Webinar on "Hybrid Energy Networks" - Austria Goes International - Block I

This Webinar is held in the framework of the international cooperation program IEA DHC Annex TS3 "Hybrid Energy Networks". /

23rd April 2020

Ralf-Roman Schmidt AIT, Austria,

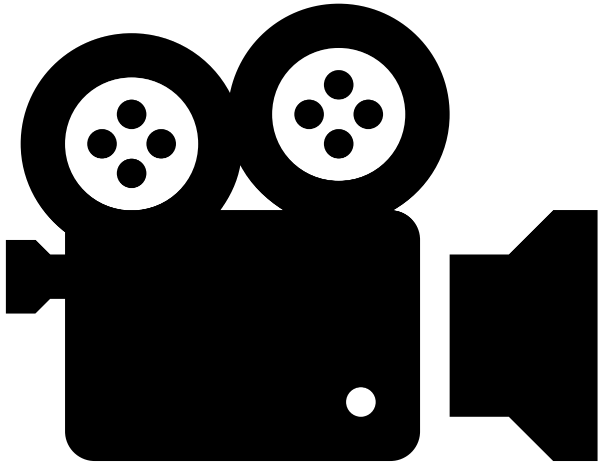
Contact: ralf-roman.schmidt@ait.ac.at

More information at

https://www.iea-dhc.org/the-research/annexes/2017-2021-annex-ts3-draft.html

AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY

This webinar is recorded



The video file will be available after the webinar on YouTube, together with the presentations

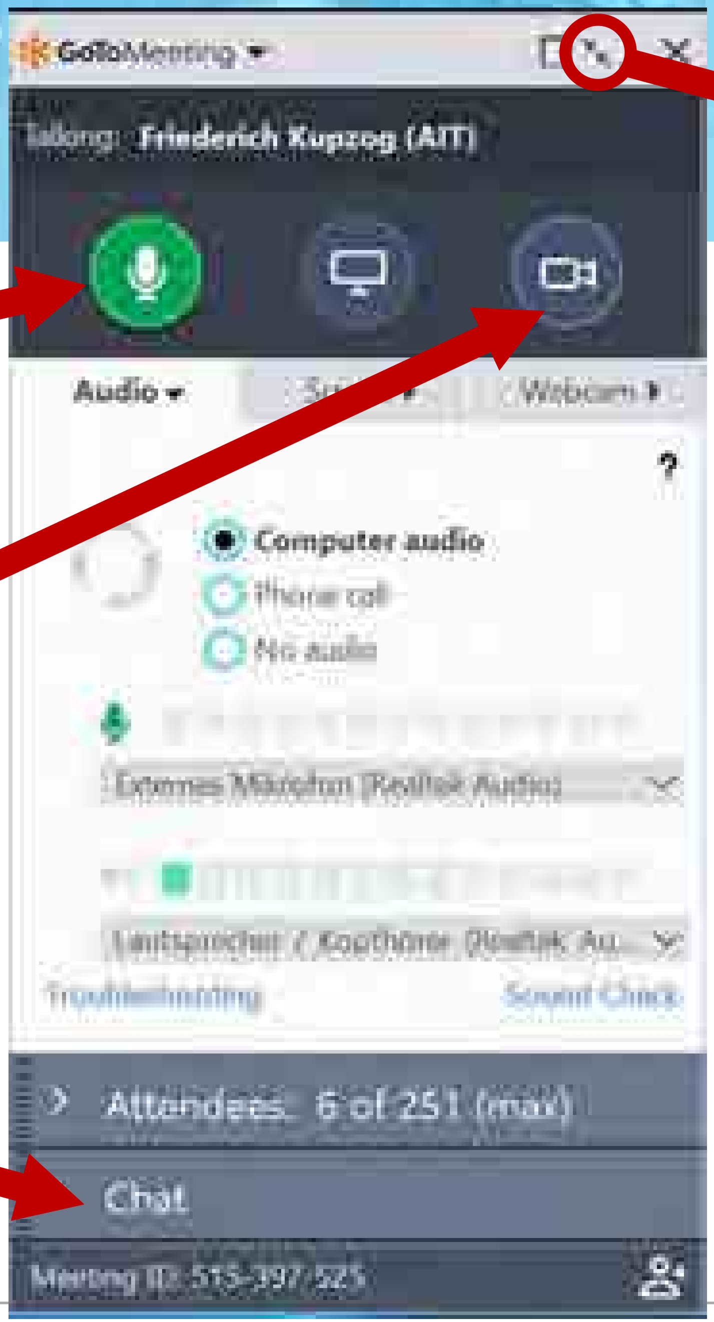
We will have a "group photo" at the end of the webinar, so please be prepared to turn on your webcam (participation voluntarily)

GoToMeeting – instructions

Mute yourself

Turn off camera

Open chat window



Minimize panel

Webinar Etiquette

- **The microphone should be muted by default**
  - They should only be switched on if you are speaking.
- **Only one person speaks at a time**.
  - Requests to speak are reported via chat ("**rts**"),
  - the moderator will ask then the speakers to speak.
  - Please state your name and institution before you speak
- **Please turn off your webcam**!
  - No general video transmission in order to reduce the bandwidth.
  - The camera can be used at short notice for spoken contributions.
  - We will make a “group-photo” at the end of each block
- **Caution with humor and sarcasm!**
  - much of the original effect between the lines can be lost

Agenda Block I

9:30	*Testing of technical connections*
10:00	**Introduction into the Webinar and the international cooperation program IEA DHC Annex TS3** *(Ralf-Roman Schmidt, AIT)*
	Transformation towards the 4. and 5. generation district heating, tends and examples *(Christian Doczekal, Güssing Energy Technologies GmbH)*
	Challenges for hybrid energy networks and e.on solutions *(Boris Kleemann, E.ON)*
	ThermaFLEX: Experiences from an Austrian flagship project on flexible district heating systems *(Ingo Leusbrock, AEE Intec)*
	Assessment of integrated multi-carrier distribution networks *(Edmund Widl AIT)*
	EnRSim: a simple tool for designing and assessing renewable production strategies *(Nicolas Vasset, CEA)*
11:30	*End of Block I*

Agenda Block II

12:30	*Testing of technical connections*
13:00	**A modular energy management system for the optimal operation of cross-sectoral energy systems** *(Daniel Muschick, BEST)*
	Innovative Cogeneration and Trigeneration concepts using LiBr absorption machines for heating and cooling *(Harald Blazek, Stepsahead)*
	Heating and cooling strategies and 2050 scenarios for Austria, results of the Heat Roadmap Europe project *(Peter Sorknæs, Aalborg University)*
	Decarbonising the austrian space heating sector: a transition scenario for 2050 *(Lukas Kranzl, TU Wien)*
14:00	**An analysis of strengths, weaknesses, opportunities and threats of DHC networks within an integrated energy system** (*Ralf-Roman Schmidt, AIT)*
	online voting and open discussion round
14:30	*End of Block II*

IEA DHC Annex TS3: Hybrid Energy Networks - District Heating and Cooling Networks in an Integrated Energy System Context

Introduction into international DHC Annex TS3

Ralf-Roman Schmidt

AIT, Austria

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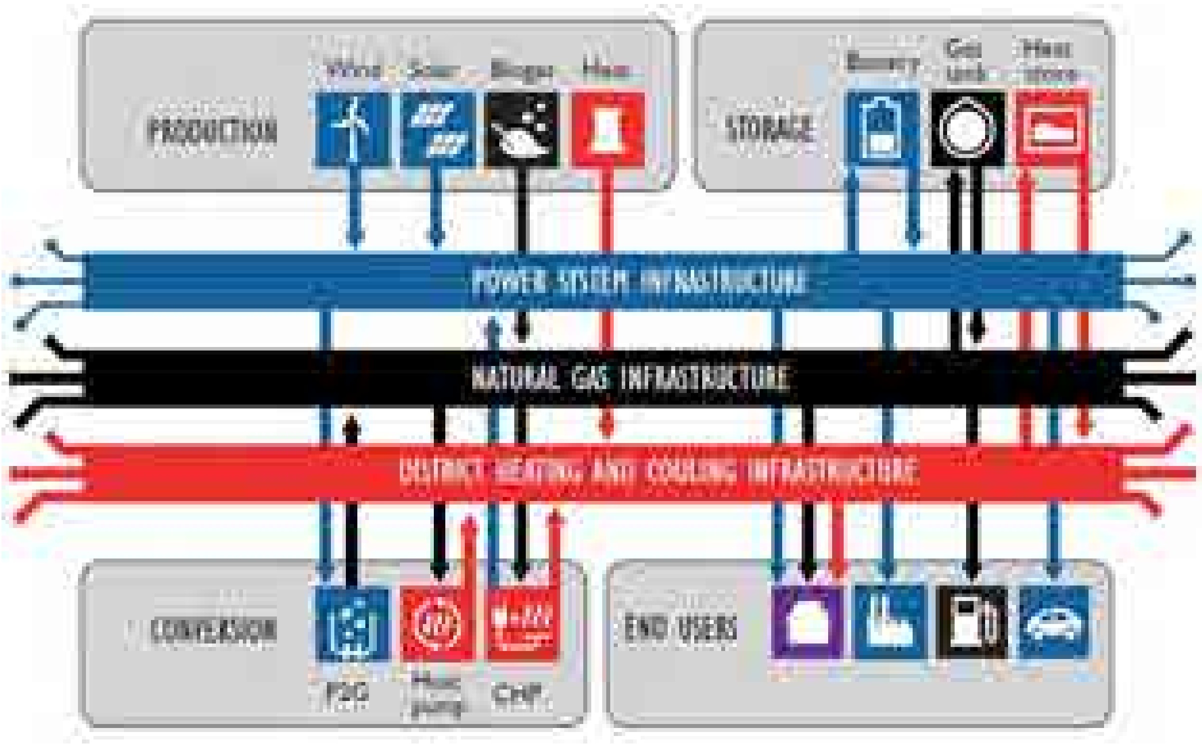
The IEA technology cooperation program (TCP) on district heating and cooling (DHC)

- **a platform for international experts**
  - dedicated to helping to make DHC and CHP powerful tools for energy conservation and the reduction of environmental impacts of supplying heat
  - Current members: Austria, Belgium, Canada, China, Denmark, Finland, France, Germany, Korea, Norway, Sweden, United Kingdom, United States of America.
- **The projects within the IEA DHC TCP are either**
  - Funded through a **cost-sharing** approach (by the member states)
  - Funded through a **task-sharing** approach (the participants contribute resources in-kind for connecting existing national and international projects), e.g. Annex TS3
- **More information: http://www.iea-dhc.org/home.html**

IEA DHC Annex TS3: Background

- The integration of the electricity/ gas grids and heating/ cooling networks is considered as one of the key measures for decarbonizing the energy system (aka “sector coupling”). This
  - triggers important **synergies**, that couldn’t be realised by optimizing the sectors individually.
  - is connected to several **challenges**, such as an increasing competition between the energy domains and a higher complexity.



Hybrid Energy Networks, Examples

- **combined heat and power (CHP)**
- **power-to-heat (PtH)**
- **heat pump (HP)**
- **electric boilers (eB)**
- **power-to-gas (PtG)**

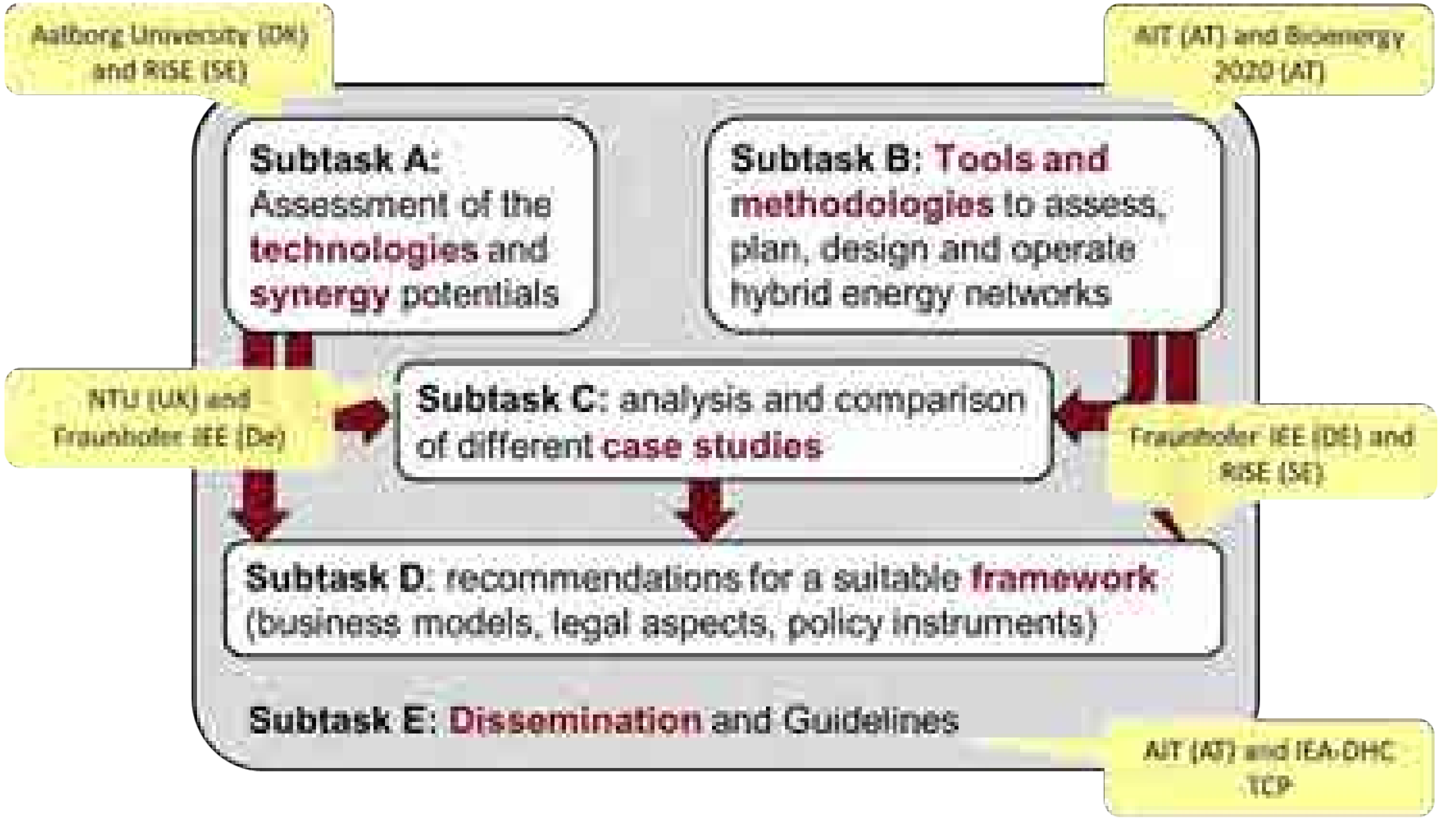
- Using biogas from local biomass in micro **CHPs** for supplying to rural DHN
- Decentralized **eBs** in domestic hot water storages for using local PV energy
- Waste heat from data centers supplied via **HPs** or directly to the DHN
- Small scale DHN supplied by central **HPs** using ambient energy
- Integration of **CHP** via ORC (Organic Rankine Cycle) in biomass-based DH networks for producing electricity
- Large scale **eBs** centrally integrated in DHN for participating on short term electricity markets
- Low temperature DHN using electric booster **HPs** for domestic hot water preparation
- Anergy networks using “neutral” supply temperatures between 15 and 25°C (up to 40°C) and **HPs** in each building
- Cooling networks with central adsorption chillers, electric chillers (reverse **HPs**) and cold storages
- Using waste heat from the **P2G** re-conversion of hydrogen via **CHP** plants in DHN
- Using waste heat from **P2G** / electrolysis processes in the DHN
- …

Hybrid Energy Networks, Definition (DRAFT)

	Level of energy system integration	
	min	**max**
Technology layer (e.g. density and diversity of coupling points (CHP, PtH, PtG …), system flexibility/ storage integration, advancement of controls and analytics)	Single coupling points, delivering high shares of heat, central controls of network and coupling points	Multiple and diverse coupling points, each of them able to deliver high shares of heat supply, advanced controls, automation and analytics (e.g. IoT platforms, model predictive controls, forecasting of electricity prices and head demand)
Strategic layer (e.g. integration of (distributed) renewables and waste heat, transformation strategy and integrated planning)	Central structures, integration of coupling points only as a reaction on (short-term) market pressure	Decentralized structures, integrated and forward-looking planning and design of the energy system, optimized interaction within the different networks, considering decarbonization scenarios (urban/ national)
Organization layer (e.g. innovation in business models and services offered, level of consumer / prosumer integration, ownership/ acceptance)	minimum permissible ownership of coupling points and network assets, traditional business models (e.g. direct energy sales)	Maximum permissible ownership of network assets and coupling points, high share of prosumers, innovative business models and services offered (e.g. dynamic pricing, establishing local energy markets, enabling prosumers to participate at different el. markets)

IEA DHC Annex TS3: aim and structure

- **Aim**: to promote the opportunities and to overcome the challenges for DHC networks in an integrated energy system context. The Annex
  - provides a holistic approach for assessing, planning and operation,
  - considers technical aspects (system configuration, operational strategy) and strategic aspects (business model, regulatory frame).



IEA DHC Annex TS3: Schedule and outcomes

Definition phase	Preparation phase		Working phase					
2017 /Fall	2018 /Spring	2018 /Fall	2019 /Spring	2019 /Fall	2020 /Spring	2020 /Fall	2021 /Spring	2021 /Fall
Austria	Stockholm	Berlin with Industry WS	Stockholm shared WS with ISGAN	France – on invitation by CEA	Online TelCo and public Webinar	Nottingham – attached to the IEA DHC symposium?	Austria attached to the mission innovation week ?	Denmark – attached to the 4DH / SES conference?

Expected results:

- A **SWOT analyses** of HEN
- An assessment of suitable **technologies** and HEN concepts
- Country reports on national **energy scenarios** (Denmark, Austria …)
- Collection and assessment of international **case studies**
- A review of existing **methods and tools**
- **Best practice guidelines** and online tutorials for planning, designing and operating HEN
- A report on **exergy as evaluation criteria** for HEN
- Development of new **business models**
- Policy papers and recommendation on **market design and regulations**
- **workshops** with local industries
- **Publications and presentations** on various conferences
- a final **guidebook** summarizing the results
- …

Thank you for your attention!

Contact:

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Transformation towards the 4. and 5. generation district heating, tends and examples

(Christian Doczekal, Güssing Energy Technologies GmbH)

IEA DHC Annex TS3
„Hybrid Energy Networks“

Transformation towards the 4th and 5th generation district heating, trends and examples

Christian Doczekal
23.04.2020

Is there a need to transform 3rd generation DH into 4th generation DH?

→ not possible in most cases

→ reach sub-goals in that direction

→ still a lot of homework to do at 3rd gen.

→ lower heat losses, optimise operation

How to reduce return flow temperatures?

CUSTOMER INTERACTION IS KEY

→ think different

THE BENEFITS TO THE END **CUSTOMERS**

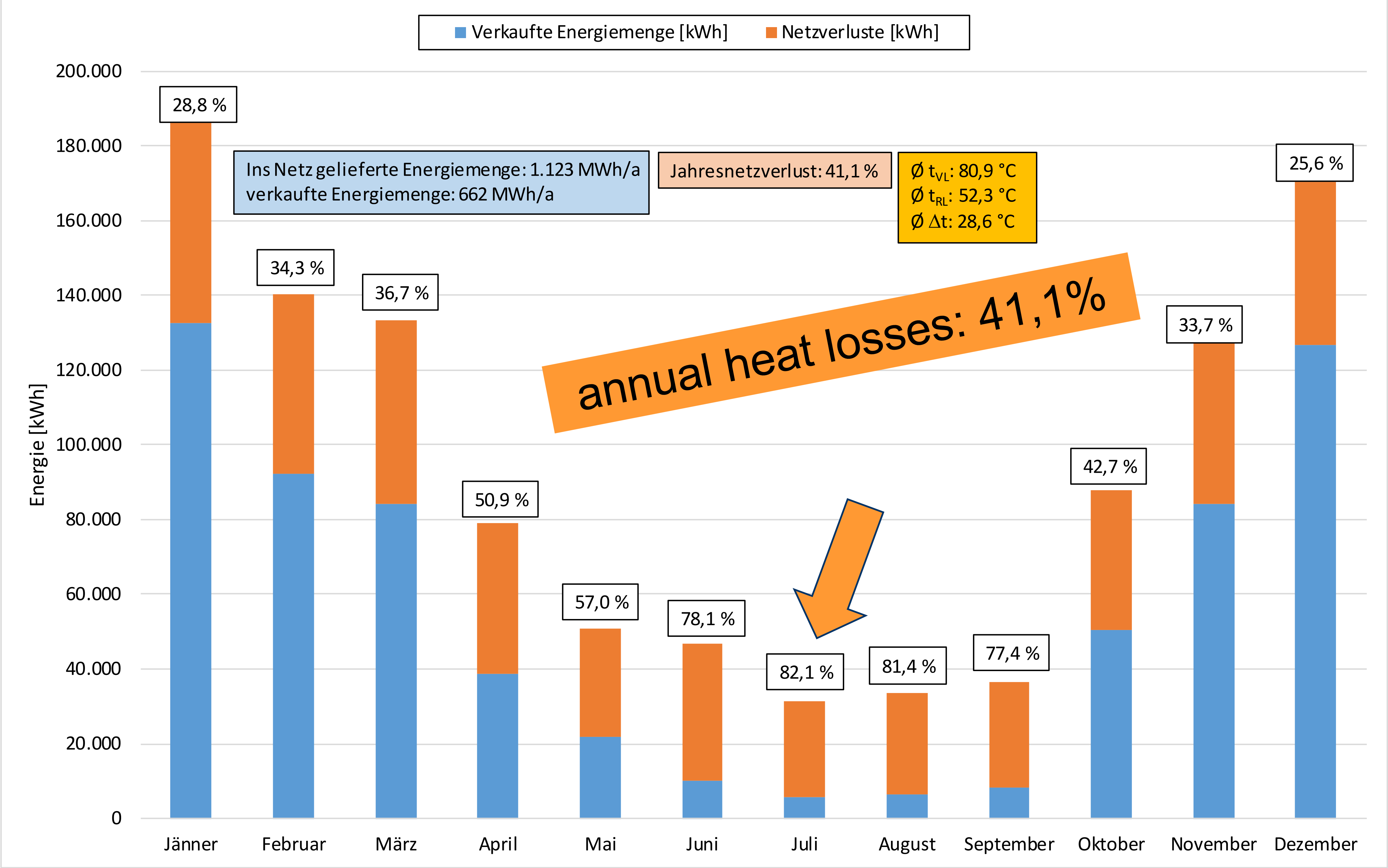
MOTIVATE THE **CUSTOMER** TO LOWER RETURN TEMPERATURE

THE GOAL IS SAVING MONEY FOR THE **CUSTOMERS**

Tom Diget
(Viborg District Heating Company, Denmark)

source: http://www.e-pages.dk/dbdh/67/19

Still a lot to do!



