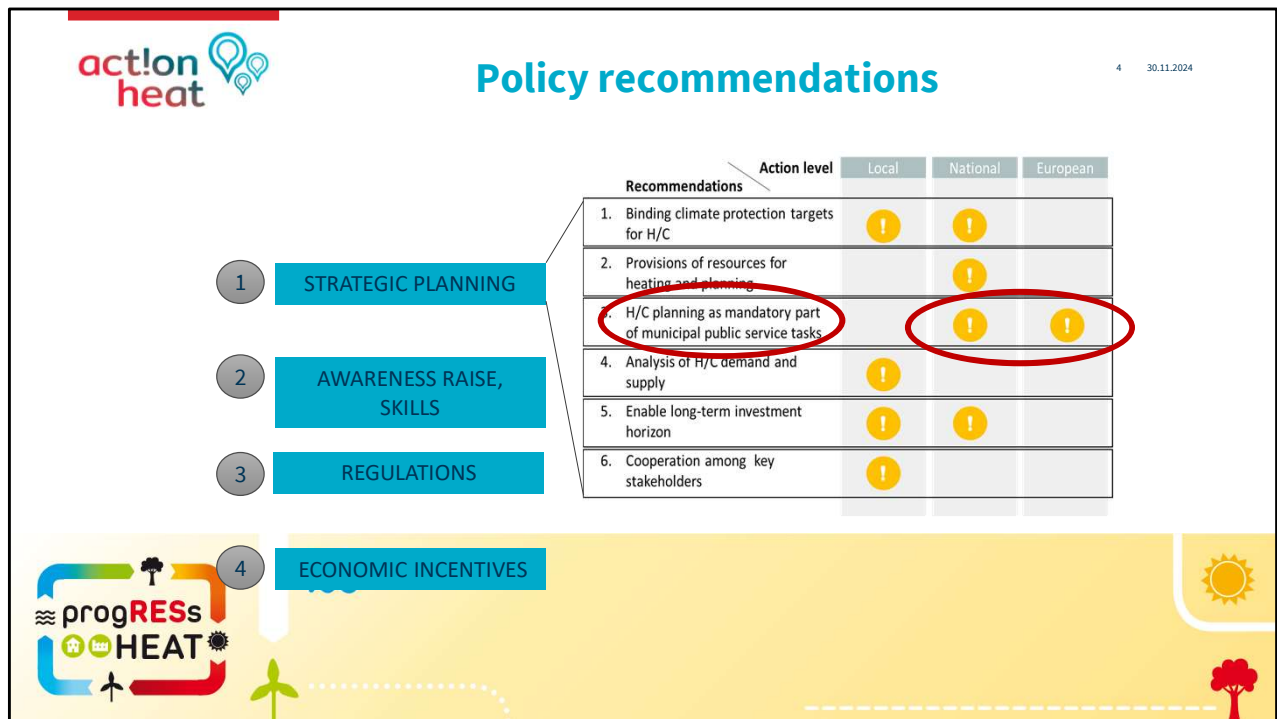
Content

- 1. Recommended policies for H&C planning**
- 2. Overview of current situation in Europe**
- 3. Mandatory heat planning in the EED2023**
- 4. Special focus on zoning for district heating**
- 5. Discussion**





- Emphasis on strategic planning, regulations, awareness-raising, and economic incentives to drive effective heat planning.
- Collaboration is essential across local, national, and EU levels to align policies and maximize impact.
- Zoning policies, combined with mandatory connection requirements, can significantly improve district heating networks.

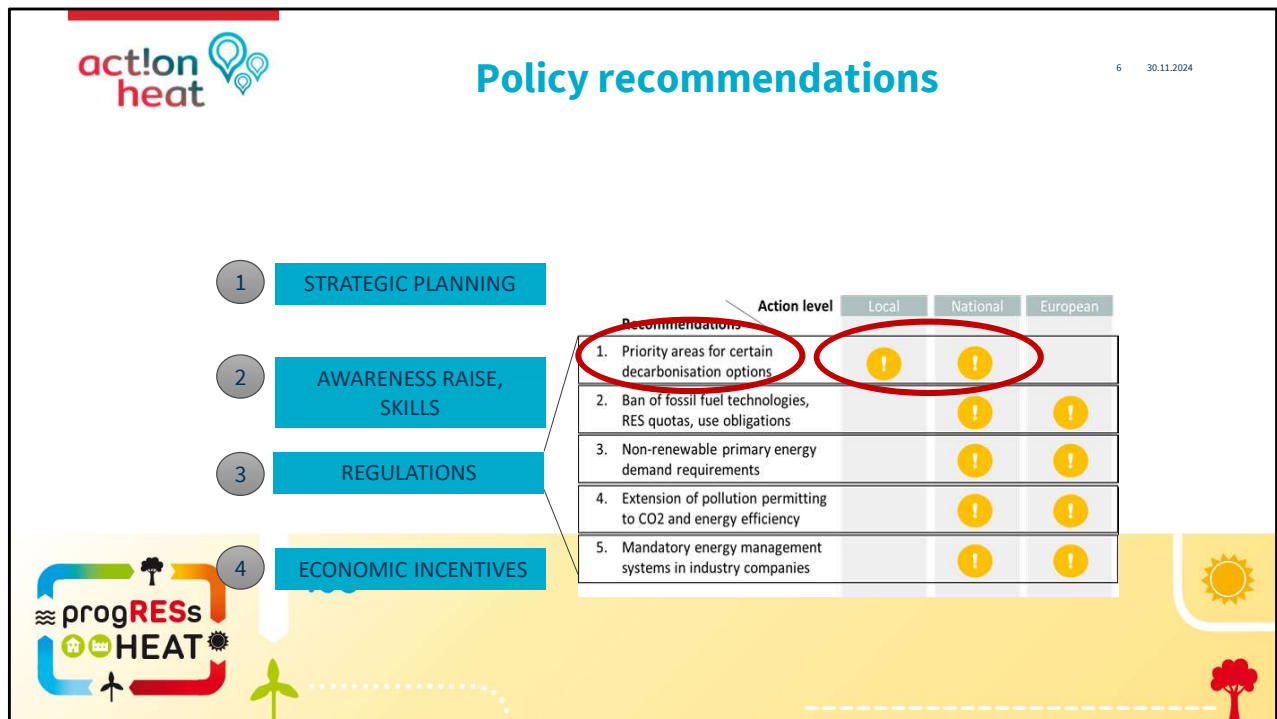


- Heating and cooling (H&C) planning should be a mandatory responsibility for municipalities.
- Establishes a structured approach to meet local energy needs efficiently and sustainably.
- Ensures alignment with national and EU-level policies for cohesive action.
- Helps municipalities prioritize energy efficiency and integrate renewable sources in H&C supply.