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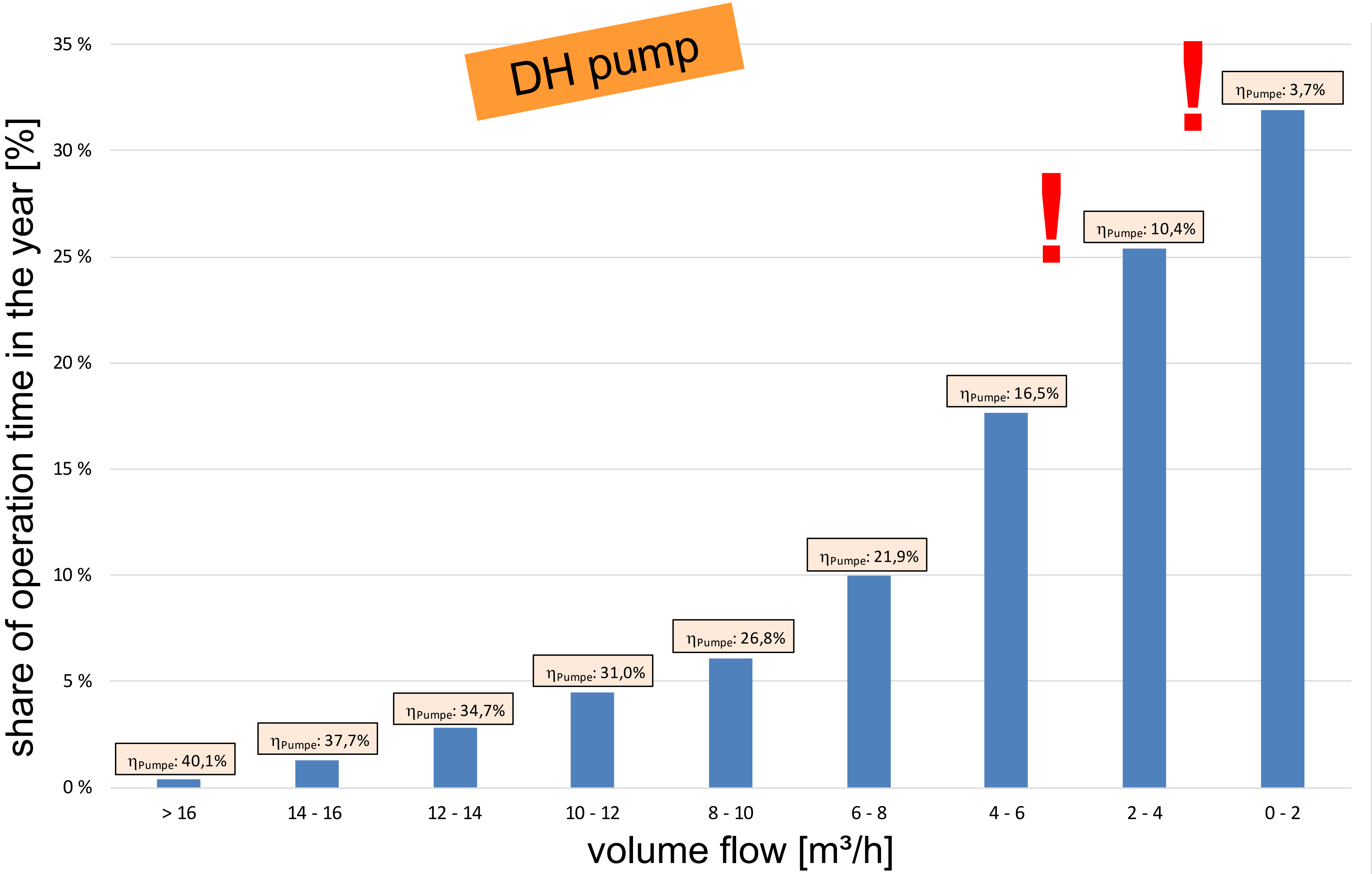

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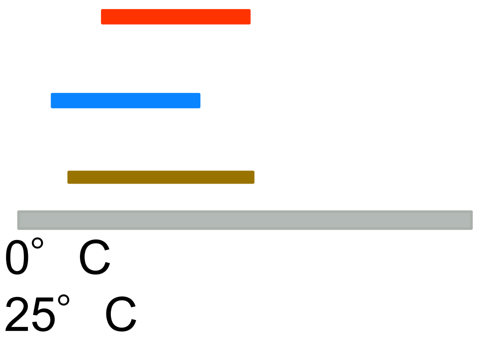
Are grid temperature levels from 5 to 25°C the solution?

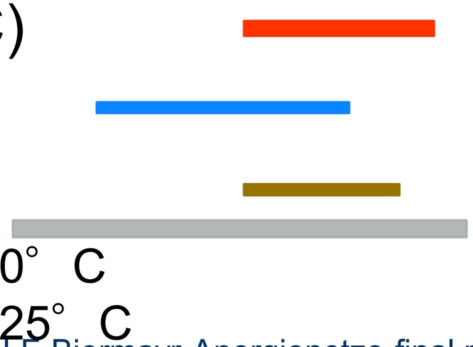
Example: Smart Anergy Quarter in Baden (SANBA)

- Anergy grid
- uninsulated plastic pipes, ~DN160

- Winter
  - warm pipe (7-12°C)
  - cold pipe (2-9°C)
  - earth (4-12°C)



- Summer
  - warm pipe (12-22°C)
  - cold pipe (7-18°C)
  - earth (12-20°C)



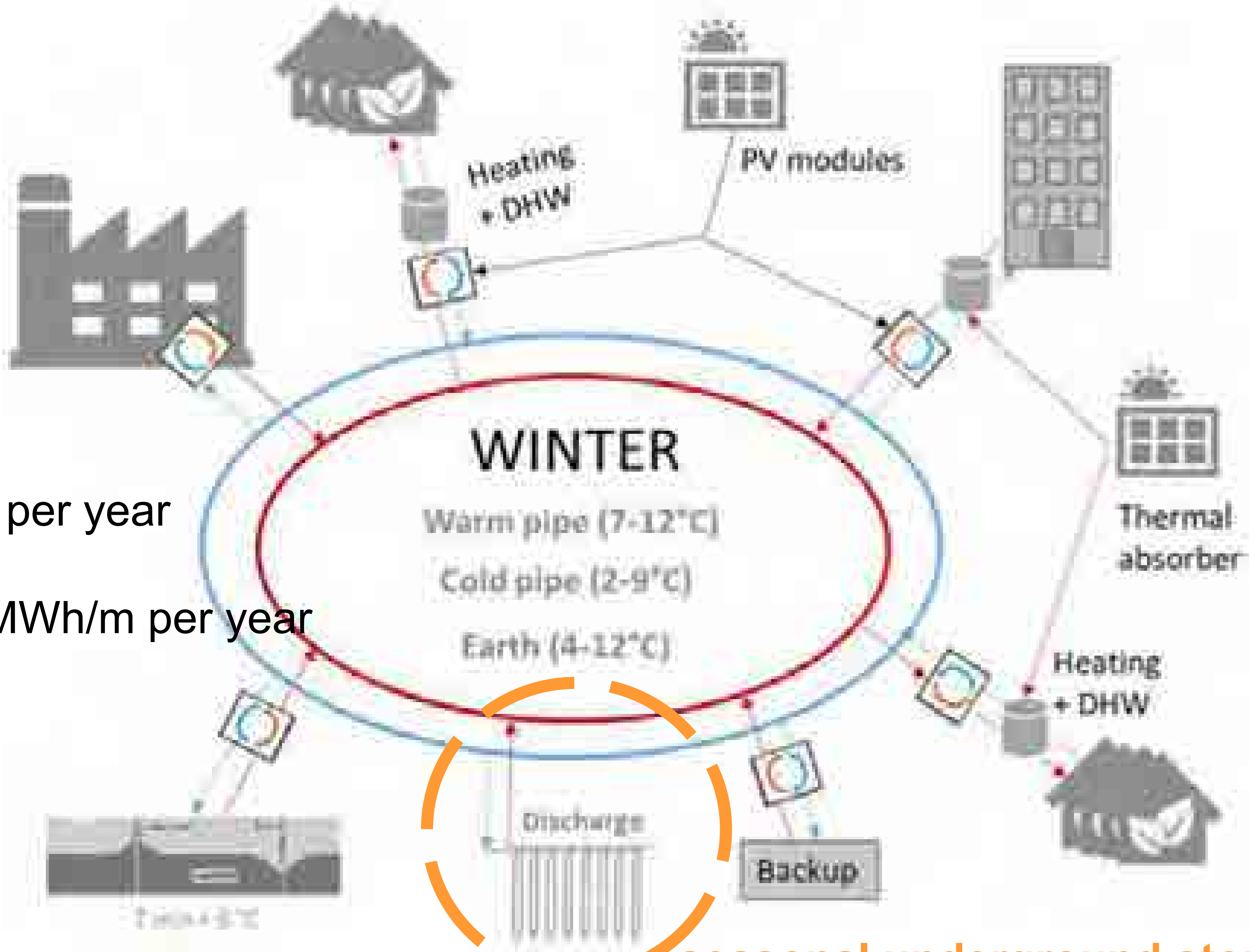
source: https://enfos.at/download/rest/EnInnov_2020_LF-Biermayr-Anergienetze-final.pdf

Example: Smart Anergy Quarter in Baden (SANBA)

Savings for dairy: electricity from 100 coolers

Heat losses: ~1% per year

Heat density: ~3 MWh/m per year



seasonal underground storage

source: https://enfos.at/download/rest/EnInnov_2020_LF-Biermayr-Anergienetze-final.pdf

- Lessons learned
  - calculable benefits needed for the waste heat supplier
  - without interruption of the process
  - easier gathering waste heat from cooling systems, than from waste water
  - free-cooling is not free of charge (in terms of the overall economy)
  - Anergy grids are investment intensive
    - rate of return on capital has a great influence on the specific heat generation costs
    - So minimise the investment costs (uninsulated plastic pipes, redundant heat source)

source: https://enfos.at/download/rest/EnInnov_2020_LF-Biermayr-Anergienetze-final.pdf

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www.get.ac.at
http://at.linkedin.com/in/christian-doczekal-19768684
https://www.xing.com/profile/Christian_Doczekal

Further sources:
https://www.heatflex.at
https://www.coolheating.eu/images/downloads/D4.1_Handbook_EN.pdf

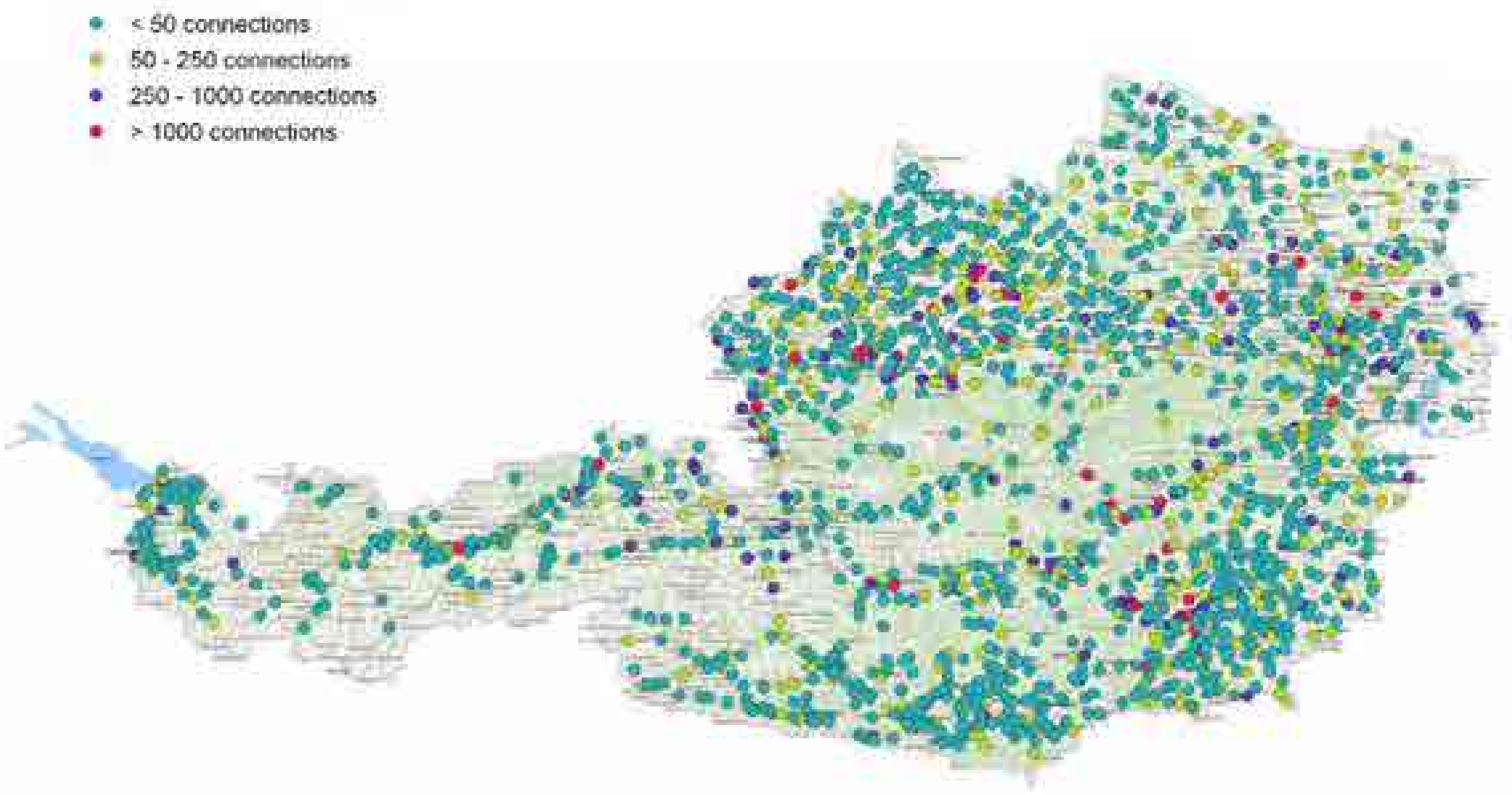
Challenges for hybrid energy networks and e.on solutions

(Boris Kleemann, E.ON)

→ unfortunately, the slides cannot be shared

ThermaFLEX: Experiences from an Austrian flagship project on flexible district heating systems

(Ingo Leusbrock, AEE Intec)



Data sources: http://www.austrian-heatmap.gv.at

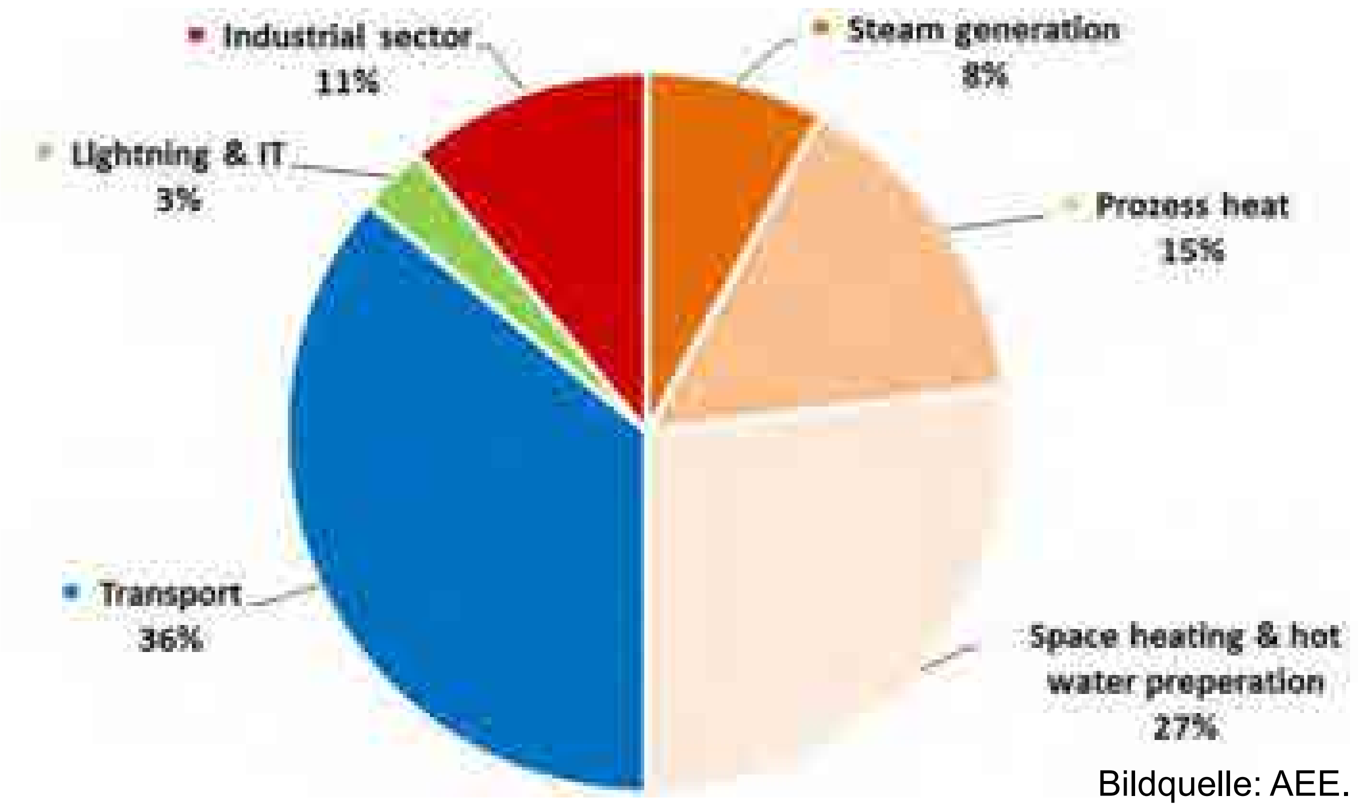
Map data © www.openstreetmap.org

ThermaFLEX: Experiences from an Austrian flagship project on flexible district heating systems

Ingo Leusbrock, Joachim Kelz

AEE – Institute for Sustainable Technologies (AEE INTEC)
8200 Gleisdorf, Feldgasse 19, Österreich

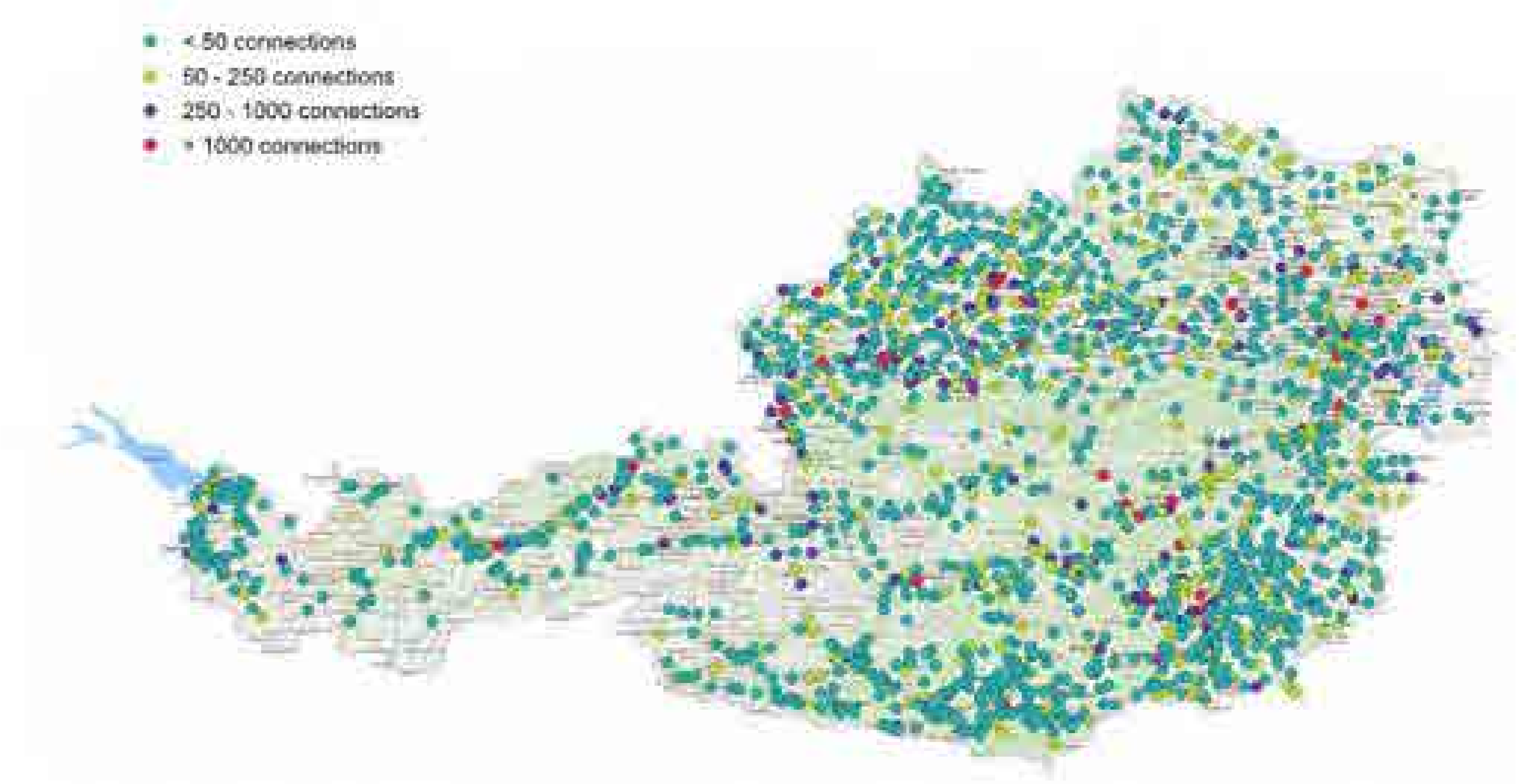
District heating in Austria



Bildquelle: AEE. Daten: Statisik Austria 2017

- >50% of primary energy demand (~311 TWh/a) in Austria = thermal demand
- 24% of thermal demand via district heating
  - 38 TWh / a

More than 3000 district heating systems in Austria



What is a flexible district heating system?

Flexibility in district heating

What is a flexible district heating system?

Technical components

- Renewables
  - Biomass
  - Solar
  - Heat pumps
  - Geothermal
- Storage
  - central & decentral
  - Small- & large-scale
- Waste heat

Flexibility in district heating

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Systemic interventions

- Sector coupling
- Control
- Lower system temperatures
- Integrated planning process
- Monitoring and optimization
- Link with spatial energy planning

Flexibility in district heating

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Non-technical measures
- User integration
- Stakeholder integration
- Innovative business models and cooperations

Systemic interventions
- Sector coupling
- Control
- Lower system temperatures
- Integrated planning process
- Monitoring and optimization
- Link with spatial energy planning

Flexibility in district heating

ThermaFLEX - Thermal demand and supply as flexible elements of future sustainable energy systems

- Concept development, demonstration, monitoring, evaluation etc.
- 7 demonstrators
  - 27 partners
  - Start 01.11.2018, 4 years project
  - budget research project 4.6 mln Euro
  - budget demonstrators 4.8mln Euro
- Part of energy model region „GreenEnergyLab“
  - www.greenenergylab.at

VORZEIGEREGION ENERGIE

ThermaFLEX: general setup

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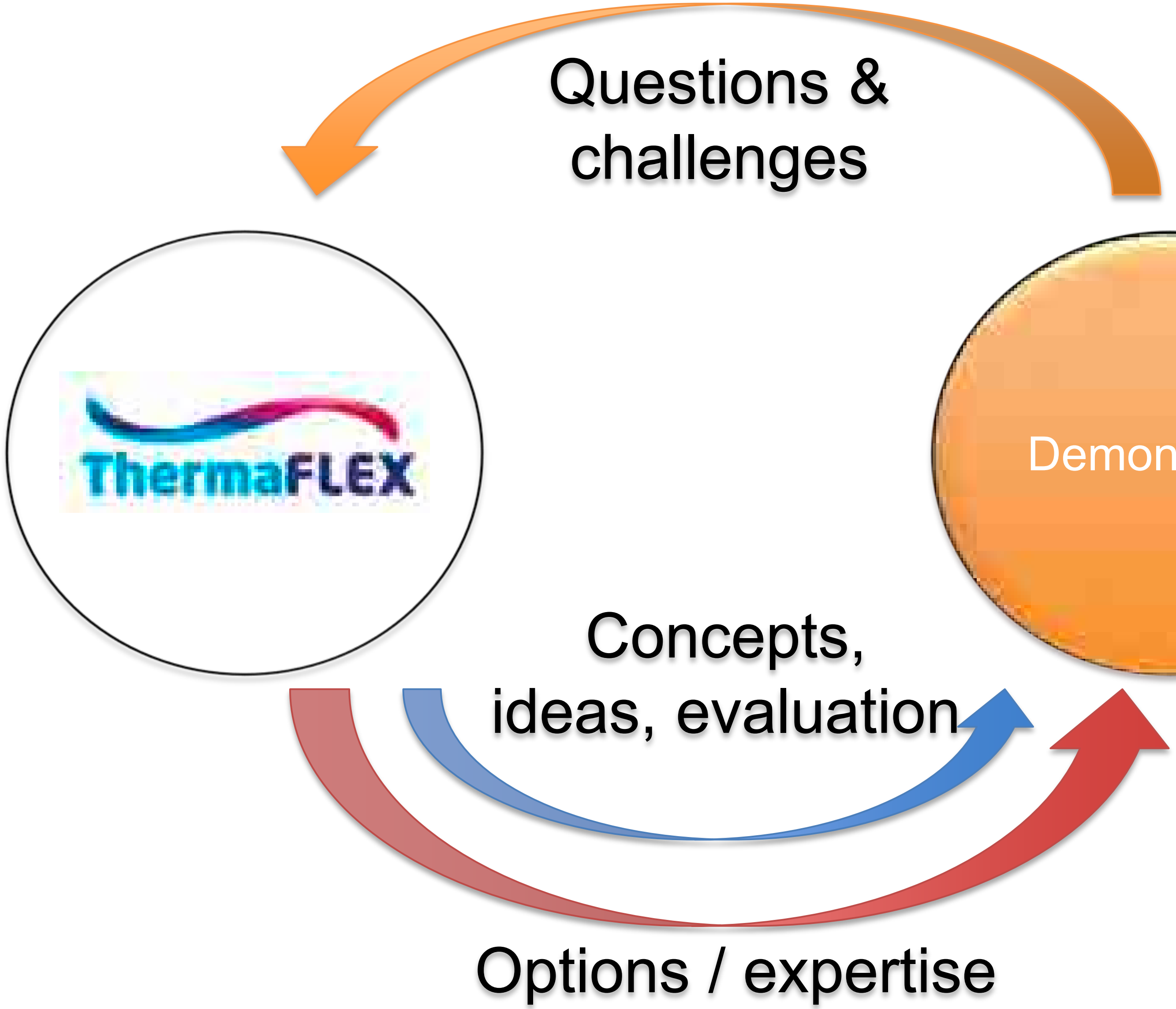
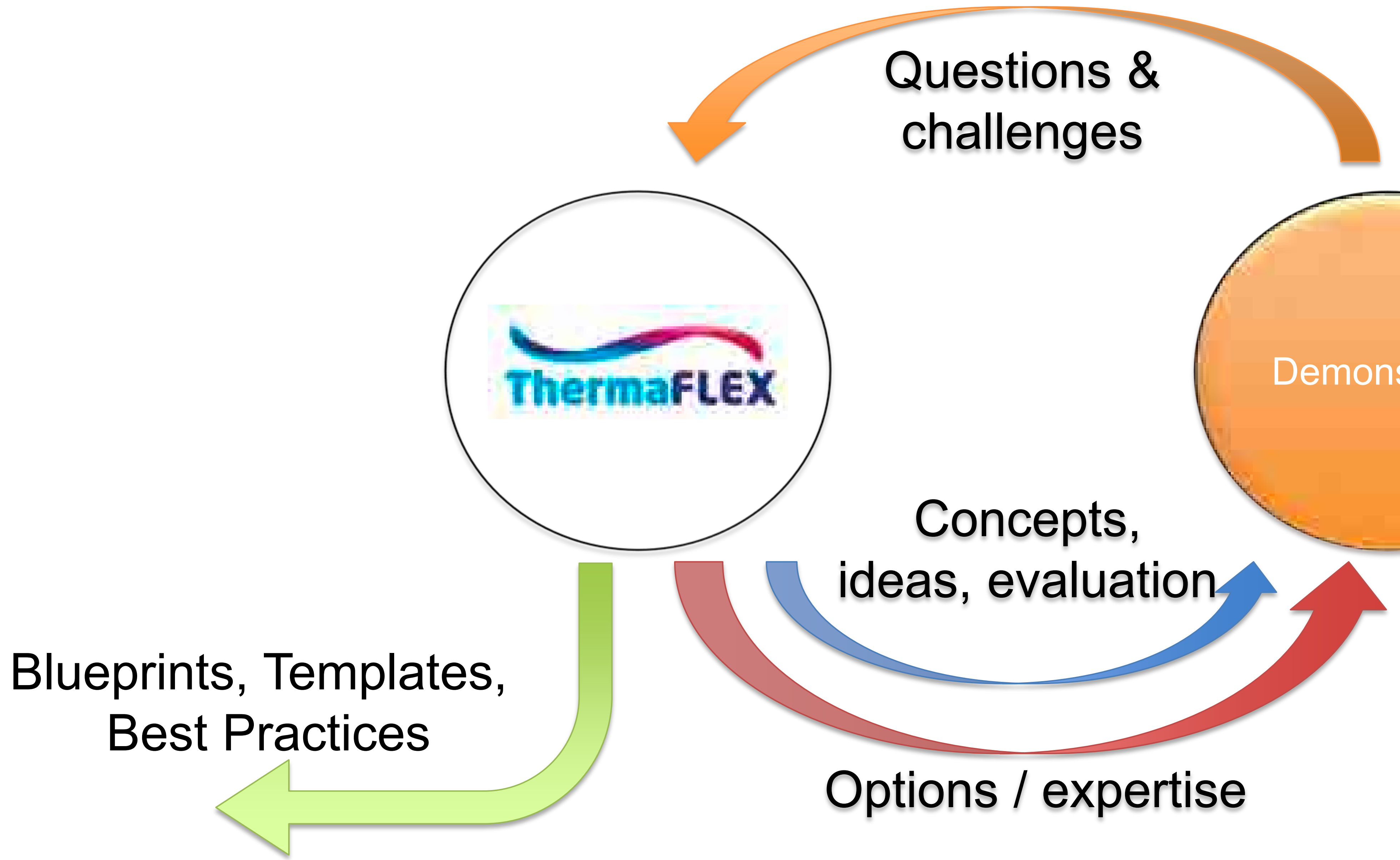
Demonstrator

ThermaFLEX: general setup

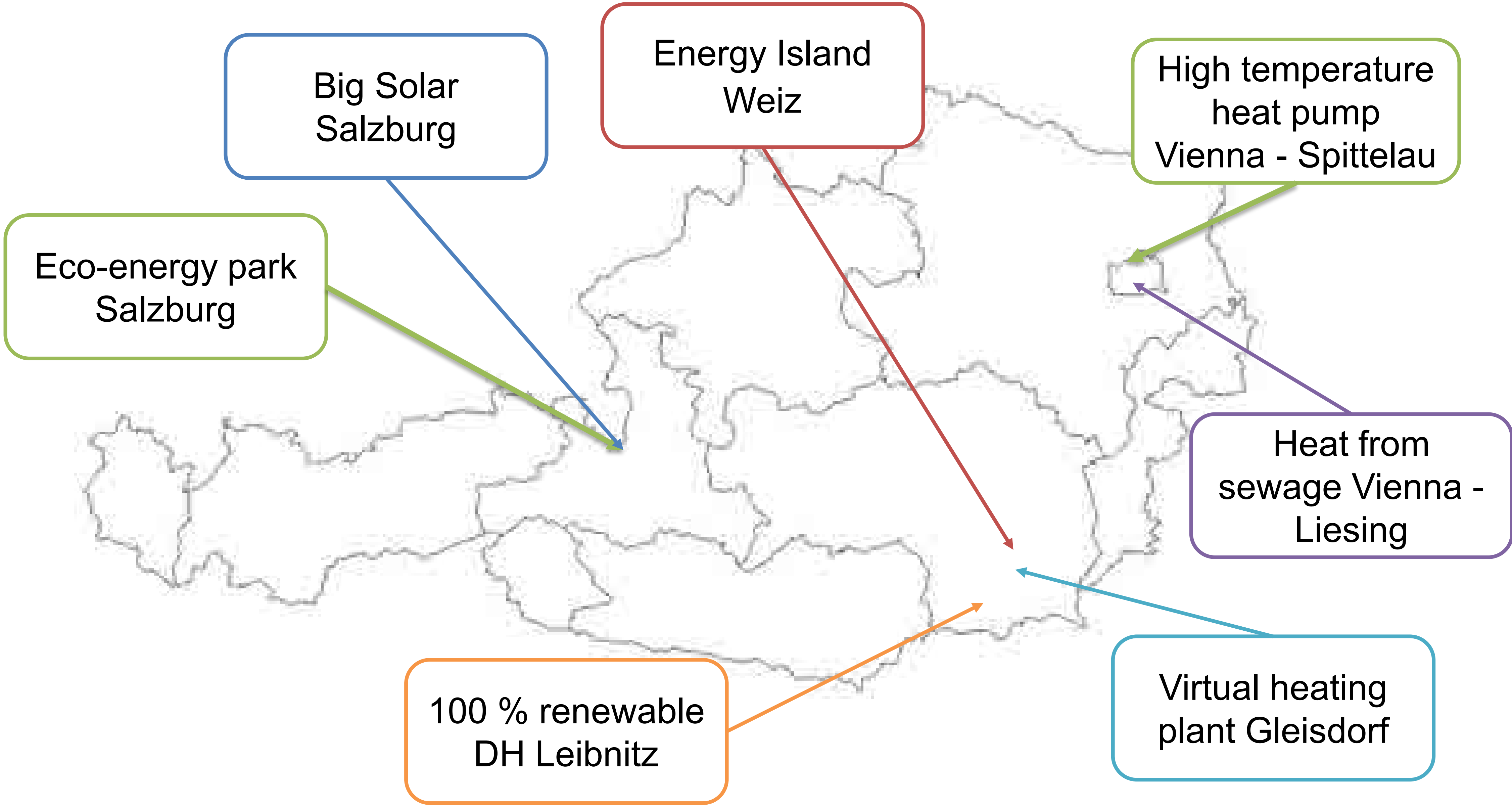
ThermaFLEX: general setup



ThermaFLEX: general setup

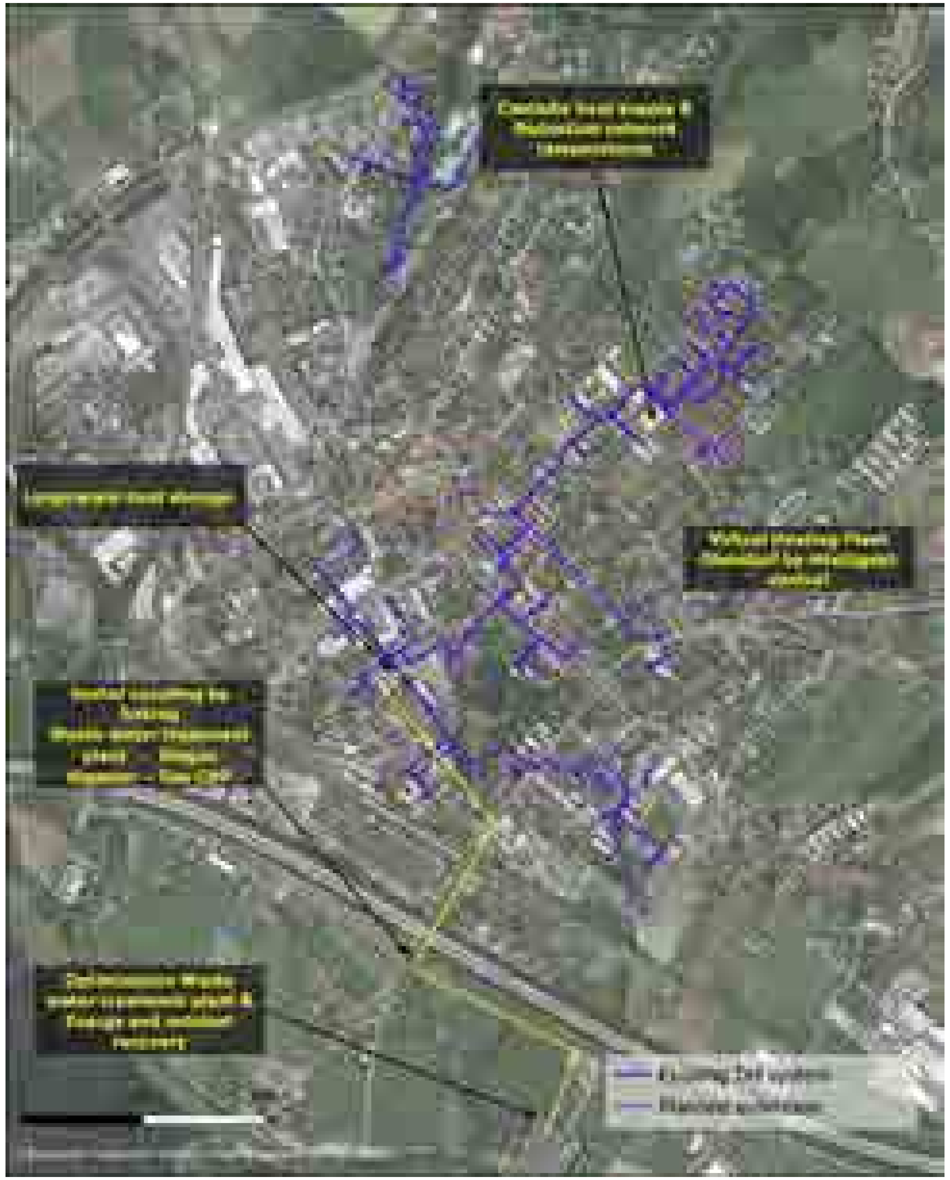


7 demonstrators in Austria

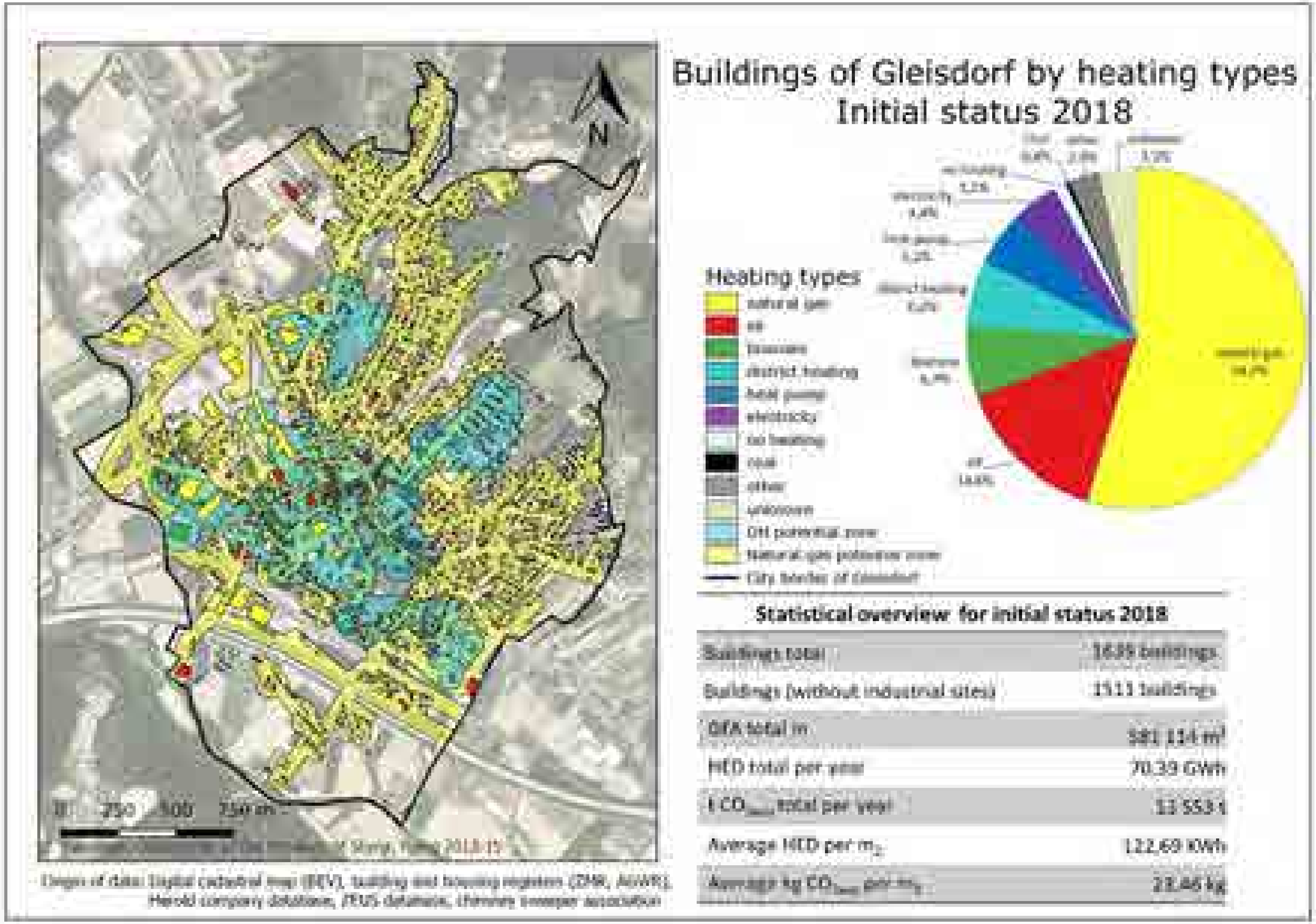


Virtual Heating Plant Gleisdorf - Overview

- Elements investigated & demonstrated
  - Supply from Return solutions & low temperature branches
  - Central & decentral storage options
  - Heat pump solutions
  - Integration Wastewater treatment plant
  - Monitoring and control
    - Virtual Heating Plant
  - User & stakeholder integration
  - Embedding in municipal spatial energy planning process and climate program
- Planned costs
  - approx. 2,5 M€ investment costs
  - approx. 1,0 M€ funding



Process for future scenarios and investment decision



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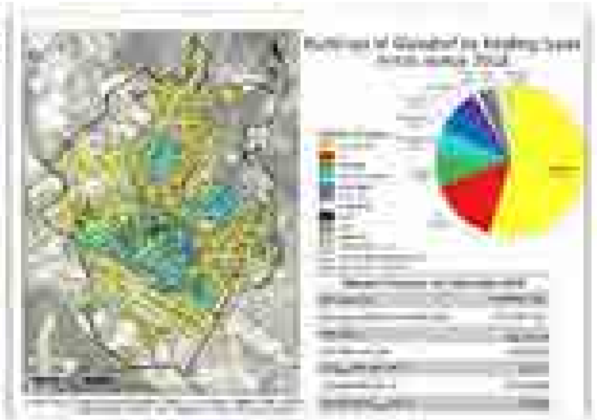
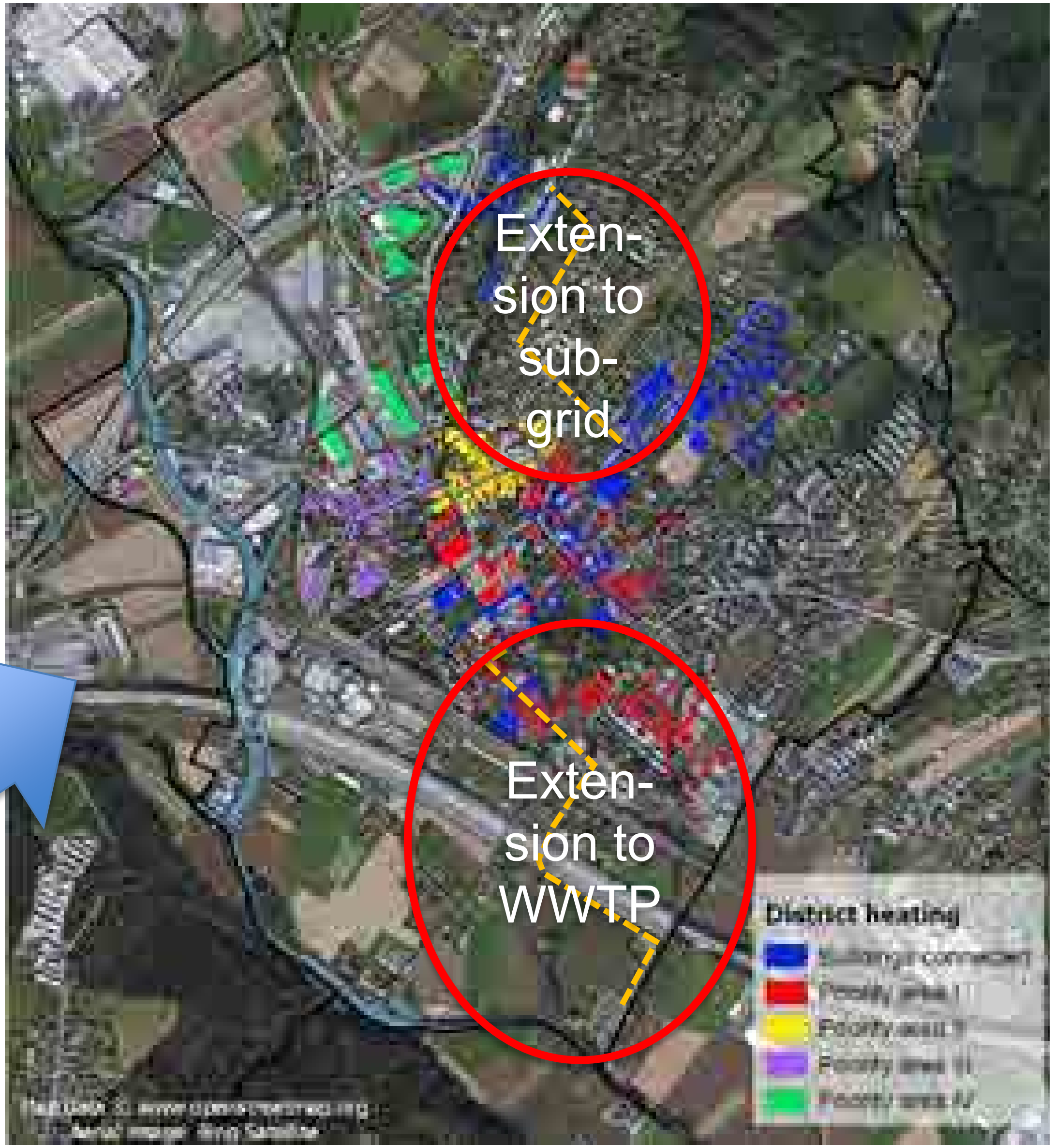