		Recommendations	Action level		
			Local	National	European
1	STRATEGIC PLANNING	1. Communication of low-carbon transformation plan	!		
2	AWARENESS RAISE, SKILLS	2. Consumer empowerment and transparency of cost and benefits	!	!	
		3. Intensify policies for crucial change agents	!	!	!
3	REGULATIONS	4. Capacity building in municipalities	!	!	!



- Raising awareness is crucial to gain public support for sustainable heating and cooling (H&C) initiatives.
- Skill development programs are needed for local authorities to implement effective H&C planning.
- Educating stakeholders helps promote energy-efficient technologies and practices.
- Strong awareness and skills create a foundation for successful and long-lasting H&C solutions.



- Regulations are essential to align heating and cooling (H&C) planning with environmental and energy objectives.
- National-level designation of priority areas for district heating should be implemented locally.
- A strong regulatory framework ensures consistent standards and compliance across all regions.
- Clear regulations support the long-term sustainability and effectiveness of H&C systems.

1 STRATEGIC PLANNING

2 AWARENESS RAISE,
SKILLS

3 REGULATIONS

4 ECONOMIC INCENTIVES

Recommendations	Action level		
	Local	National	European
1. Implementation of efficient price-based economic regulations		!	!
2. Focus financial support on technologies in line with targets	!	!	
3. Coherent and innovative financial support instruments		!	



- Economic incentives are crucial to encourage investments in sustainable heating and cooling (H&C) systems.
- Financial support can make it easier for municipalities and consumers to transition to district heating and cooling.
- Incentives help accelerate the adoption of energy-efficient and renewable technologies.
- Well-designed incentives drive progress towards decarbonized and resilient H&C systems.

Selected overall conclusions to make DH renewable and efficient

- **Policy packages needed** taking into account all 4 pillars of action and 3 levels of regional scope
- **Long-term targets** and long-term **analysis / planning** is crucial at national and local level taking into account all possible options (efficiency, RES-H/C, RES-E for heating)
- **DH is the only way to decarbonise densely populated areas** with limited efficiency potentials & **DH facilitates the integration of RES**, excess heat and power-to-heat in the system
- **Zoning** (definition of DH priority areas) **is a promising approach to reach low costs of DH** even with decreasing heat demand (through high connection rates)
- Clear indication that **DH as public service cheaper than profit-oriented DH**
- **Integration / information of consumers / end-users is very important** for successful conversion to efficient and renewable DH



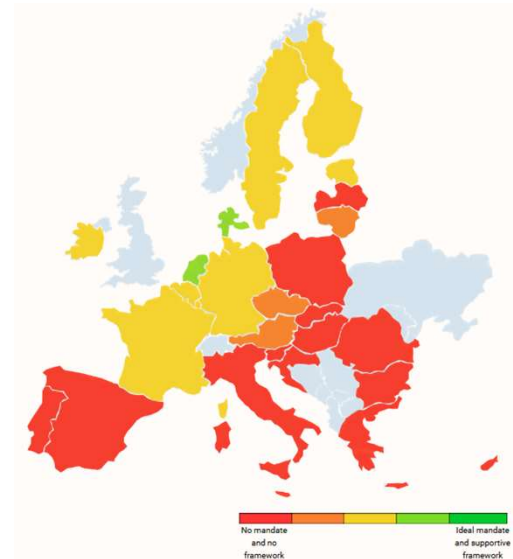
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Overall assessment

- The **political ground** for effective local heating and cooling planning is **highly uneven** across Europe
- **Support frameworks** are **very important** for an **effective** heating and cooling **planning**
- **Cooling** planning is mostly **no topic still**
- Several energy **planning documents** (e.g. SECAPs) **lack detail** as well as strategic and **spatial** dimensions



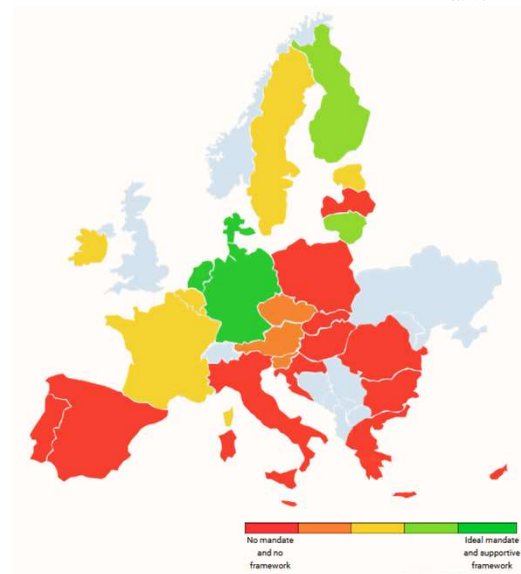
Source: EU Tracker – Local heating and cooling plans, Energy Cities - update 2024

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- H&C planning across Europe shows significant disparity; some countries lack clear policies and support frameworks.
- Technical and financial assistance are essential, as legislation alone is insufficient for effective implementation.
- Cooling planning remains a gap in many countries, with limited integration into broader H&C strategies.
- Spatial dimensions, such as zoning for district heating, are critical but often missing, reducing plan effectiveness.