Step 1



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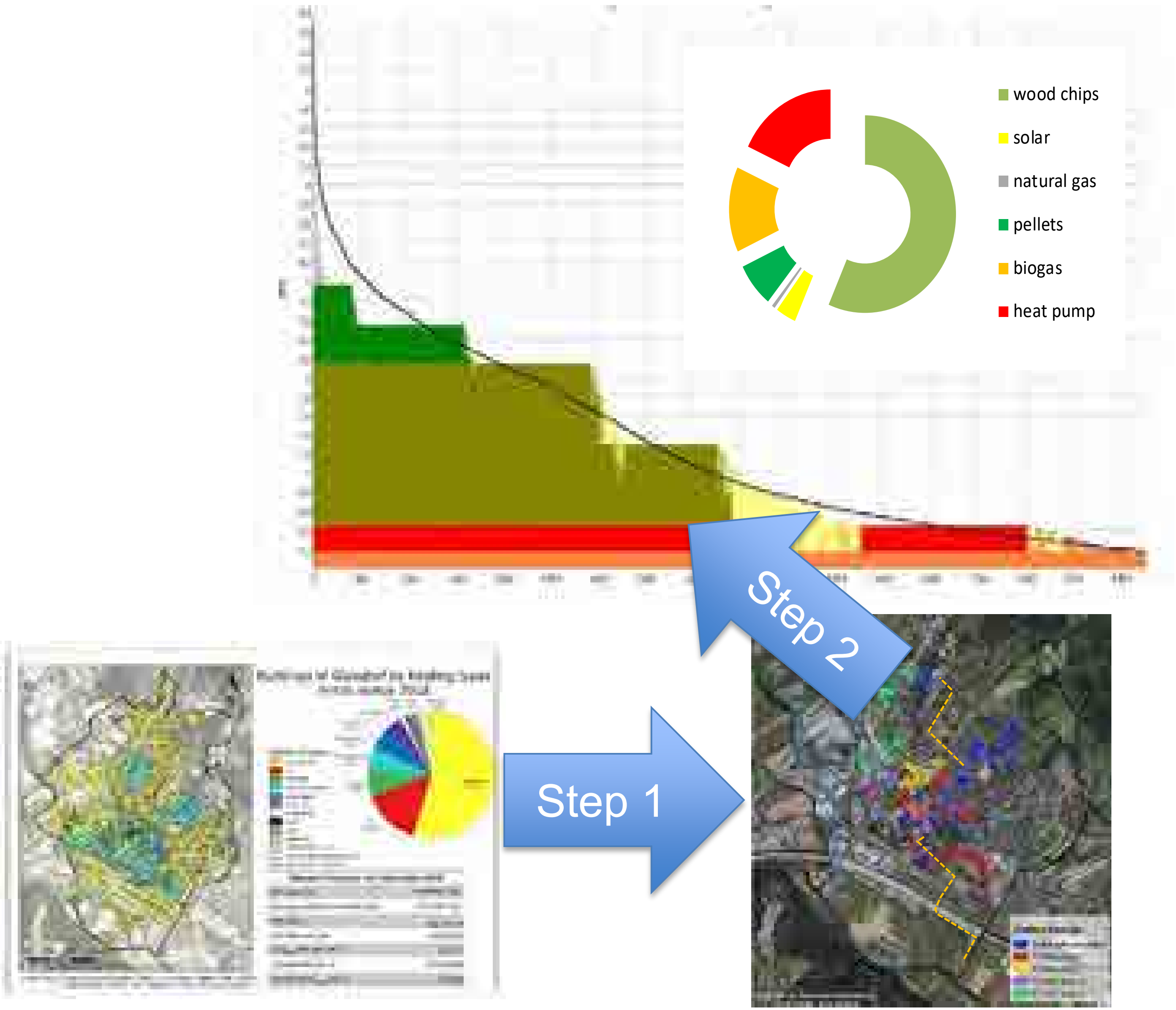

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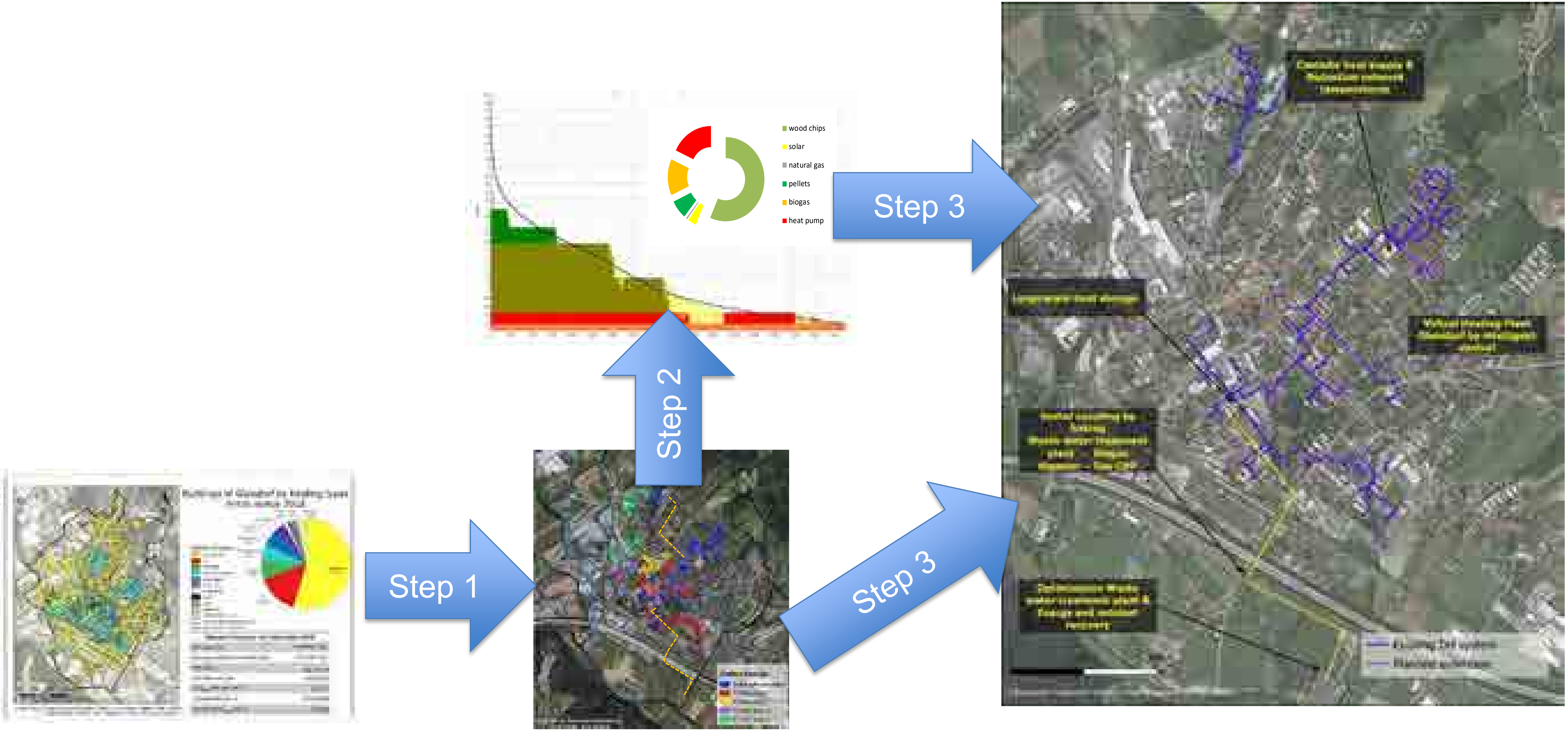
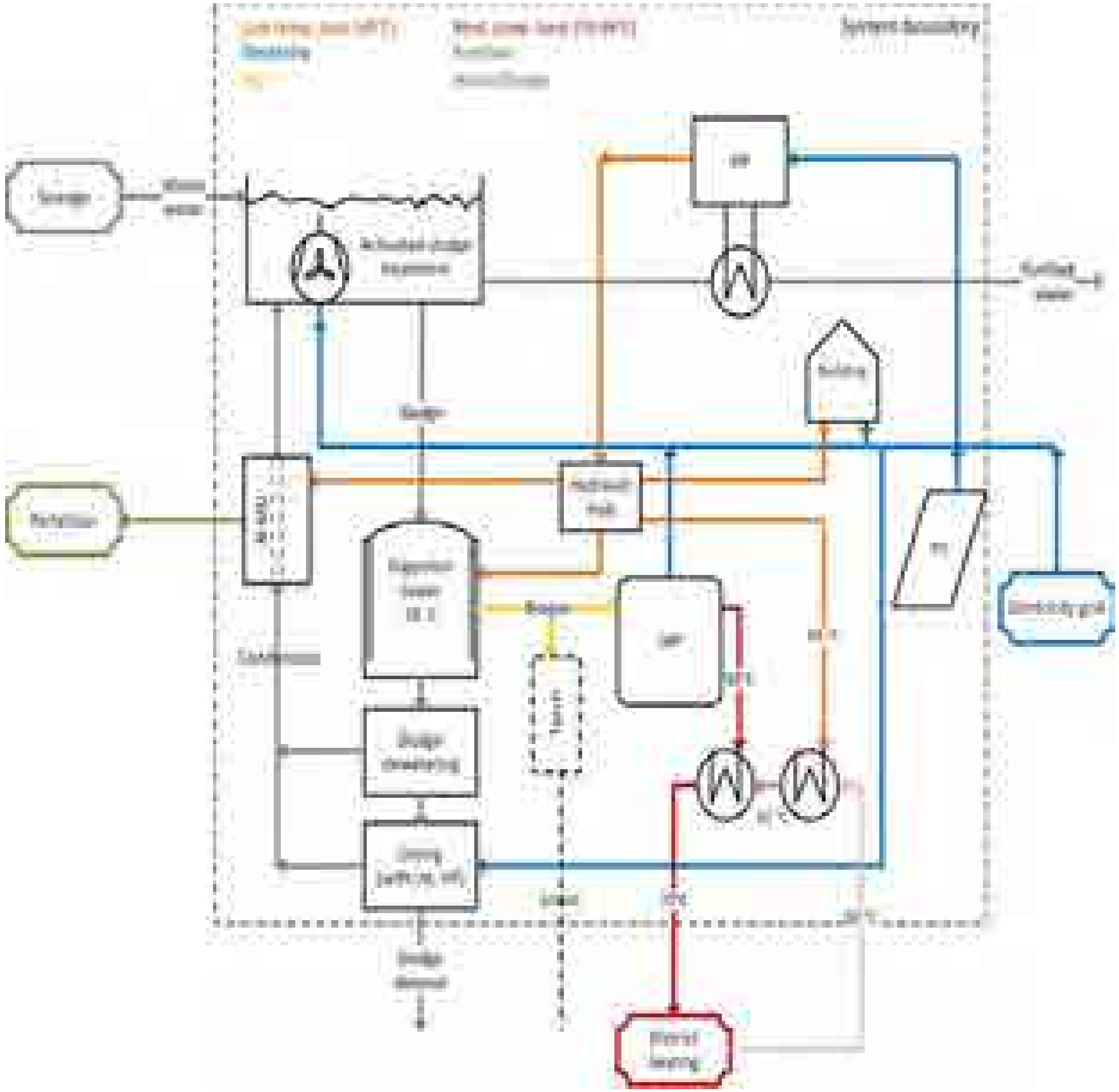


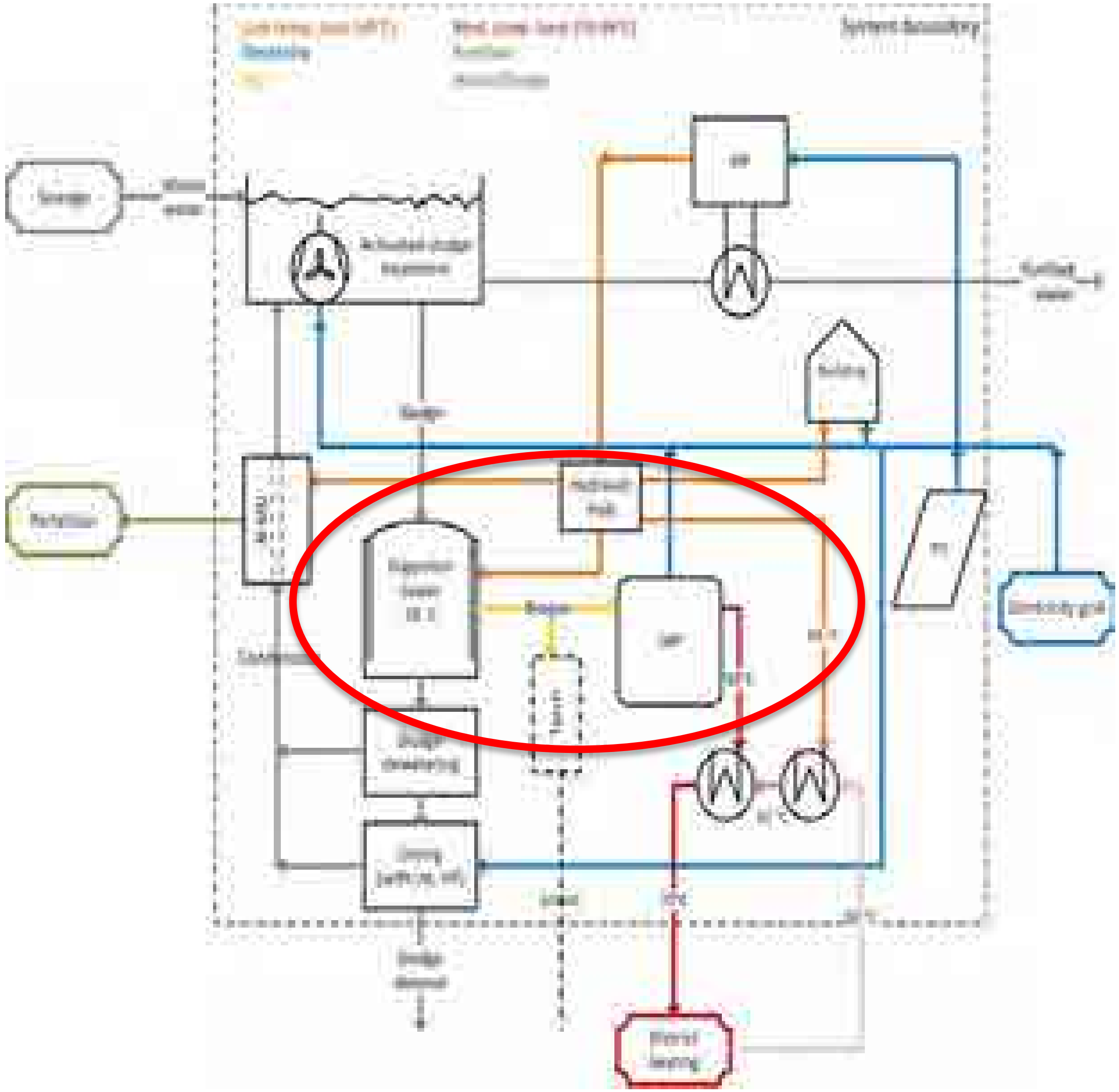
Sector coupling and hybrid network at waste water treatment plant

- WWTP as prosumer



Sector coupling and hybrid network at waste water treatment plant

- WWTP as prosumer
- Energy sources
  - Biogas from anaerobic digester
    - Direct: 220 kW_{th}
    - CHP: 90 kW_{el} / 120 kW_{th}



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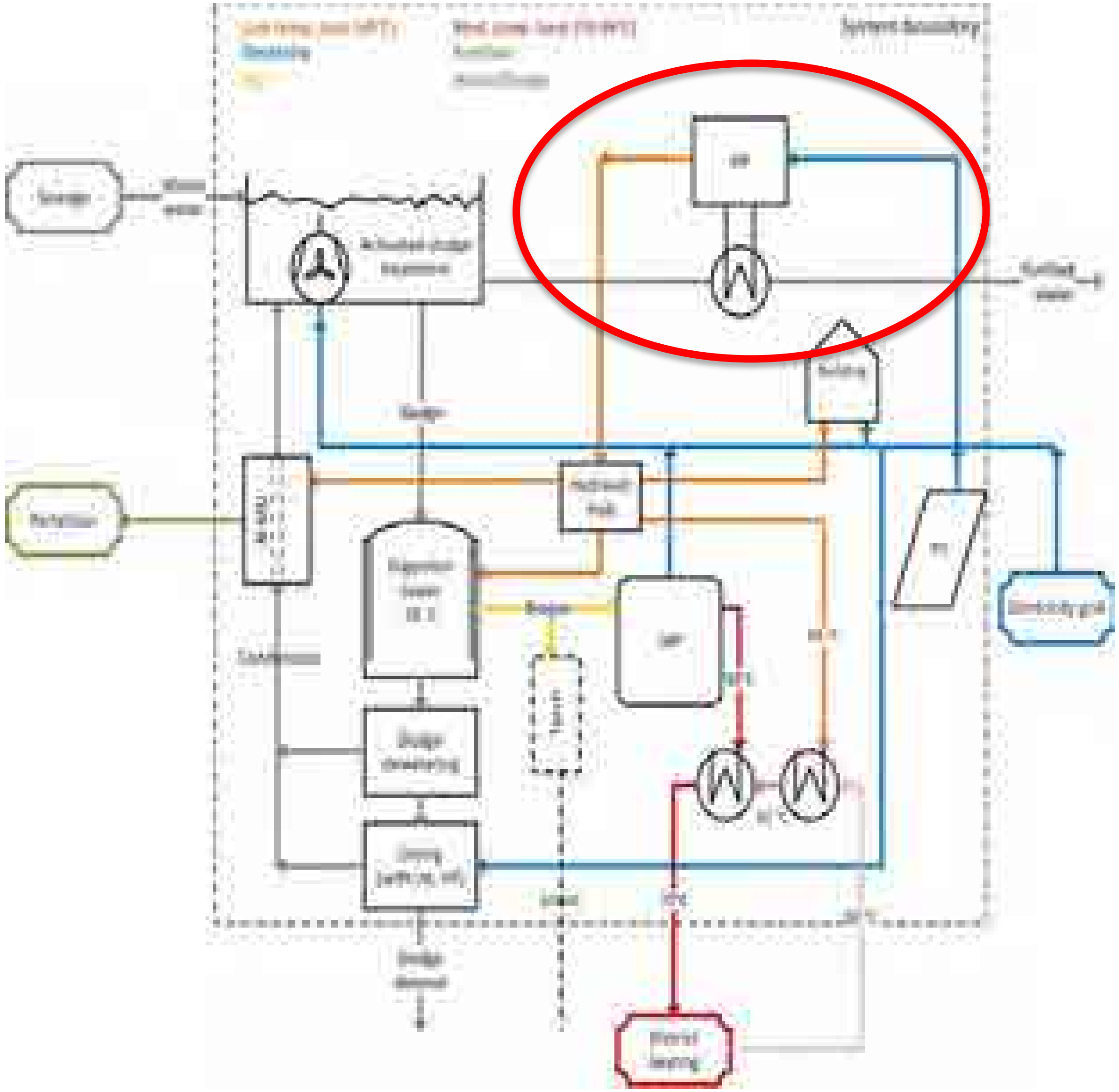
  - Treated wastewater
    - Temperatures between 10 – 20 °C
    - In combination with HP ~500 kW 24/7/365



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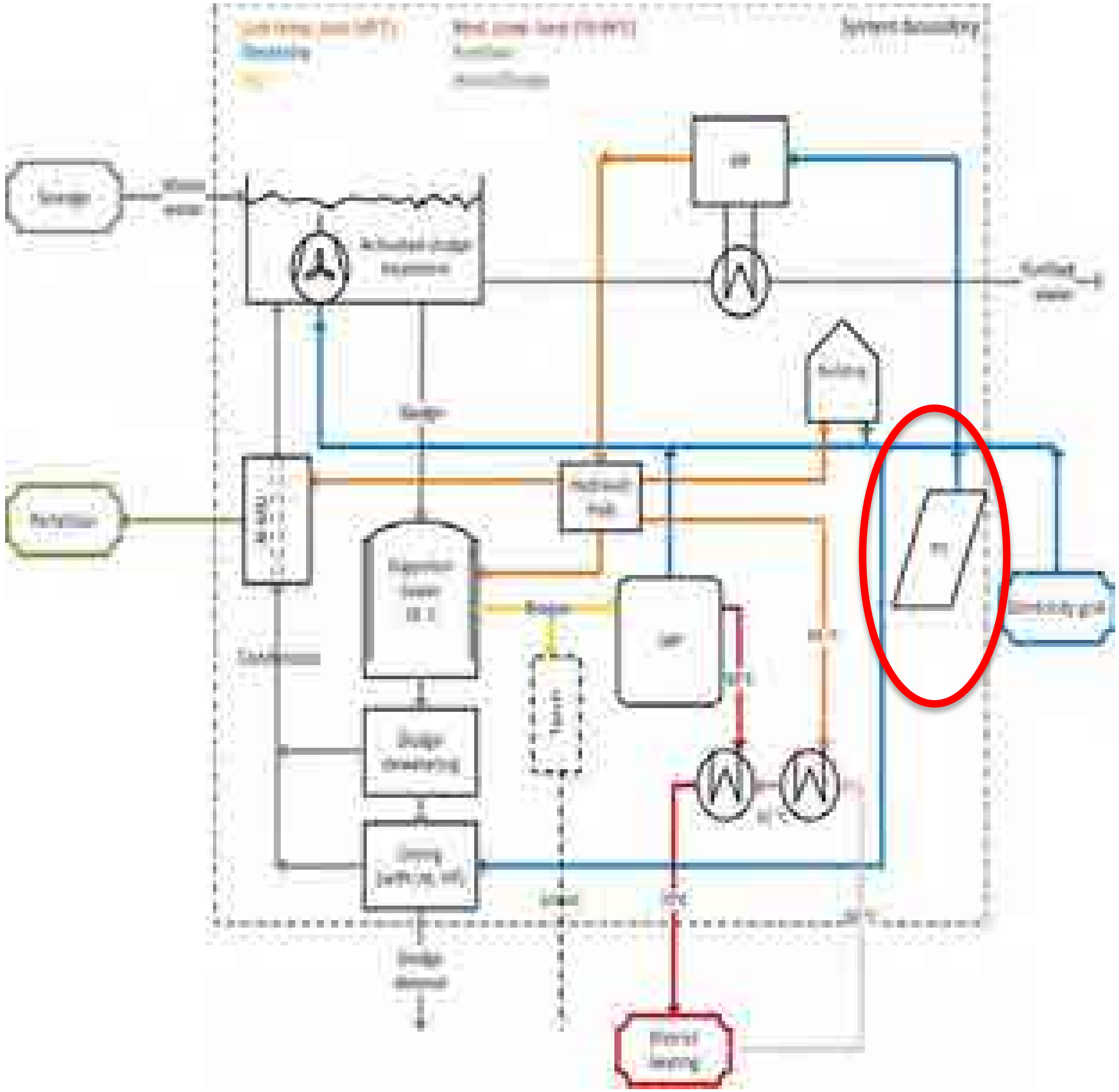
  - Local PV field



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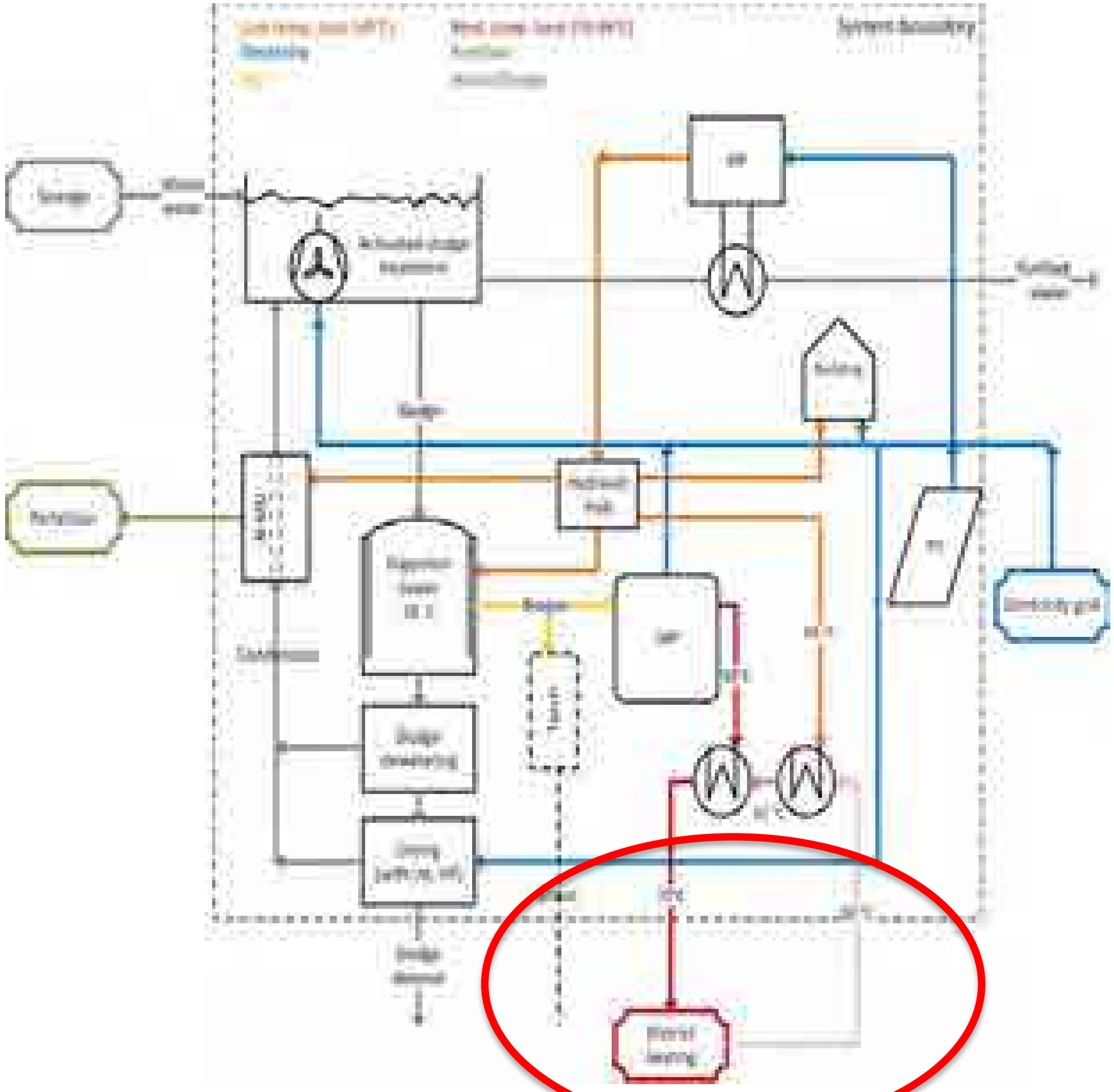
  - Treated wastewater
    - Temperatures between 10 – 20 °C
    - In combination with HP ~500 kW_{th} 24/7/365
  - Local PV field
- Link to DH system
  - Gas pipeline?
  - DH pipeline ?



AEE INTEC

IDEA TO ACTION

https://thermaflex.greenenergylab.at/

green energy lab.at

klima+ energie fonds

VORZEIGEREGION ENERGIE

Ingo Leusbrock
Mail: i.leusbrock@aee.at
Twitter: @leusbrocki
www.aee-intec.at

Assessment of integrated multi-carrier distribution networks

(Edmund Widl AIT)

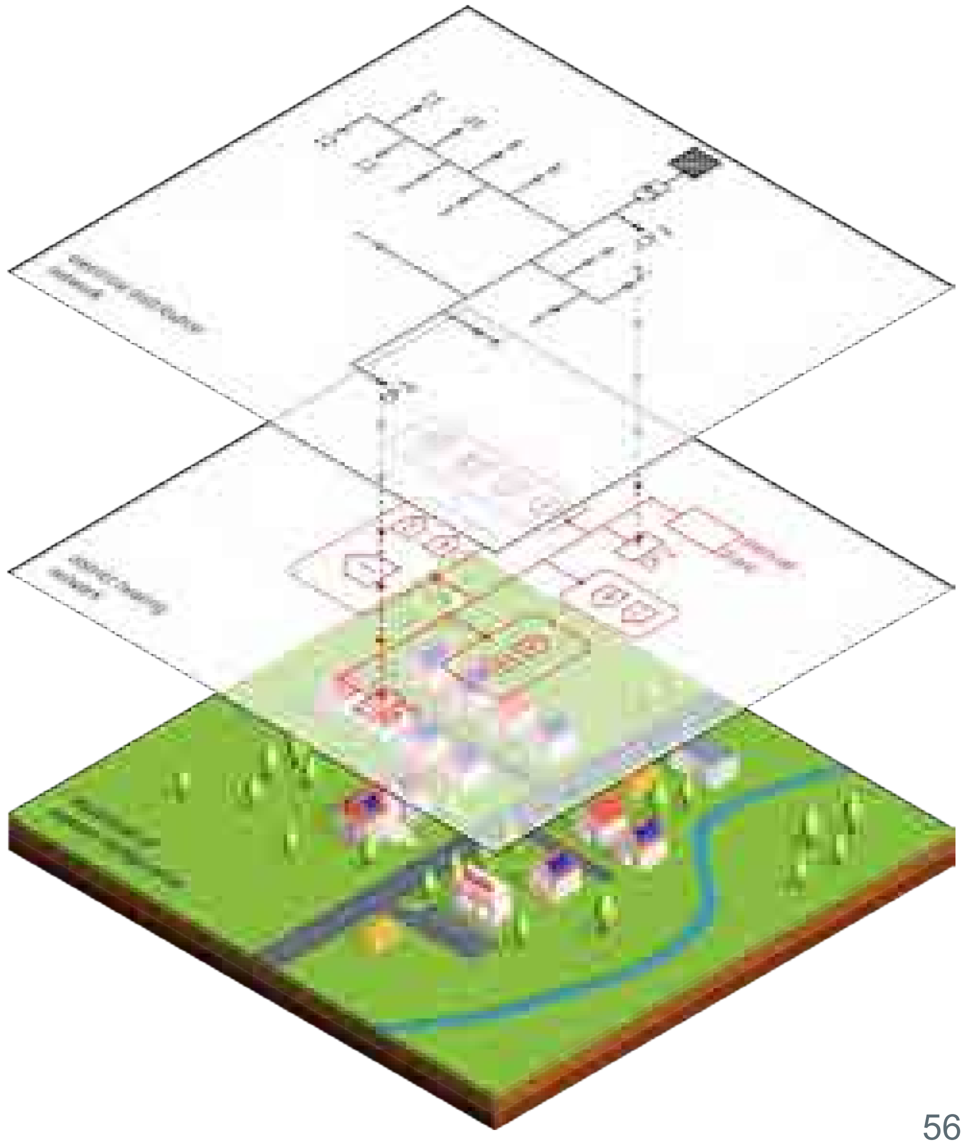
ASSESSMENT OF INTEGRATED MULTI-CARRIER DISTRIBUTION NETWORKS

Edmund Widl
AIT Austrian Institute of Technology

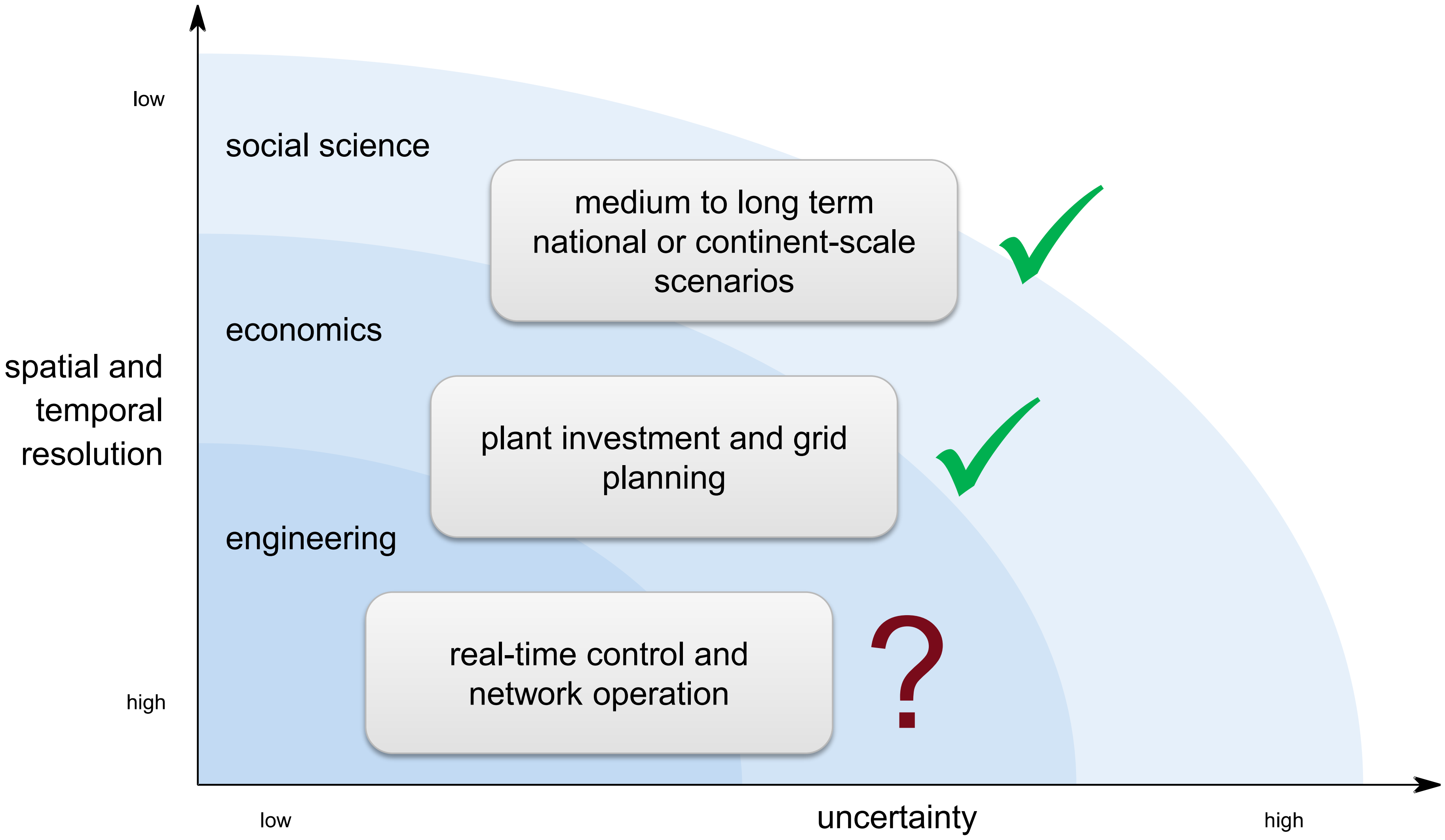
Webinar on “Hybrid Energy Networks” – Austria Goes International
23.04.2020

Integrated Multi-Carrier Distribution Networks

- Distribution grids are still largely separated today
  - electricity
  - heat
  - gas
- *Goal*: Exploitation of unused synergy potentials in the joint operation of distribution grids to increase efficiency and flexibility
- *Research projects*:
  - OrPHEuS (EU FP7)
  - IntegrCiTy (ERA-NET)
  - SmILES (EU H2020)
  - and many more …

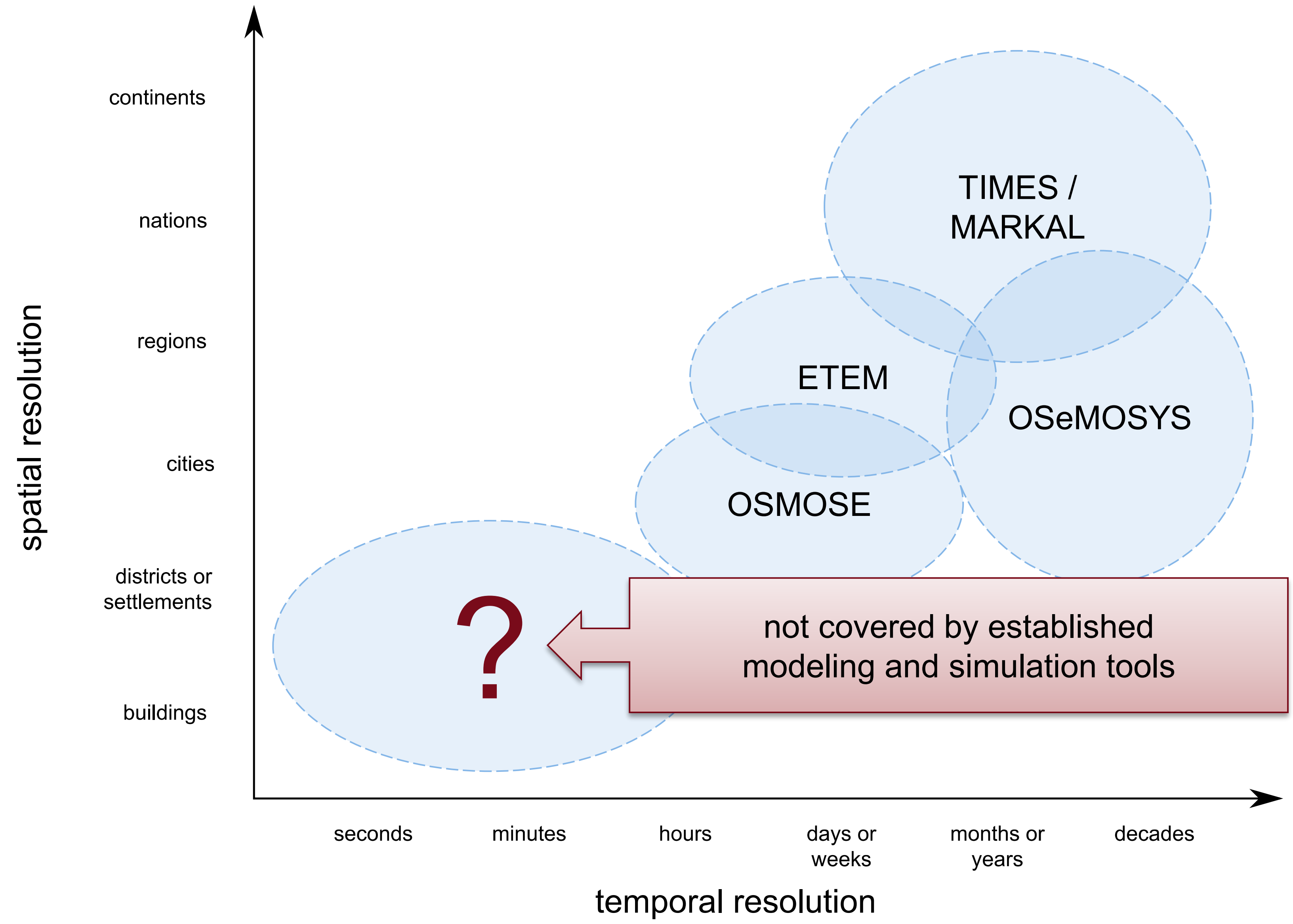


Assessment of Integrated Energy Systems: State of the Art

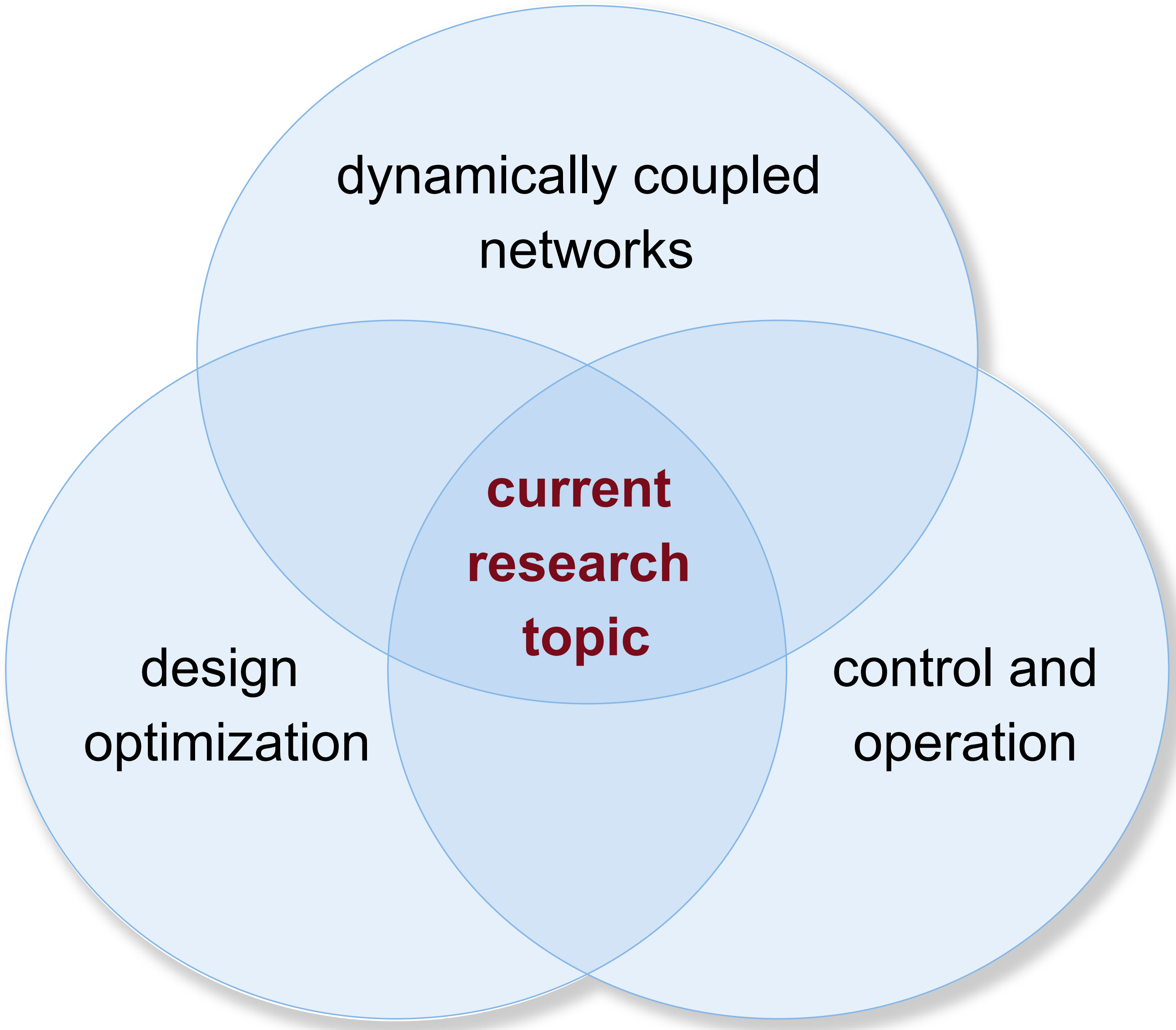


adapted from: S. Pfenninger, , A. Hawkes, J. Keirstead, “*Energy systems modeling for twenty-first century energy challenges*”, Renewable and Sustainable Energy Reviews, vol. 33, pp. 74–86, 2014