Legal framework assessment

- **In some countries long tradition**, historically with focus on security of supply
- **New obligations in some countries** in recent years (e.g. NL, DE)
- **In some countries strong incentives** implemented (e.g. Flanders, Luxembourg, FR, IE)
- Legal framework for local heating and cooling planning **fully absent in nearly half of EU countries**

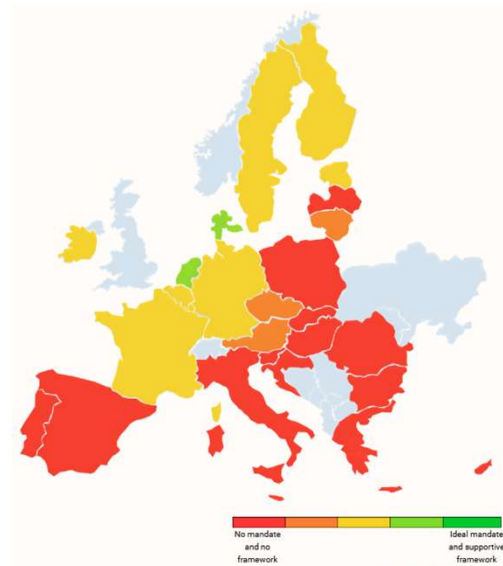


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- Some countries have a long tradition of H&C planning, often driven by energy security rather than climate protection.
- Recent years have seen new obligations introduced in countries like the Netherlands and Germany.
- Strong incentives exist in regions like Flanders, Luxembourg, and France, but nearly half of EU countries lack a legal framework.
- Comprehensive legal frameworks are essential to establish consistent and effective H&C planning.

Support framework assessment

- Technical and organisational **support frameworks** exist **in countries with obligations**
- **Financial support usually for projects**, not for the planning activities
- **Lack of staff and skills in municipalities** is barrier in all countries
- Remarkable **limitations in availability of** energy-related and **geodata** for planning purposes



Source: EU Tracker – Local heating and cooling plans, Energy Cities - pdf02024

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- Countries with H&C planning obligations often provide technical and organizational support frameworks.
- Financial support is typically project-focused, with limited funding for planning activities.
- A lack of staff and expertise in municipalities remains a significant barrier across Europe.
- Access to reliable energy-related and geospatial data is crucial for effective planning but is often insufficient.

Content

1. Recommended policies for H&C planning
2. Overview of current situation in Europe
3. Mandatory heat planning in the EED2023
4. Special focus on zoning for district heating
5. Discussion



Requirement for H&C planning

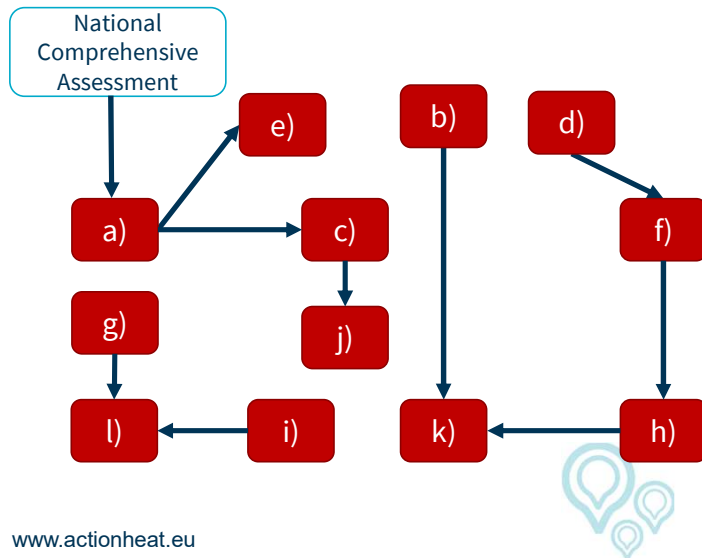
- Article 25 (6)
 - Member States shall ensure that regional and local authorities prepare local heating and cooling plans at least in municipalities having a total population higher than 45 000
- Transposition of the article into national law until September 2025
- Various requirements for the content of the local heating and cooling plans are defined



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- Article 25(6) of the EED mandates local H&C plans for municipalities with populations over 45,000.
- These plans must estimate and map potential for energy efficiency, waste heat recovery, and renewable energy integration.
- Transposition into national law is required by September 2025 to align with EU regulations.
- Clear guidelines are needed to ensure consistency and compliance across regions.

Description	
a)	provide estimate and mapping of the potential
b)	be compliant with Energy Efficiency first principle
c)	strategy for the use of the identified potentials
d)	involve all relevant stakeholders and the general public
e)	take into account relevant existing infrastructure
f)	consider the common needs of local communities and multiple local or regional administrative units or regions
g)	assess the role of energy communities and other consumer-led initiatives
h)	include analysis of H&C in local building stock
i)	assess financing
j).1	include a trajectory to achieve the goals
j).2	include the monitoring of the progress
k)	replace inefficient H&C appliances in public buildings
l)	assess potential synergies with the plans of neighboring authorities



- Plans must address energy efficiency improvements, renewable energy integration, and district heating readiness.
- Regular comprehensive assessments should be conducted to ensure compliance with EED Article 25.
- Plans should include top-down calculations and identify energy efficiency as a top priority.
- Cooling requirements, often overlooked, must be explicitly included in H&C plans.

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j).2	include the monitoring of the progress
k)	replace inefficient H&C appliances in public buildings
l)	assess potential synergies with the plans of neighboring authorities

Exact formulation:

be based on the information and data provided in the comprehensive assessments carried out pursuant to paragraph 1

and provide an **estimate and mapping of the potential for increasing energy efficiency**, including via

– **low-temperature district heating readiness**,

– high efficiency cogeneration,

– **waste heat** recovery, and

– **renewable energy**

in heating and cooling in that particular area;



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- Prioritize energy efficiency in H&C planning before exploring new energy supply options.
- Implement cost-effective measures to reduce energy demand and improve system efficiency.
- Use cost-benefit analyses to evaluate societal, economic, and environmental benefits of efficiency measures.
- Ensure energy efficiency is central to achieving climate neutrality and reducing energy poverty.

Description	
a)	provide estimate and mapping of the potential
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- “energy efficiency first” means **taking utmost account in energy planning, and in policy and investment decisions, of alternative cost-efficient energy efficiency measures** to make energy demand and energy supply more efficient, in particular by means of cost-effective end-use energy savings, demand response initiatives and more efficient conversion, transmission and distribution of energy, **whilst still achieving the objectives of those decisions**” (Governance regulation 2018, Art. 2 (18))

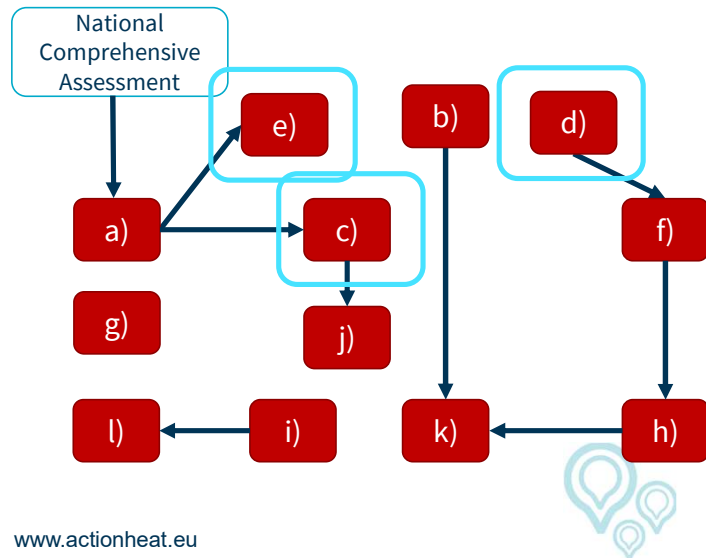
- Keywords on EE1st in the **EED 2023**, (16-21) as well **Art. 3 (5)**
 - **Cost benefit analysis**
 - Consider / assess **wider benefits of energy efficiency** solutions /measures
 - Life-cycle, Long-term perspective
 - System and cost efficiency
 - **Security of supply**
 - **Quantification** from **societal, health, economic and climate neutrality**
 - Sustainability
 - Circular economy
 - **Transition to climate neutrality**
 - **Energy poverty**

- **Integrated district heating / cooling planning:** use a cost-benefit-analysis to find most cost-effective heat supply options evaluated against reducing heat demand through energy efficiency in buildings and processes (DG ENER 2021, p. 13)



- Effective H&C plans require active involvement of all stakeholders, including local energy communities.
- Strategies should move beyond city-led initiatives, incorporating consumer-driven contributions.
- Engage stakeholders early to align expectations and ensure practical implementation of plans.
- Combine technical assessments with participatory planning to enhance acceptance and success.

Description	
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- Identifying energy potential must be complemented by strategic planning to ensure effective implementation.
- Infrastructure development should align with actionable strategies, prioritizing efficiency and sustainability.
- Stakeholder engagement is critical to designing infrastructure that meets community and policy needs.
- Incorporating diverse inputs ensures robust infrastructure planning for heating and cooling systems.

Description	
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k)	replace inefficient H&C appliances in public buildings
l)	assess potential synergies with the plans of neighboring authorities

Exact formulation:

consider the **common needs of local communities** and **multiple** local or regional **administrative units** or regions

assess the **role of energy communities** and other **consumer-led initiatives** that can **actively contribute to** the implementation of local heating and cooling **projects**



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- Local energy communities are often overlooked in H&C planning but have great potential to contribute
- Empower consumer-led initiatives to support the transition to sustainable heating and cooling systems.
- Encourage collaboration between local authorities and energy communities to create robust plans.
- Integrate community-driven solutions to enhance inclusivity and effectiveness in H&C planning.

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l)	assess potential synergies with the plans of neighboring authorities

Exact formulation:

include an **analysis of** heating and cooling **appliances** and systems in **local building stocks**, taking into account the **area-specific potentials for energy efficiency measures** and addressing the **worst performing buildings** and the needs of **vulnerable households**;



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- Reliable data, particularly geospatial and energy-related, is crucial for effective H&C planning.
- Addressing data gaps helps align planning efforts with energy efficiency and sustainability goals.
- Accurate data enables targeted interventions for vulnerable households and worst-performing buildings.
- Enhanced data collection supports better decision-making and energy poverty alleviation.

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Exact formulation:

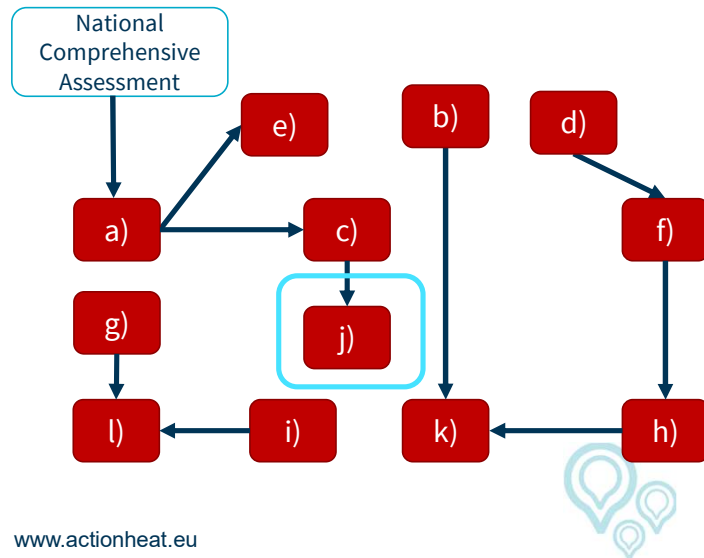
assess how to **finance** the **implementation of policies and measures** and **identify financial mechanisms** allowing **consumers** to shift to renewable heating and cooling;