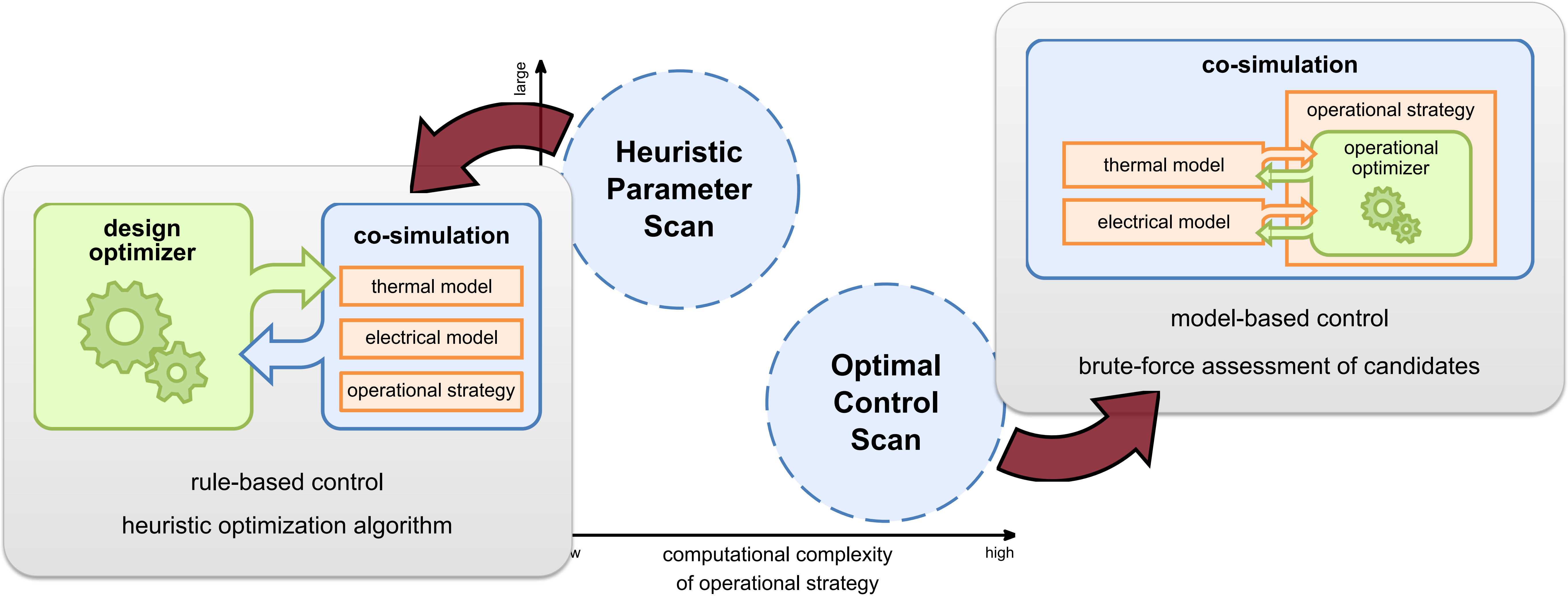
Modeling and Optimization Tools for Integrated Energy Systems



Combined Design and Control of Multi-Carrier Energy Networks

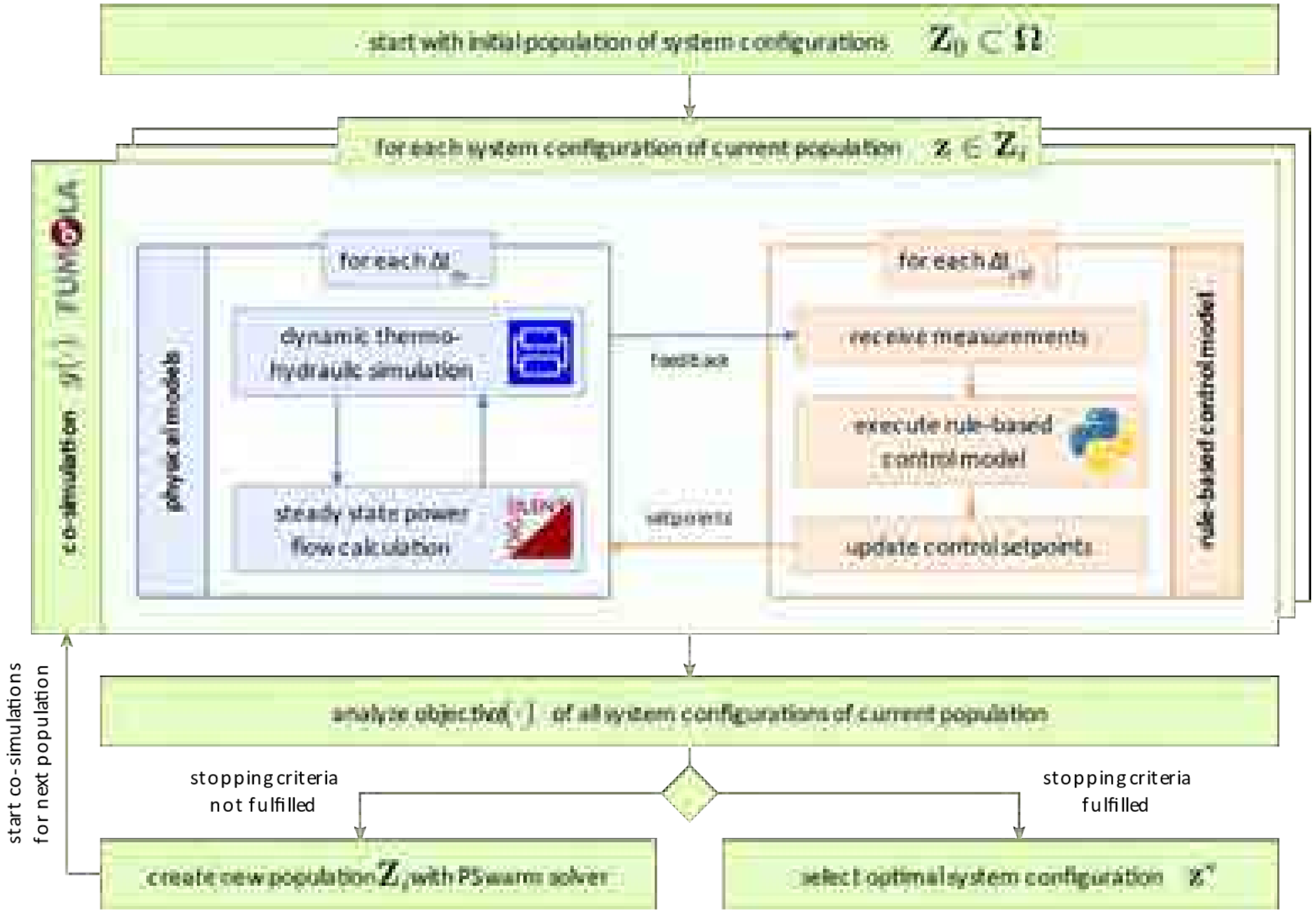


Combined Optimal Design and Control Using Co-Simulation



Adapted from: E. Widl, B. Leitner, D. Basciotti, S. Henein, T. Ferhatbegovic, R. Hofmann, *Combined Optimal Design and Control of Hybrid Thermal-Electrical Distribution Grids Using Co-Simulation*. Energies 2020, 13, 1945.

Example: Optimization and Co-Simulation Workflow and Toolchain



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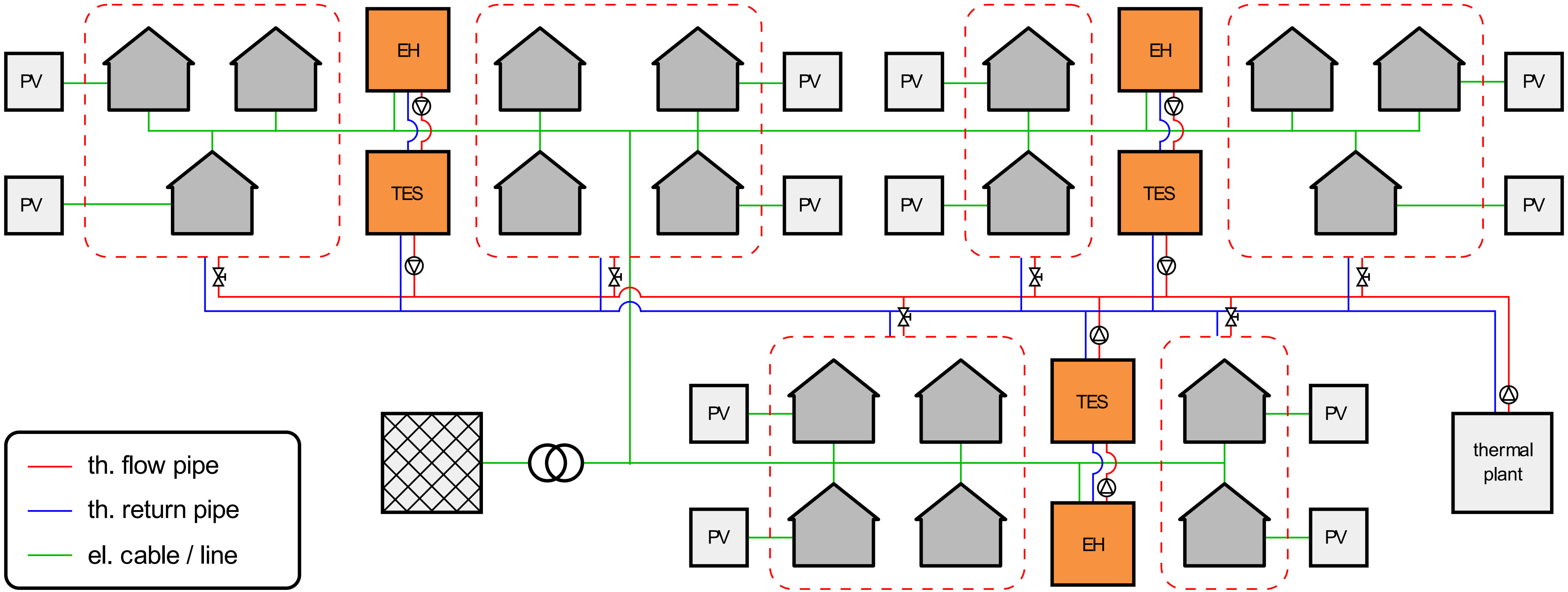
Example: Results from Detailed Technical Assessments



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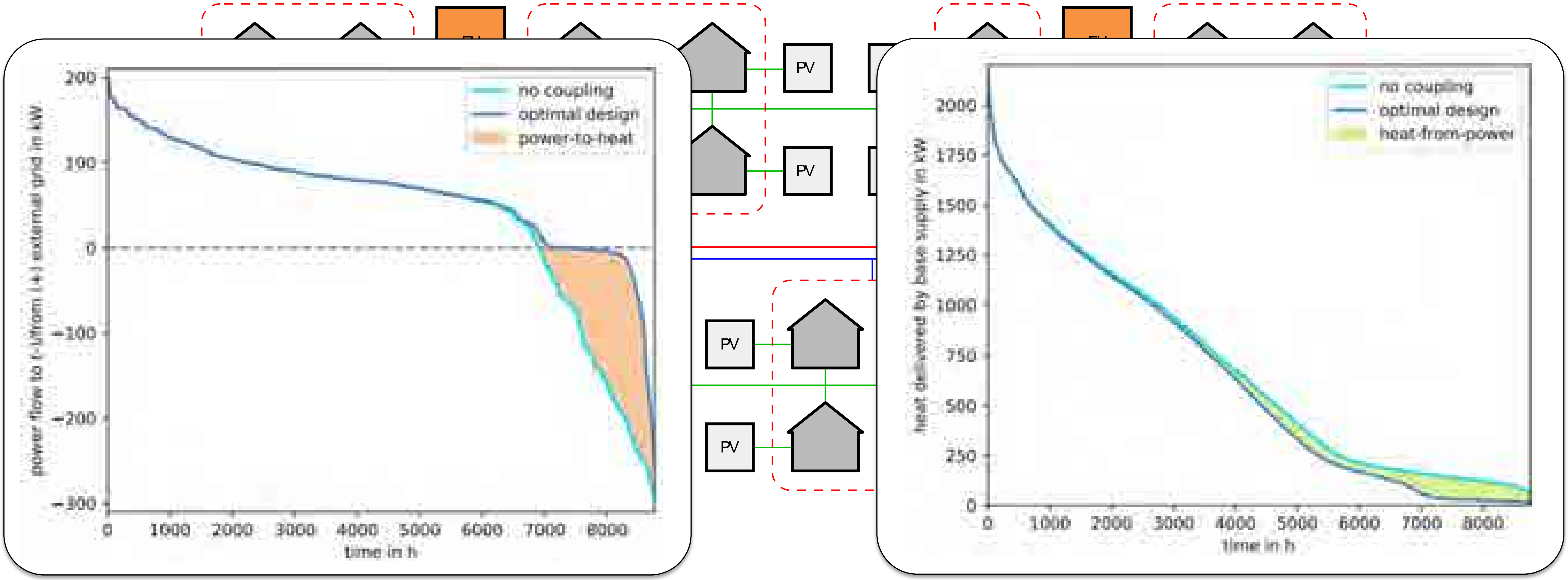
Example: Results from Detailed Technical Assessments



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Conclusions

- *technical assessments* of multi-carrier distributions systems are complex task
- *new methods and tools* for such technical assessments have been developed in recent years
- *approaches based on co-simulation* have become mature and can be used for *combined optimal design and control* of thermal-electrical distribution grids
- further reading:
  - E. Widl, B. Leitner, et al: *Combined Optimal Design and Control of Hybrid Thermal-Electrical Distribution Grids Using Co-Simulation*. Energies **13**, 1945 (2020).
  - B. Leitner, E. Widl, et al: *A method for technical assessment of power-to-heat use cases to couple local district heating and electrical distribution grids*. Energy **182**, 729–738 (2019)

EnRSim: a simple tool for designing and assessing renewable production strategies

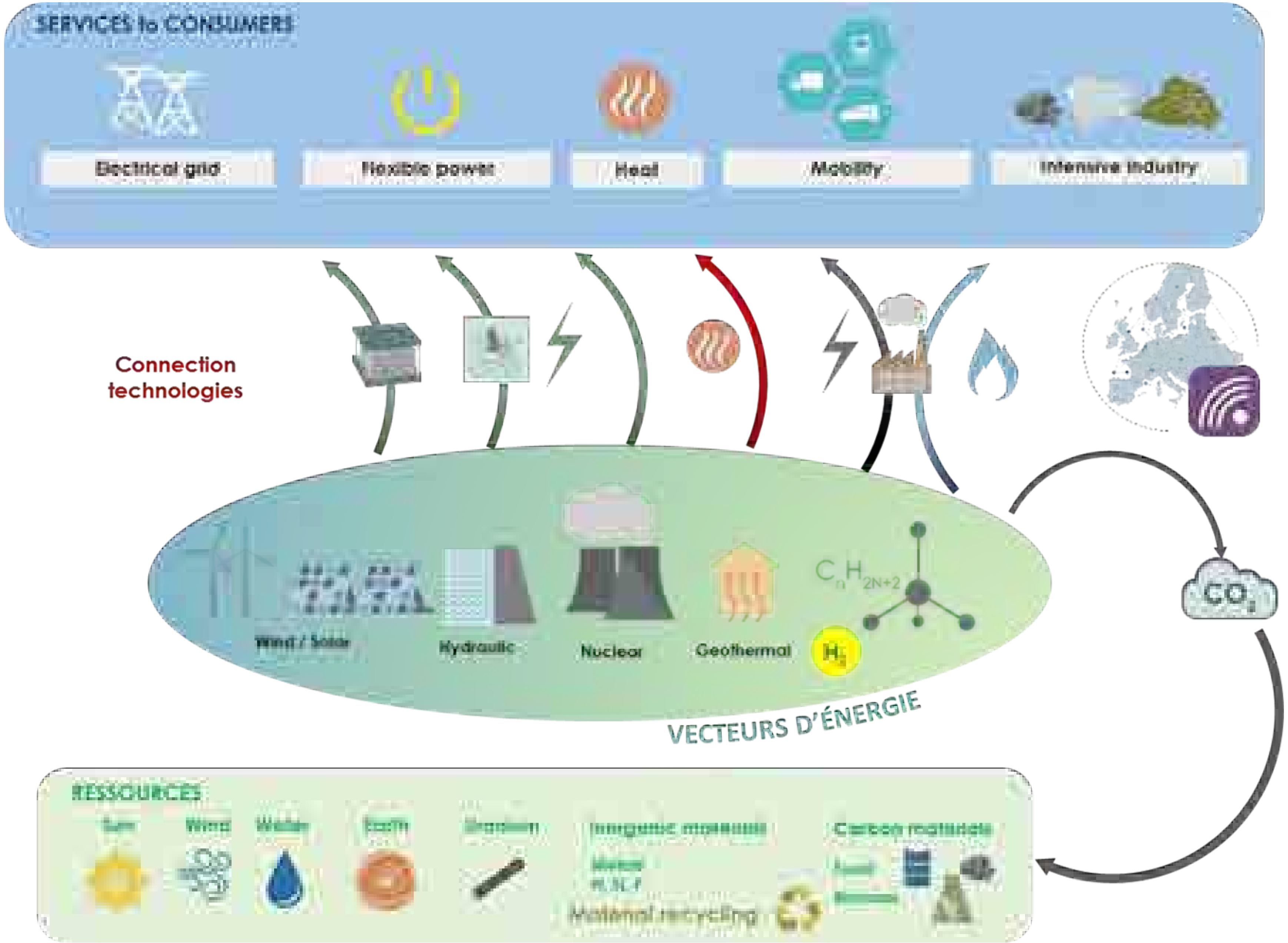
(Nicolas Vasset, CEA)

EnRSim: a simple tool for designing and assessing renewable production strategies

Dr Nicolas Vasset

French Alternative Energies and Atomic Energy Commission- www.cea.fr/english

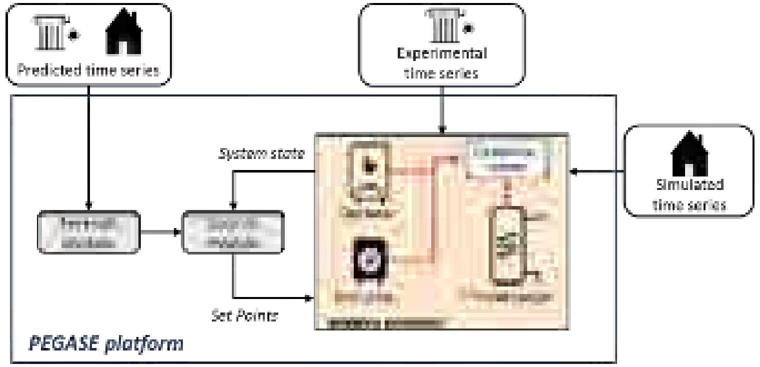
- **Multi-vectors (electricity, heat, gas, hydrogen)**
- **Combined mobility and energy management**
- **Interconnected networks, multi-scale, decentralized**
- **Intelligent (instrumentation, digitalised, monitoring)**
- **Economic model**



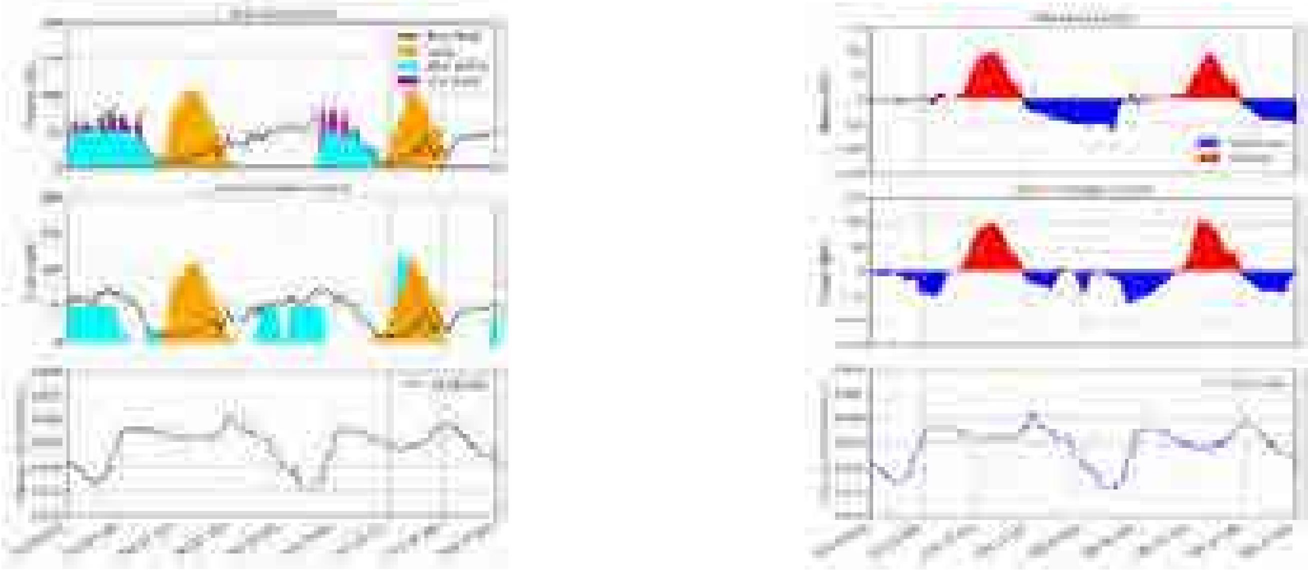
POWER-TO-HEAT : DISTRICT HEAT AND COOLING FOR THE FLEXIBILITY OF ELECTRICAL NETWORKS

THE OBJECTIVES:

- Optimisation of **excess electricity** by conversion to heat
- More **flexibility to grid** using low cost thermal storage
- **Efficient energy conversion** using thermodynamic machines
- **Combined heat and cold** production with dual heat pump



Combined electricity and heat optimisation



Test of advanced control strategies

CONTEXT OF ENRSIM DEVELOPMENT

DHN can massively distribute Renewable Energy (Biomass, Geothermal, Solar)

↓

Expected considerable development of DHN in the coming years

↓

Improve the sizing of the renewable production units in accordance to the other production units