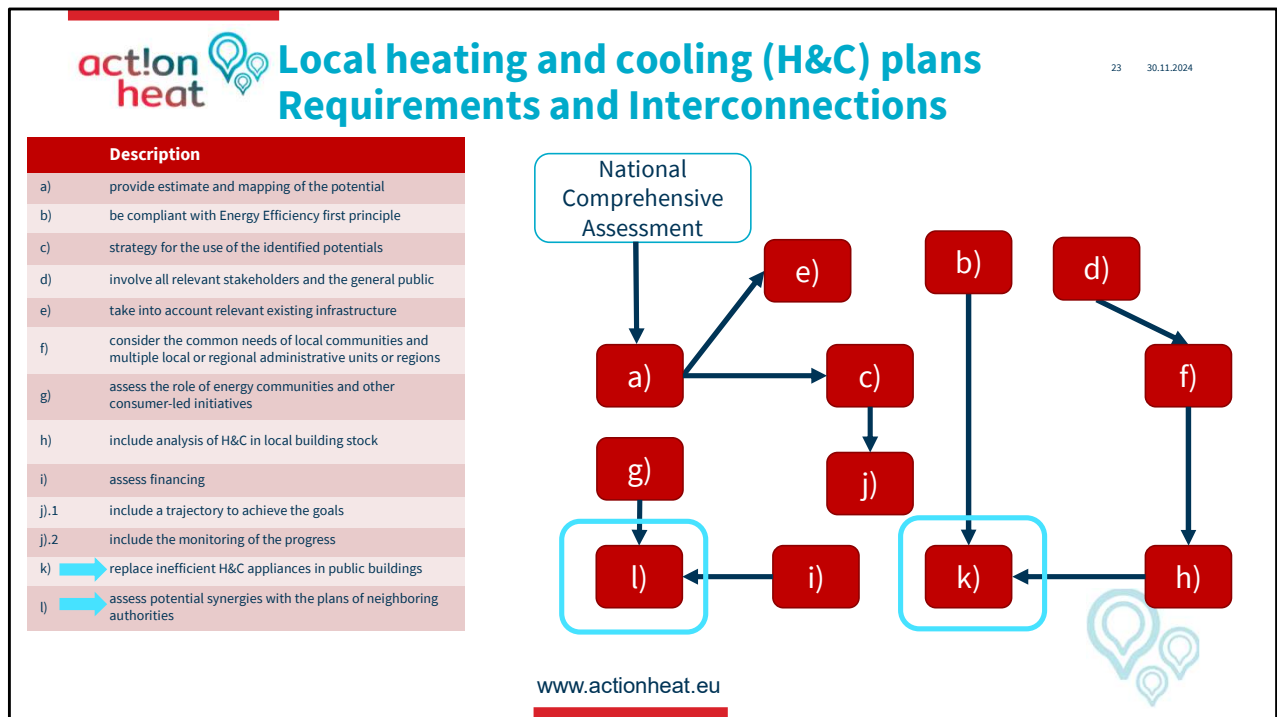
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- Identify funding mechanisms to support the shift to renewable heating and cooling systems.
- Develop strategies to make financing accessible for consumers and municipalities.
- Prioritize financial support for vulnerable households to ensure an equitable transition.
- Link financing solutions to long-term H&C plans to sustain momentum in decarbonization efforts.

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- Develop clear roadmaps with milestones to track progress towards decarbonization goals.
- Transition from target setting to actionable trajectories with defined steps and timelines.
- Monitoring and evaluation mechanisms are crucial to ensure compliance and adapt plans as needed.
- Incorporate feedback loops to improve planning based on real-world outcomes.



- Public buildings offer an accessible starting point for municipalities to implement H&C plans.
- Targeting public buildings can demonstrate the feasibility of energy efficiency measures.
- These projects set an example for broader community adoption of sustainable practices.
- Prioritize retrofitting and renewable energy integration in public infrastructure to drive decarbonization.

Directive Breakdown		Key Words Collection for checking the relevant passages in the H/C plan documents	Checklist for compliance
Potential for increasing energy efficiency	estimate	Renovation, efficiency, renovation scenario, demand forecast, maps, building archetype, building renovation status, maps	# Building renovation scenarios are presented # A description of the method and the assumptions of the renovation scenarios is provided # Heat zoning (current state of demand) based on building renovation/demand/building type is presented # A map with savings over the territory is provided
	mapping		
Potential for low-temperature district heating readiness (readiness of buildings)	estimate	Low temperature district heating (LTDH) (readiness), renovation level, low temperature supply systems, radiators	# The temperature level of the existing heat supply systems in the buildings are mentioned / analysed # Buildings potentially supplied by LTDH are identified # Zones potentially suitable for low-temperature district heating are identified
	mapping		
Potential for high efficiency cogeneration	estimate	High efficiency cogeneration, CHP, highly efficient	# High-efficiency cogeneration is mentioned in the plan # Existing (cogeneration) plants are presented on a map # Relevant parameters for cogeneration plants to be highly efficient is presented # Presented potentials of cogeneration plants distinguish between highly efficient and not highly efficient
	mapping		
Potential for waste heat recovery	estimate	Waste water treatment, waste heat, industrial waste heat, data centers	# Locations of waste heat sources are identified # Estimates of the temperature level and the available waste heat are presented
	mapping		
Potential for Renewable Energy	estimate	Shallow geothermal, deep geothermal, Solar PV, Solar thermal, Biomass	# The available potential of renewable energy for heat and cold supply is presented (in terms of energy and/or power) # The potential is shown on a map (maybe not covering all potentials)
	mapping		
Potential for cooling	estimate	cooling demand, commercial buildings	# An estimation of the energy demand for cooling of buildings is presented # A map showing the (theoretical) energy demand for cooling in the territory is presented # The increasing cooling demand due to climate change is addressed
	mapping		



- A checklist was developed to ensure compliance with regulatory requirements.
- Include mapping and estimation of energy efficiency potential and renewable integration.
- Address energy poverty and prioritize measures for vulnerable households.
- Standardized checklists simplify evaluations and improve plan consistency across regions.