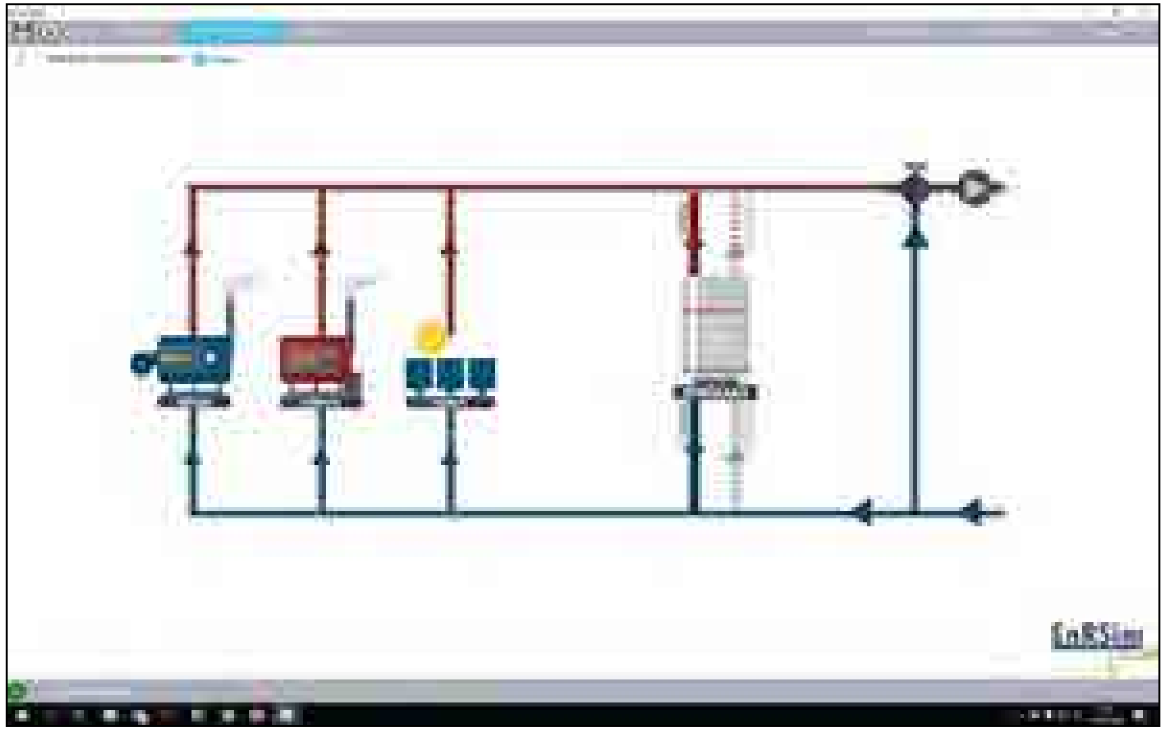
↓

Simplified Tool accessible by engineering offices
→ **business oriented and easy-to-use**

→ EnRSim

GENERAL OVERVIEW

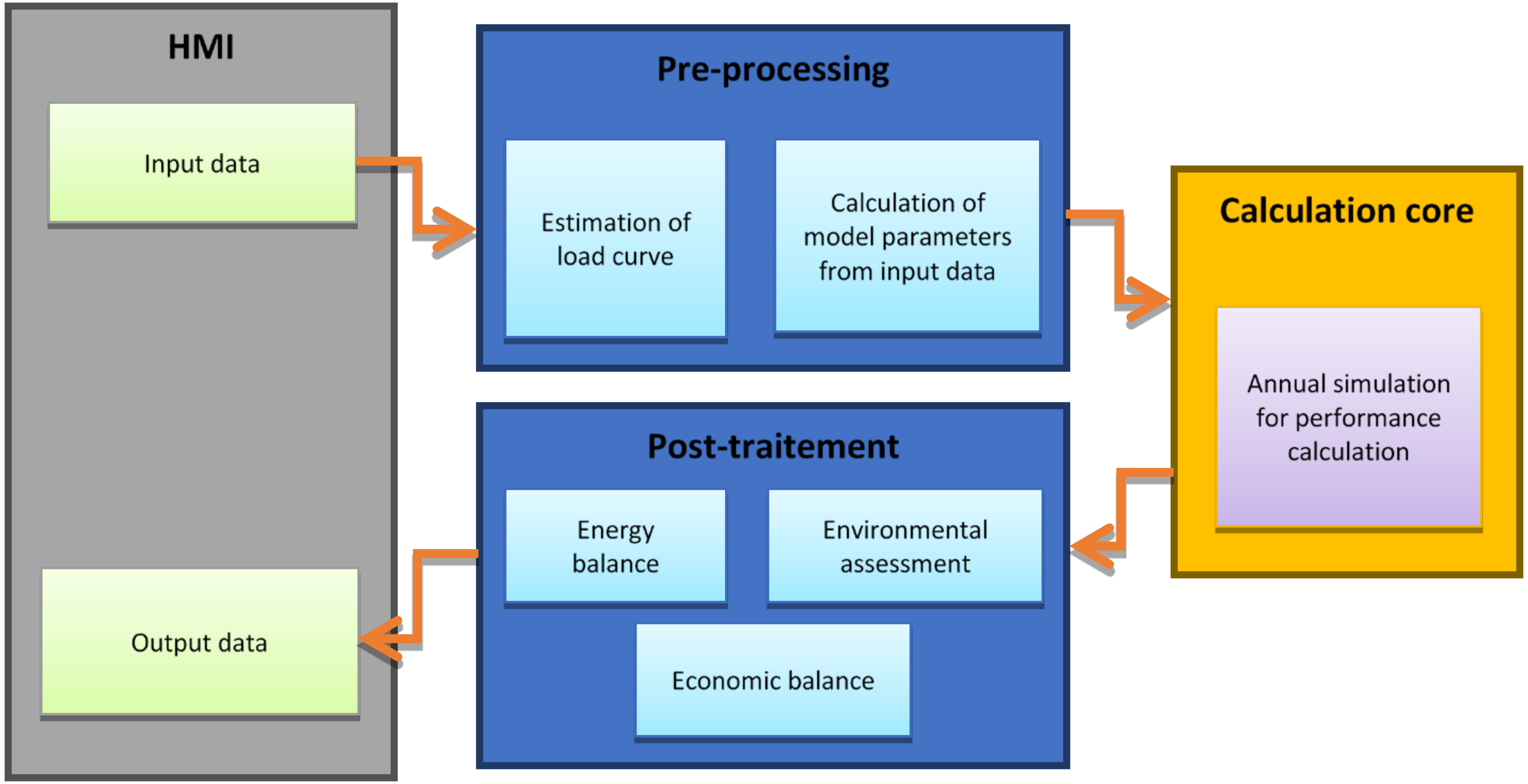
Development of a free simplified calculation tool for renewable energy based production plants of heating network with a focus on solar thermal.



- **Simulated Technologies**
  - Solar Thermal
  - Biomass Boiler
  - Gas Boiler
  - CHP
  - Heat Pumps
  - Daily Heat Storage

- **Obtained Results**
  - Energetic Indicators: Production per unit, …
  - Environmental Indicators: CO2 content, REN ratio, …
  - Economic Indicators: LCOE, …
  - Operational Indicators: Number of startups, overheating alerts, …

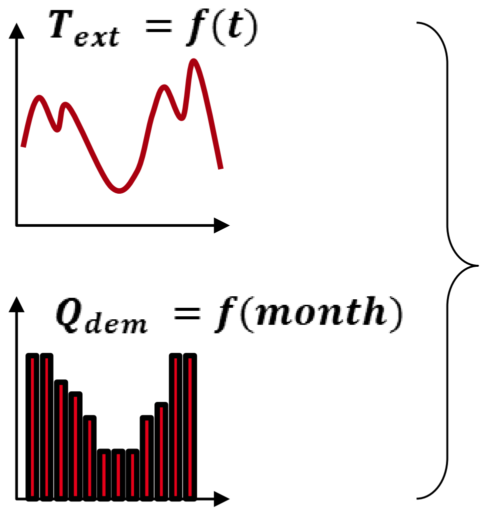
OVERALL TOOL ARCHITECTURE

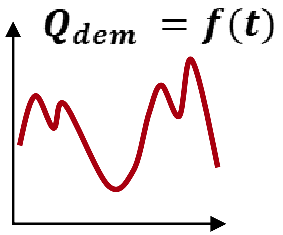


- *1h time step*
- *Yearly Simulation*
- *About 1min calculation time*

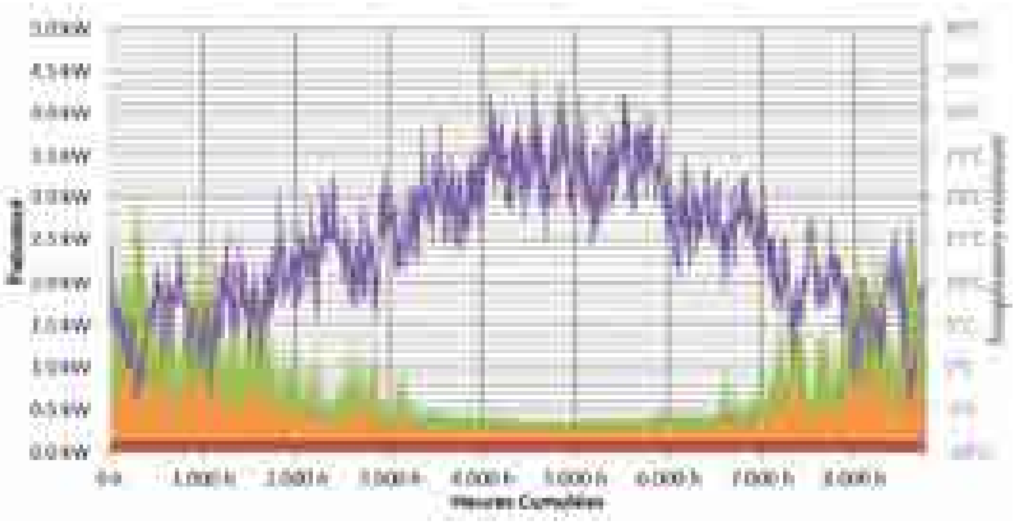
PRE-PROCESSING MODULES

1 - Load Curve

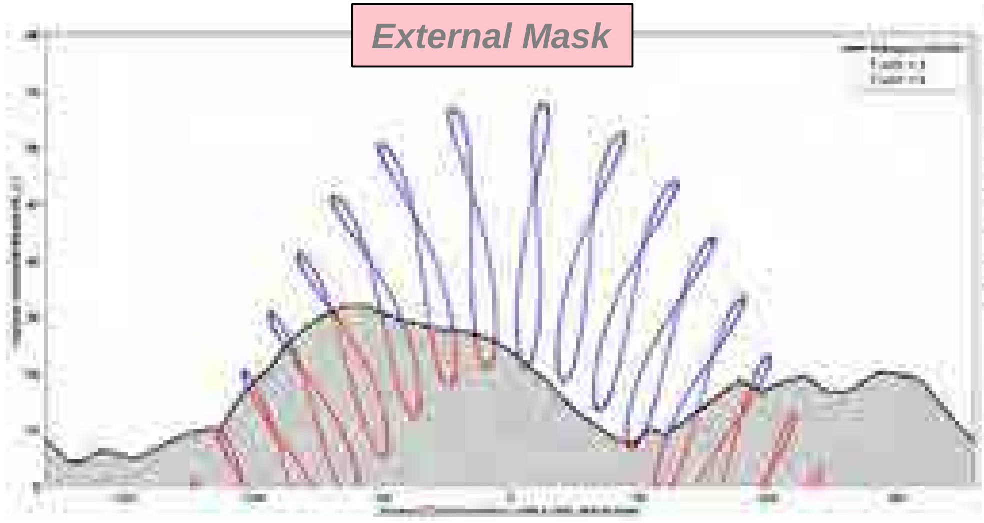


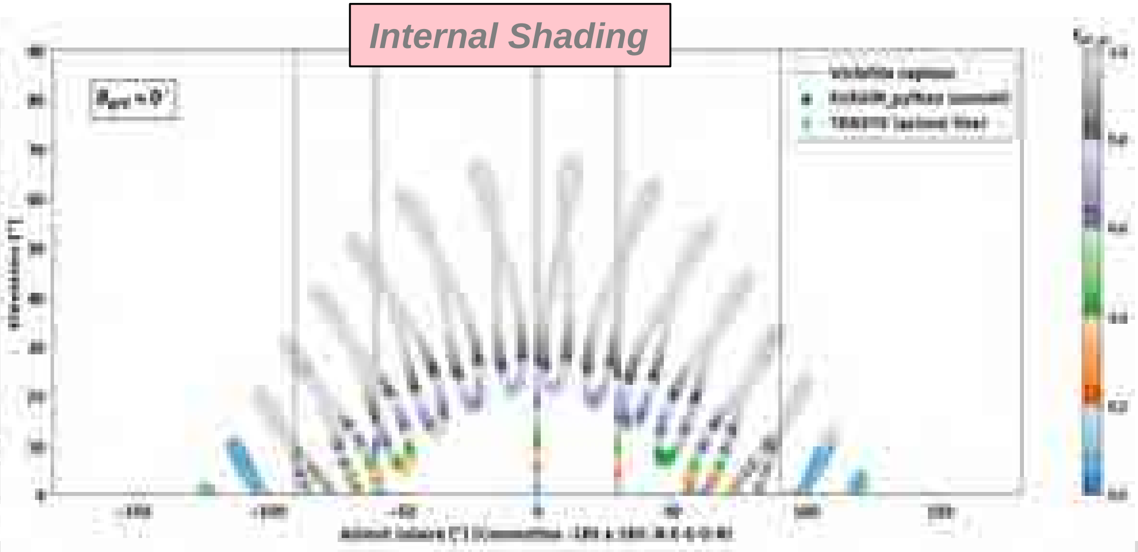


Space Heating
Domestic Hot Water
Network loss



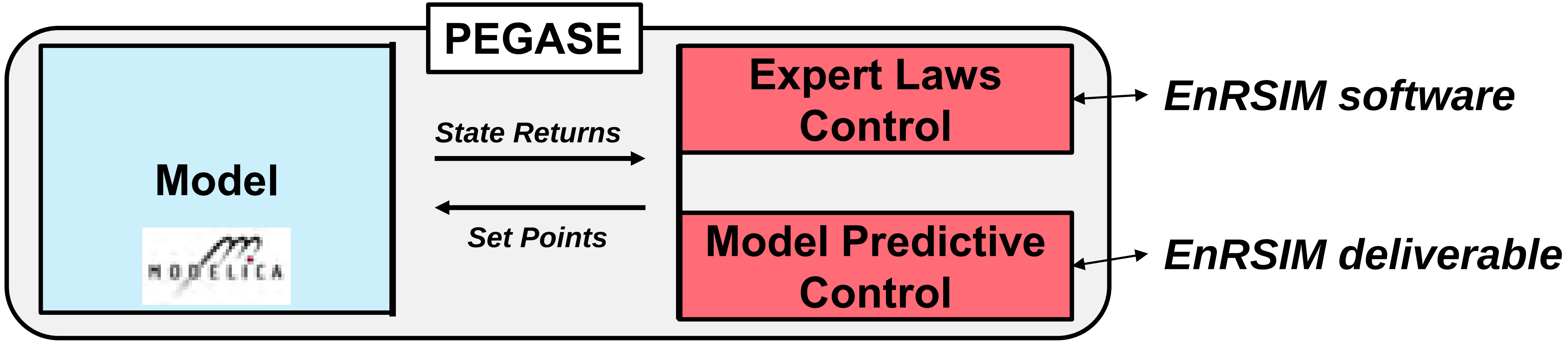
2 - Solar Masks

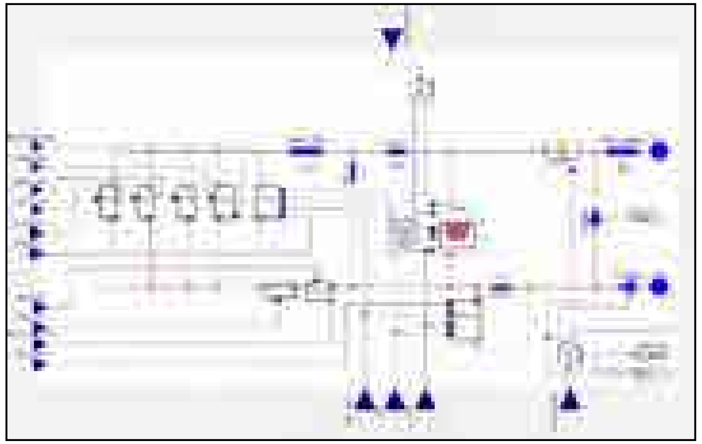


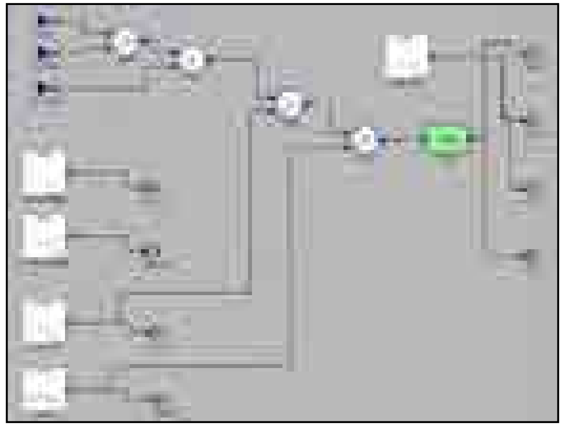


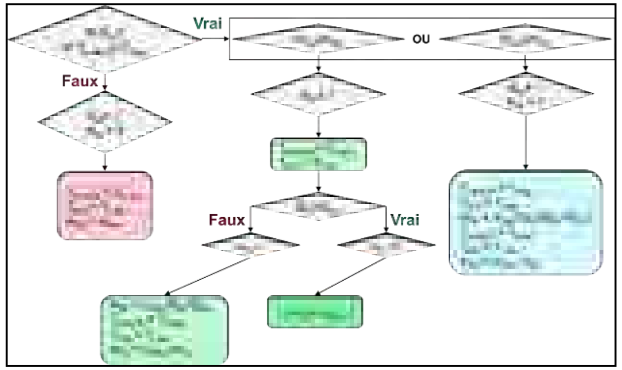
CALCULATION CORE

- Dynamic numerical simulator
- Embedded in a FMU
- Control performed in CoSimulation
  Using proprietary software PEGASE

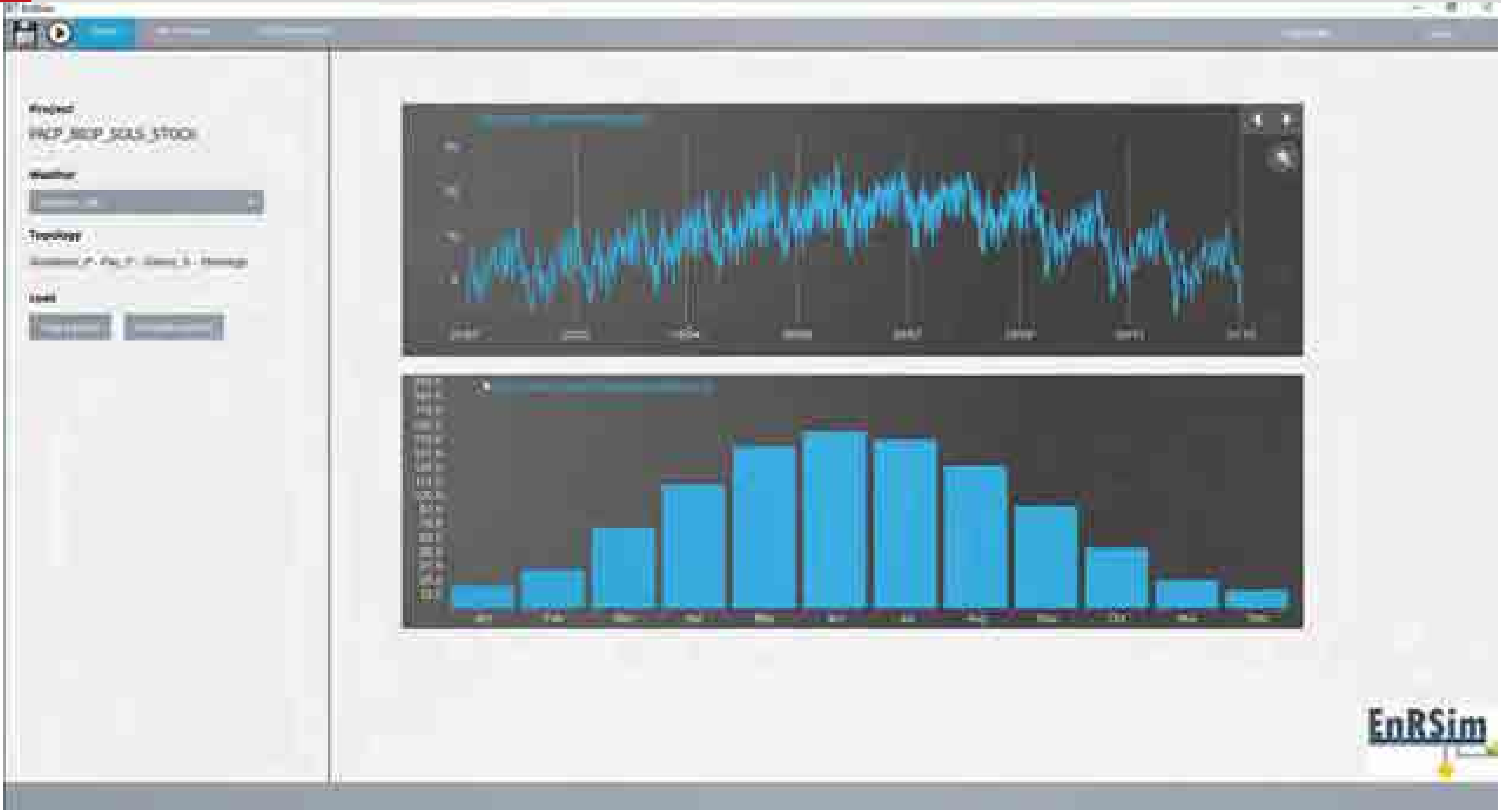








SOME VISUALS ON THE TOOL



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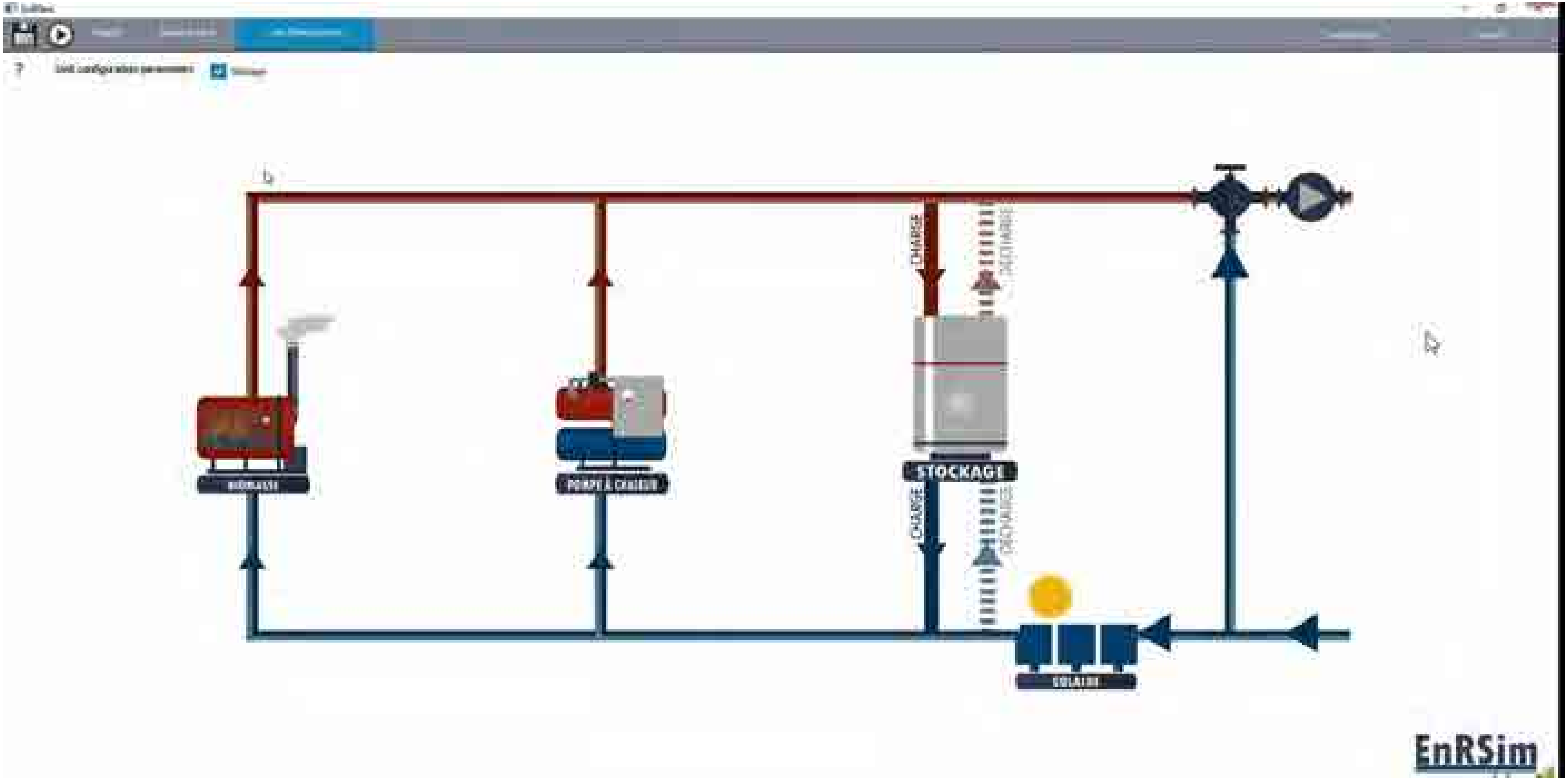


SOME VISUALS ON THE TOOL

CONCLUSIONS

- **A tool that integrates:**
  - Modelica simulation models (DistrictHeating) encapsulated with FMU protocol
  - A control module (C++ library)
  - Pre and Post processing modules (Python libraries)
  - A user friendly GUI

- **A tool to calculate energetic mix on pre-feasibility study**
  - different solar system for DHN : centralized, with/without storage,…
  - different energy sources

- **Further Objectives:**

Demonstrate the interest of MPC control in simplified calculation tool
→ Optimize the design of the system and thus reduce the investment cost

ADEME
Agence de l'Environnement et de la Maîtrise de l'Énergie

- **V1 in French and English in Beta-Testing phase**
- **Will be distributed as executable on *ines-solaire.org (June 2020)***

End of Block I – thank you for your attention!