Conclusions on Art. 25 (6) implementation

- Requirements and compliance:
 - **All aspects** integrated in the requirements in Art. 25 (6) **make sense in integrated / strategic heat planning**;
 - A **strict interpretation** of each requirement **might lead to many plans not compliant**;
 - In a first round of developed plans compliance could potentially be met when majority of requirements are integrated at least somehow; in the next round of plans with higher level of detail
 - **Guidance** of how compliance can be achieved and is interpreted **is needed**
- It makes sense to **provide assistance from the regional (/national) level**:
 - Provision of **guidelines** for the implementation / interpretation of the requirements
 - **Draft text to be included** in the heat plans
 - **Framework agreements** for heat planning
 - Involvement of the regional energy agency



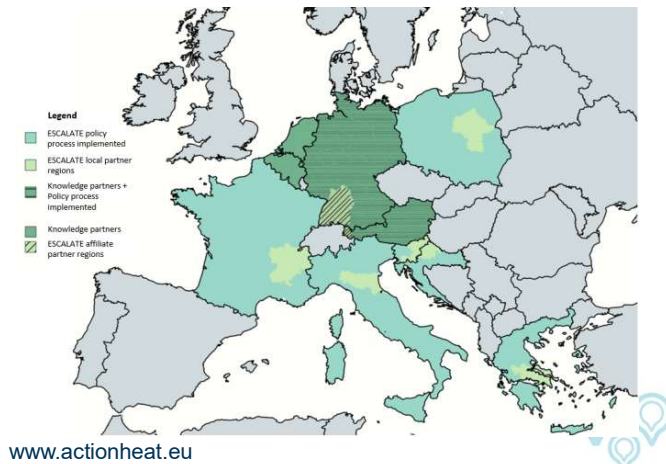
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- Strong guidance is essential to ensure municipalities meet regulatory requirements.
- Provide frameworks at national and regional levels to support effective H&C planning.
- Include clear guidelines on interpreting and implementing compliance criteria.
- Assistance from energy agencies can help municipalities align plans with policy goals

New LIFE project ESCALATE

ESCALATE local heating and cooling transition plans: Regional multipliers of capacity building and technical support to empower local administrations

- LIFE project, just entered the GA preparation phase
- Directly focusing on LRAs and the implementation of Art. 25(6)
- Involved:
 - 8 local energy agencies
 - 5 knowledge partners
 - 1 communication partner
 - 10 countries



- Update heating and cooling (H&C) plans to reflect the latest regulations and priorities.
- Ensure plans are comprehensive, addressing energy efficiency, renewable integration, and zoning.
- Emphasize the role of municipalities in implementing detailed, actionable strategies.
- Align planning processes with evolving technological and policy landscapes.

Content

1. Recommended policies for H&C planning
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Structure of the chapter

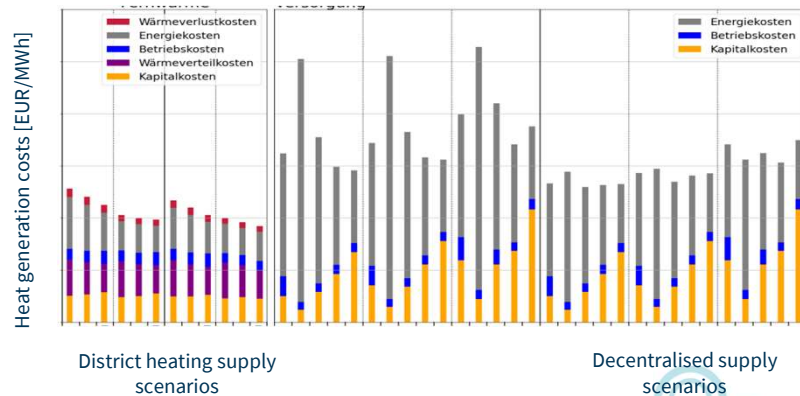
- Why are DH zones / priority areas meaningful?
- Difference between zoning and priority areas / mandatory connection
- Overview of DH zoning and mandatory DH connection in the EU
- Aspects of regulating mandatory DH connection



- Need to understand the difference between zoning and priority zones

Why district heating?

- District heating can be the most cost-effective supply option under certain circumstances
- Primarily dependent on distribution costs and availability of locally available energy resources

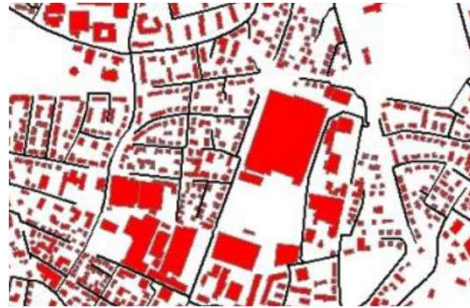


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- District heating (DH) is often the most cost-effective option in densely populated areas.
- Reduces distribution costs and integrates renewable energy sources effectively.
- Enables CO₂-neutral heat supply where alternative options are limited.
- Provides a scalable solution for decarbonizing heating in urban regions.

Heat distribution costs

- Costs for heat distribution:
 - Capital costs for pipeline construction
 - Transmission lines (for large networks), distribution lines, and house connection lines
 - Costs depend on dimension, type of pipe and effort of laying
 - Operating costs (pumping power, maintenance of the network)
- Reference value - delivered amount of heat:
 - Total amount of heat delivered to customers at the transfer station



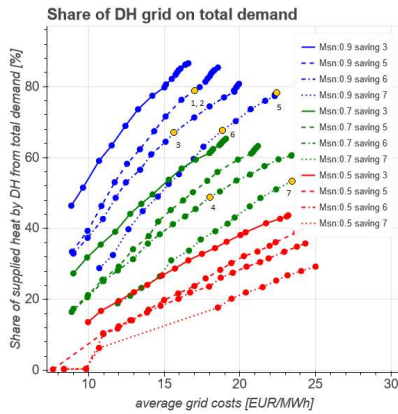
→ The costs per heat supply decrease the more heat consumers per meter of trench length are (can be) connected



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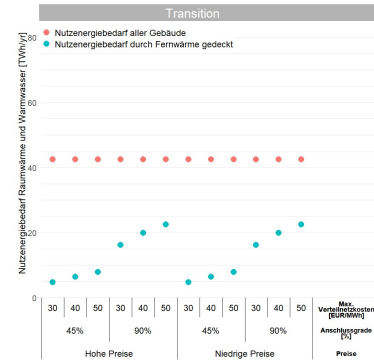
- Heat supply costs decrease with higher connection rates and shorter trench lengths.
- Increasing connections improves economic viability and reduces per-unit costs.
- Renovations that lower heat demand impact the profitability of DH systems.
- Achieving high connection rates is key to making DH systems cost-effective.

Heat distribution costs – sensitivity



Source: Hotmaps, Wärme- und Kälteplan der Stadt Frankfurt a.M. (2020)

- Clear influence of the connection rate / market shares on servable areas / economic potential
- Renovations and the resulting reduced heat demand also affect profitability



Source: Potenzial für eine effiziente Wärme- und Kälteversorgung, Studie im Auftrag des BMK (2021)

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- Higher connection rates significantly lower heat supply costs for consumers.
- Increased connections enable the use of advanced and cost-efficient technologies.
- High-density connections improve network efficiency and reduce operational costs.
- Connection rates directly influence the economic potential of district heating systems.

Why zoning? Why priority areas?

- Reduction of heat supply costs for heat consumers
 - see previous explanation
- Air quality control
 - To prevent emissions that reduce the quality of life in the inhabited / used area
- Enabling a CO₂-neutral heat supply
 - Possibly no potential / no possibility of CO₂-neutral supply, except district heating
 - For example, heat pumps cannot be implemented (space, noise)
 - For example, no prospect of CO₂-neutral gas (at acceptable prices)
- Enabling the economically viable use of CO₂-neutral potentials
 - For example, deep geothermal energy



- Zoning identifies areas where district heating (DH) is most feasible and cost-efficient.
- Priority areas ensure high connection rates, making expensive technologies more viable.
- Proper zoning reduces costs for consumers while enabling CO₂-neutral heat supply.
- Supports efficient infrastructure planning by focusing on economically viable regions.

Difference between zoning and priority areas / mandatory connection

- **DH zoning:**

- identify areas / zones, where the most meaningful heat supply is via district heating

- **DH priority / mandatory DH connection:**

- a building is forced by law to connect to the existing DH system in certain situations



- Zoning defines areas where district heating (DH) is the most efficient heat supply option.
- Mandatory connections legally require buildings to join DH networks in designated zones.
- Zoning supports strategic infrastructure planning, while mandatory connections ensure utilization.
- Both approaches aim to increase connection rates and reduce system costs.

Identification of areas where DH makes sense (zoning)

- Database
 - Heat demand measured vs. estimated
 - Costs incurred (e.g. installation costs, or installation of heat pumps, ...)
 - Methodology
 - What costs are being used?
 - What depreciation periods, interest rates, etc.?
 - What is the alternative being compared against?
- There are always uncertainties in the data and assumptions
- What is crucial is a method and calculation that is accepted by the actors involved
- A standardized method helps to increase acceptance and reduce transaction costs

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- Reliable data, including heat demand and installation costs, is critical for zoning assessments.
- Methodologies should consider depreciation periods, interest rates, and alternative options.
- Standardized methods increase transparency and acceptance among stakeholders.
- Address uncertainties with robust assumptions and clear communication.

Overview of DH zoning and mandatory DH connection in the EU

- DH zoning is done in several regions in EU within energy/heat plans with different focus (e.g. DK, NL, EE, LT, SE, DE)
- DH zoning is not always connected to a mandatory DH connection (e.g. currently in NL there is always an opt-out possible)
- Most widespread variant of mandatory DH connection is for new buildings (existent in 26% of all EU countries + Norway, Iceland, Ukraine, UK, at least in some regions)
- Many regions work with incentives to bring buildings to connect to DH in DH zones
- In several countries currently new zoning and mandatory connection approaches are under discussion / development (e.g. DE, AT, UK, NL)

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- District heating (DH) zoning is integrated into heat plans in several EU regions, such as Denmark and Germany.
- Mandatory connections are not always required but exist for new buildings in some countries.
- Incentives are widely used to encourage connections in designated DH zones.
- New zoning and mandatory connection policies are under discussion in many EU countries.

Aspects of regulating mandatory DH connection

- DH must increase the common good
- DH must be the cheapest solution
- DH supply must be guaranteed
- Who is obliged to connect to DH?
- How to define alternative solutions to DH?



- Mandatory connections ensure district heating (DH) supports public benefits, including climate protection and energy security.
- DH must provide the most cost-efficient and sustainable solution for society.
- Regulatory frameworks define when mandatory connections are required, balancing feasibility and public interest.
- Clear provisions ensure DH systems align with environmental and economic goals.

District heating must increase the common good

- Climate and resource protection (e.g., Germany, EEWärmeG, Switzerland, MuKE)
- Supply from waste heat and renewable resources / highly efficient district heating (e.g., Styria (Austria), StRoG)
- Public health, e.g. air pollution control (e.g., Upper Austria LuftREnTG)
- Most cost-efficient solution for the society (e.g. Danish Heating Supply Act)
- Energy supply security (e.g. LT National Energy independence strategy, Danish Heating Supply Act)



- Countries link mandatory district heating (DH) connections to broader societal benefits.
- These include environmental protection, public health improvements, and economic efficiency.
- DH enhances energy security by leveraging renewable energy and reducing dependency on imports.
- Policies must balance public interest with cost-effectiveness for mandatory connections.

District heating must be the cheapest solution

- A mandatory connection should generally not result in additional costs for consumers compared to an alternative solution.
- **Denmark / UK:** a standardized method derives regions, where DH is the cheapest heat supply option (Danish Heating Supply Act, UK Energy Act 2023)
- **France:** a DH connection obligation is only possible if a study demonstrates that DH is the most cost-effective supply option (Bacquet et al. 2022)
- **Switzerland:** depends on Canton; In Zürich an xls sheet is used to calculate levelized costs of heat for DH compared to an oil heating for single buildings (Planungs- und Baugesetz Zürich)
- **Estonia:** DH regions are determined via a feasibility analysis developed by the municipality (often outsourced) in collaboration with the local operator and participation of the public; DH price is regulated and needs to be approved by the Competition Authority (EE District Heating Act)

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- Countries differ in their approach to mandatory district heating (DH) connections.
- Some focus on environmental and health benefits, while others prioritize energy security and cost-efficiency.
- Regulatory frameworks must align with national priorities while ensuring fairness and sustainability.
- A tailored approach considers local contexts and common good principles.

District heating supply must be guaranteed

- It must be ensured that there is a provider offering services at appropriate prices
- **Denmark:** municipal DH provider with a non-profit obligation (Danish Heating Supply Act).
- **Styria, Austria:** mandatory connection only with a binding commitment from the DH provider, including information on reasonable and specific prices and conditions (StRoG 2010 & Stmk BauG).
- **Estonia:** DH regions are determined by the municipality in collaboration with the local operator (EE District Heating Act)



- Authorities and DH operators must ensure reliable and affordable heat supply in mandatory connection zones.
- Municipal DH providers, like those in Denmark, often operate under non-profit obligations.
- Transparent commitments from DH operators build trust and ensure compliance with regulations.
- Clear pricing and service conditions are essential for consumer confidence.

Who is obliged to connect?

- **In most cases only for new construction:** in 26% of all EU countries (+ Norway, Iceland, Ukraine, UK) there is a connection obligation in some form; predominantly only for new construction and in individual municipalities / states (Bacquet et al. 2022)
- **Zurich, Switzerland:** new construction as well as in case of replacement of the heating system; an approval of the building authority is needed for every replacement of heating systems (Planungs- und Baugesetz Zürich)
- **France:** in classified heating networks (DH priority areas) mandatory connection for new buildings or those undergoing major renovations if their heating/cooling capacity exceeds 30 kW
- **UK:** exemptions for areas, where connecting to a heat network is not cost-effective or where a better low-carbon solution exists; Buildings not already communally heated within designated zones will not be required to connect, although they may choose to do so
- **Vienna, Austria:** ban of gas heating and mandatory DH connection in case DH is near enough for new buildings; In designated DH areas / expansion areas grid will be built, connection is promoted; general agreement in city and utility to not use gas for heating in the future



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- Mandatory district heating (DH) connections primarily apply to new buildings in most EU countries.
- Some countries, like Switzerland, extend obligations to heating system replacements in existing buildings.
- Policies often require cost-effectiveness studies to justify mandatory connections.
- Clear exemptions are defined for areas where DH is not feasible or cost-effective.

Challenge: Approval and definition of alternatives

- In climate and resource protection, other alternatives than DH with CO₂-neutral provision always need to be allowed
- What is technically infeasible? What is economically unreasonable?
- Especially for existing buildings this is more challenging
- At the same time: it is crucial that with overly broad exceptions, district heating might no longer be the most economical option



- Mandatory DH connections must account for technical feasibility and economic viability.
- Alternatives to DH must be clearly defined, balancing climate and resource protection goals.
- Existing buildings pose challenges due to diverse heating systems and retrofit costs.
- Policies should avoid overly broad exceptions to maintain the economic viability of DH systems.

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Summary

- Many activities ongoing in different countries
- Some countries have strong policies in place
- Many countries still do not have relevant heat planning policies in place
- Open questions in all places
- No one solution fits all



Room for your questions



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Thank you very much for the interest!

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3 Summary and Conclusions

The webinars highlighted key challenges and opportunities in the decarbonization of heating and cooling (H&C) systems across Europe. One major issue was the accessibility of H&C data. While better data availability is needed, the influence of local political structures was recognized as essential for the success of decarbonization efforts. A supportive political environment can help address data gaps, with tools like the Hotmaps database playing a crucial role.

The importance of dynamic, geospatial data for heat planning was emphasized, though inconsistencies in data quality across regions complicate the process. Collaborative knowledge sharing and open-source tools, such as energy atlas projects, were seen as helpful, but localized adjustments are needed to ensure effectiveness.

The potential of industrial excess heat for district heating was also discussed. While industries often use excess heat internally for cost benefits, supplying heat externally is a valuable option, provided there are necessary infrastructure investments. Planning for backup suppliers and managing heat losses are essential for a consistent supply.

Excess heat from data centers, especially outside the Nordic countries, was another important topic. While Nordic nations reuse heat from large data centers, smaller centers in other parts of Europe are beginning to adopt similar strategies. However, the political and technical conditions for heat reuse vary by country, requiring tailored solutions.

The use of low-temperature wastewater for district heating, particularly in smaller municipalities, was presented as a cost-effective and eco-friendly solution. Successful cases in Northern Europe were highlighted, with hopes for expansion through stakeholder and policymaker engagement.

Geothermal energy emerged as a promising option for decarbonizing district H&C systems. Its potential depends on local conditions, and advanced technologies like Enhanced Geothermal Systems (EGS) could broaden its applicability. Effective geothermal integration requires strategic planning and stakeholder engagement.

As space cooling demand grows in Europe, sustainable solutions like district cooling and passive cooling strategies are gaining attention. While renewable energy integration and energy-efficient technologies are key to meeting decarbonization targets, addressing data gaps remains a priority for effective policy implementation.

Finally, heat planning challenges, particularly long timelines and evolving market conditions, were discussed. Rapid advancements in technologies like heat pumps present both opportunities and difficulties. Ensuring CO₂-efficient systems and maintaining transparency and community involvement are critical for achieving long-term, sustainable outcomes. The webinars emphasized the need for flexible, data-driven approaches, with strong political, technical, and community engagement for successful decarbonization.