Block II will start at 13:00 CET

Webinar on "Hybrid Energy Networks" - Austria Goes International - Block II

This Webinar is held in the framework of the international cooperation program IEA DHC Annex TS3 "Hybrid Energy Networks". /

23rd April 2020

Ralf-Roman Schmidt AIT, Austria,

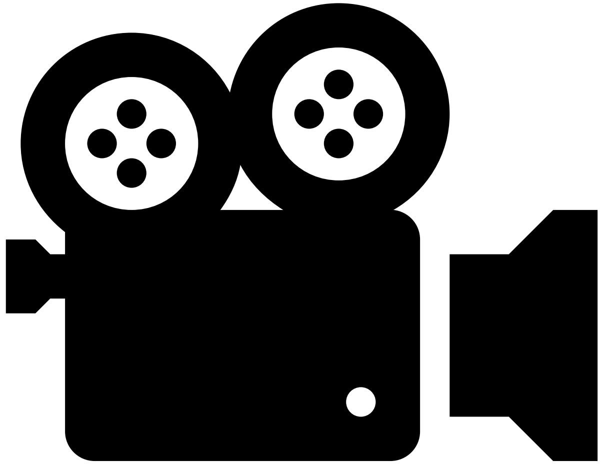
Contact: ralf-roman.schmidt@ait.ac.at

More information at

https://www.iea-dhc.org/the-research/annexes/2017-2021-annex-ts3-draft.html

AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY

This webinar is recorded



The video file will be available after the webinar on YouTube, together with the presentations

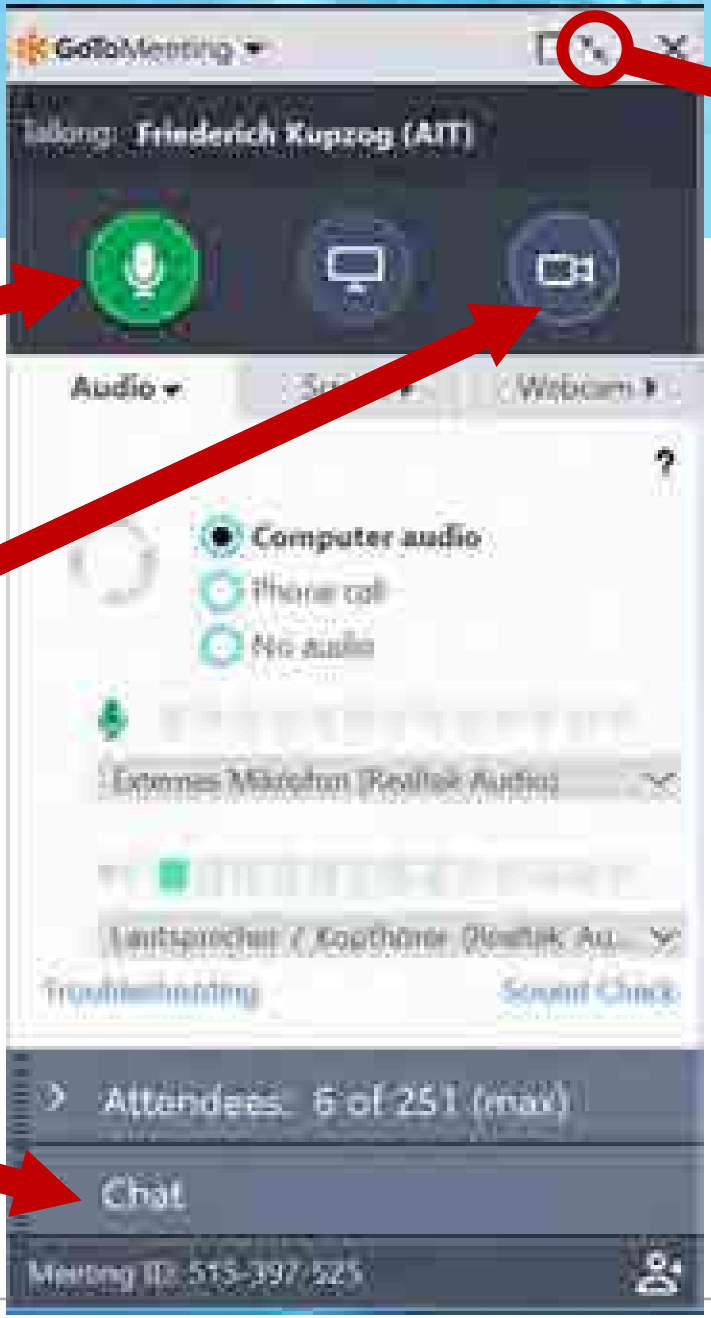
We will have a “group photo” at the end of the webinar, so please be prepared to turn on your webcam (participation voluntarily)

GoToMeeting – instructions

Mute yourself

Turn off camera

Open chat window



Minimize panel

Webinar Etiquette

- **The microphone should be muted by default**
  - They should only be switched on if you are speaking.
- **Only one person speaks at a time**.
  - Requests to speak are reported via chat ("**rts**"),
  - the moderator will ask then the speakers to speak.
  - Please state your name and institution before you speak
- **Please turn off your webcam**!
  - No general video transmission in order to reduce the bandwidth.
  - The camera can be used at short notice for spoken contributions.
  - We will make a “group-photo” at the end of each block
- **Caution with humor and sarcasm!**
  - much of the original effect between the lines can be lost

Agenda Block II

12:30	*Testing of technical connections*
13:00	**A modular energy management system for the optimal operation of cross-sectoral energy systems** *(Daniel Muschick, BEST)*
	Innovative Cogeneration and Trigeneration concepts using LiBr absorption machines for heating and cooling *(Harald Blazek, Stepsahead)*
	Heating and cooling strategies and 2050 scenarios for Austria, results of the Heat Roadmap Europe project *(Peter Sorknæs, Aalborg University)*
	Decarbonising the austrian space heating sector: a transition scenario for 2050 *(Lukas Kranzl, TU Wien)*
14:00	**An analysis of strengths, weaknesses, opportunities and threats of DHC networks within an integrated energy system** (*Ralf-Roman Schmidt, AIT)*
	online voting and open discussion round
14:30	*End of Block II*

Live voting
→ at the end of Block II

Join at
slido.com
#40284

Please already prepare

the following questions:

1. What are **key elements** of "hybrid energy networks" from your point of view?
2. What are the most important **strength (S) and opportunities (O)** / **weaknesses (W) and threats (T)** of Hybrid Energy Networks from your point of view?
3. What would be the **most important measures** (policy, regulation, market, awareness, training, technology/ tools …) for **improving and accelerating the implementation** of Hybrid Energy Networks?

A modular energy management system for the optimal operation of cross-sectoral energy systems

(Daniel Muschick, BEST)

A modular Energy Management System for the optimal operation of cross-sectoral energy systems

IEA DHC Annex TS3 industry Workshop

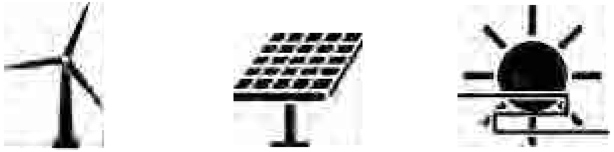
GotoMeeting, 23rd of April, 2020

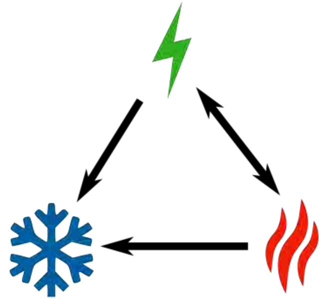
Daniel Muschick, Valentin Kaisermayer, Andreas Moser, Markus Gölles

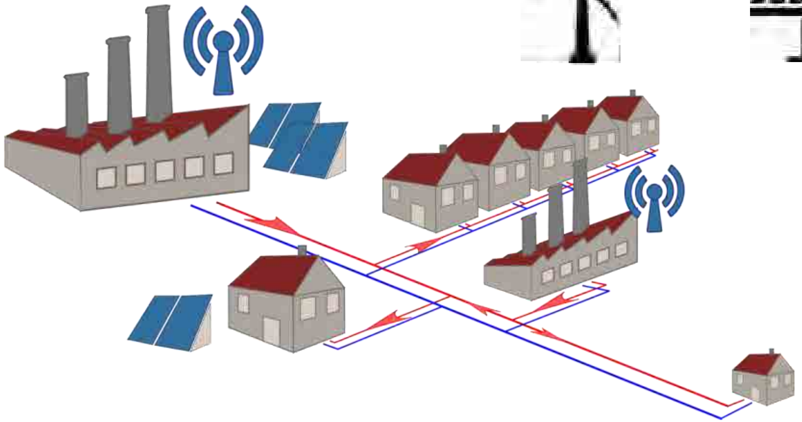
Motivation for Optimization

Growing complexity of **integration in networks** (variable tariffs, energy market)

Integration of **renewable**, but **volatile** energy sources





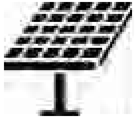


Increased **coupling** between sectors

Need to ensure **economical** and **ecological** energy supply

Motivation for Predictive Control Strategies

- We need a **forecast** of the yield from renewable sources, of the energy demand and tariffs…

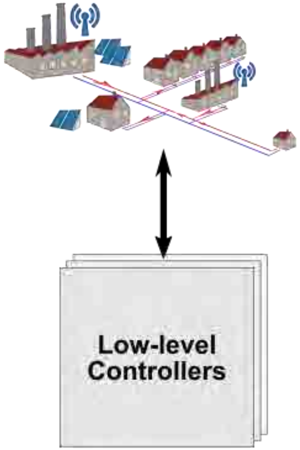


- … for an effective **buffer & battery management** …

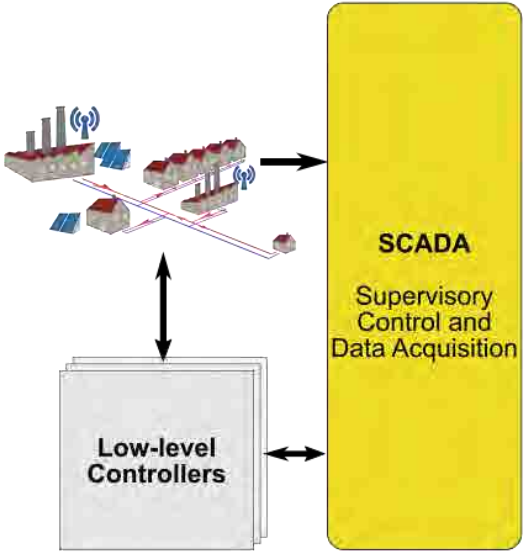
- … for a participation in **energy markets** …
- … and a cost-efficient **unit commitment** of the producers

→ **We need a predictive control strategy**

Steps Towards Optimal Operation



Steps Towards Optimal Operation



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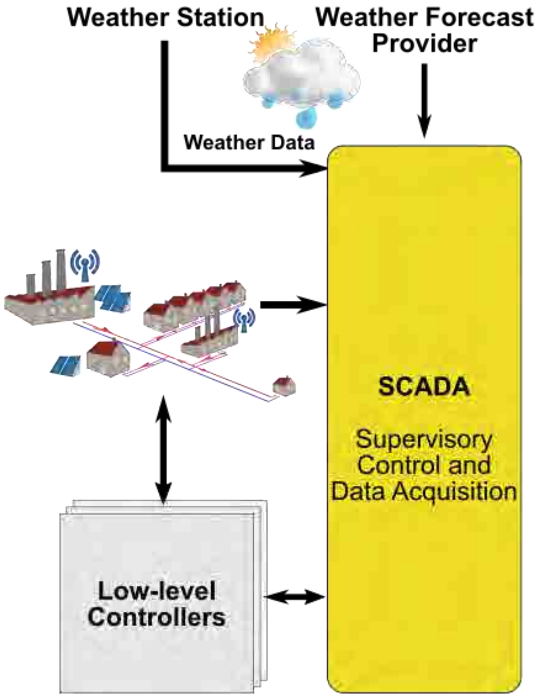

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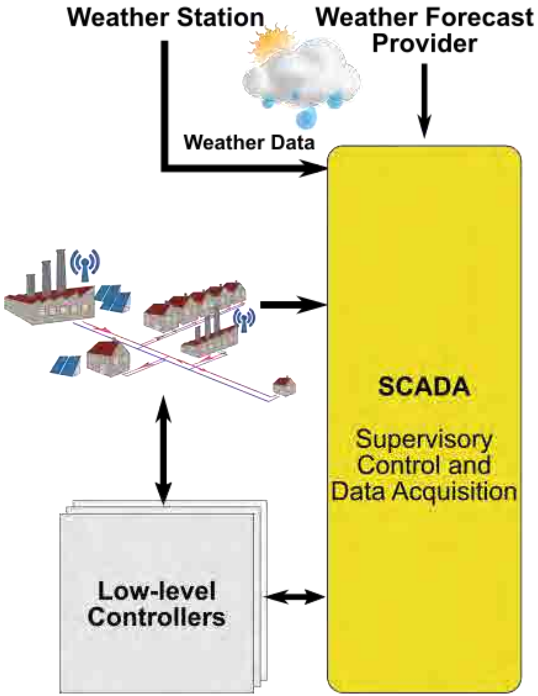
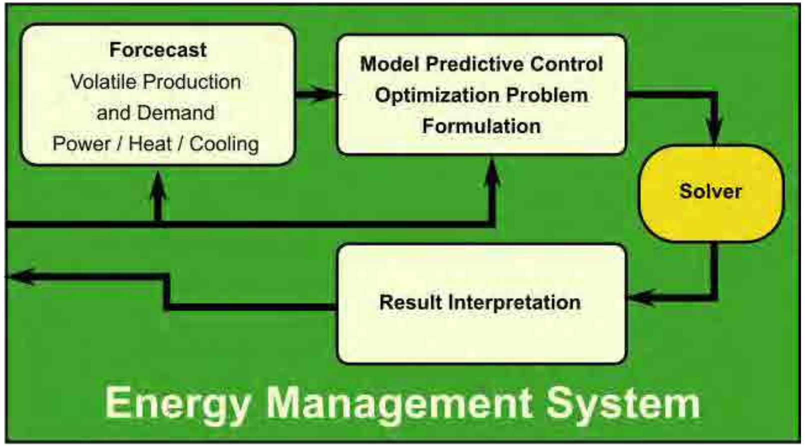
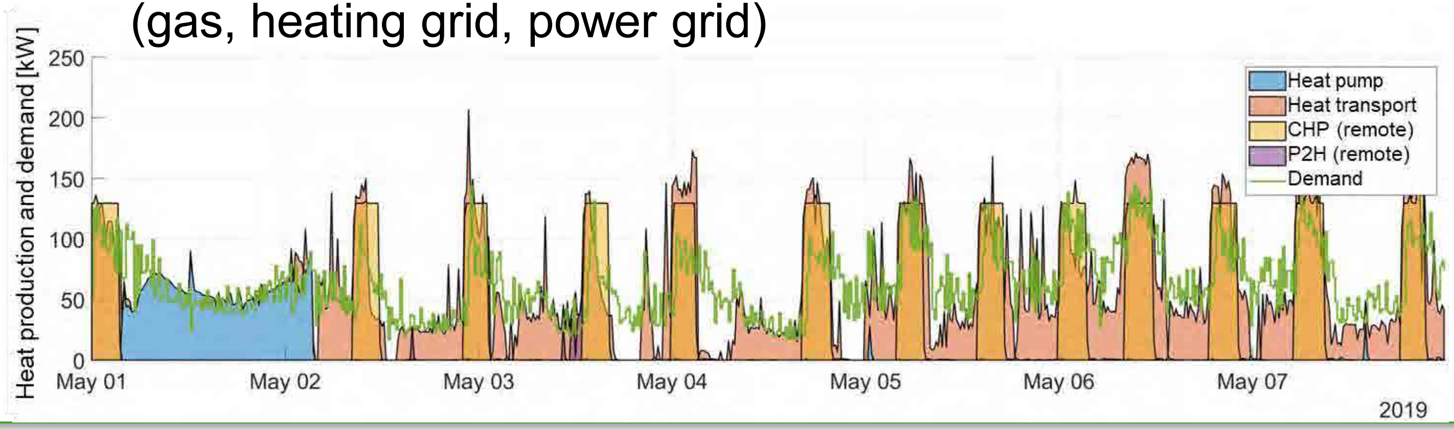




Steps Towards Optimal Operation

- **The EMS delivers an Operating Strategy**
  - Unit dispatch (on/off), set points
  - Charging / discharging of (thermal) storages and batteries
  - Selling / purchasing energy from networks (gas, heating grid, power grid)



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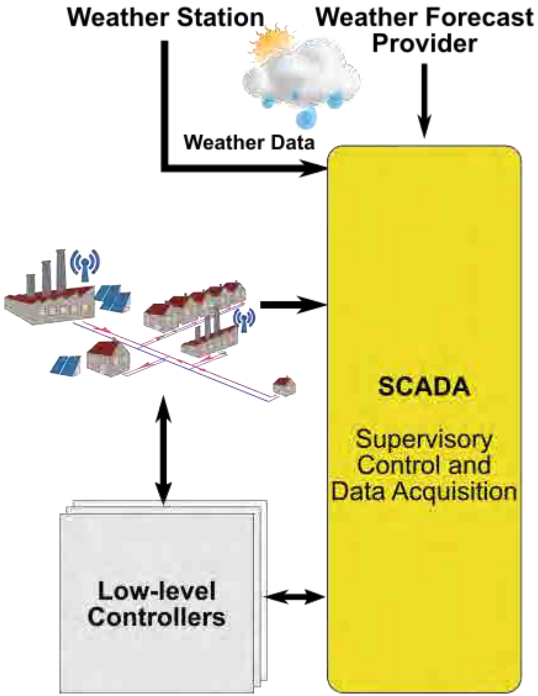

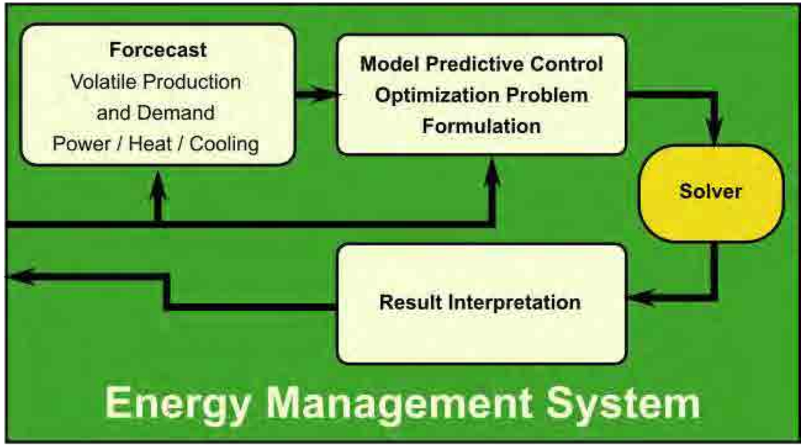

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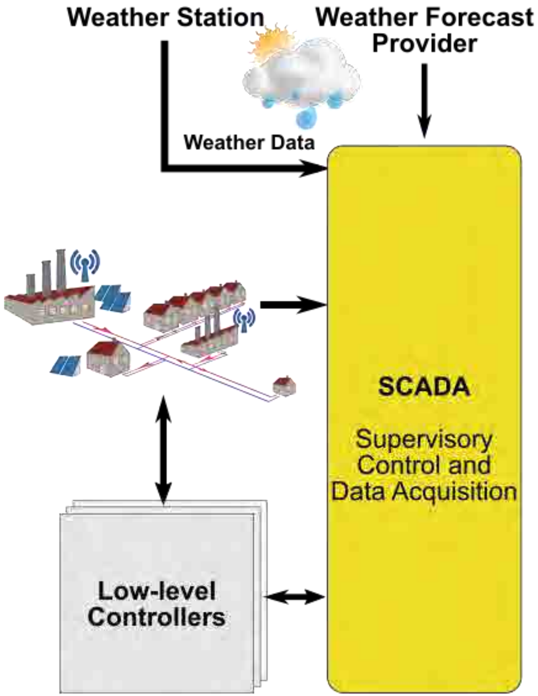
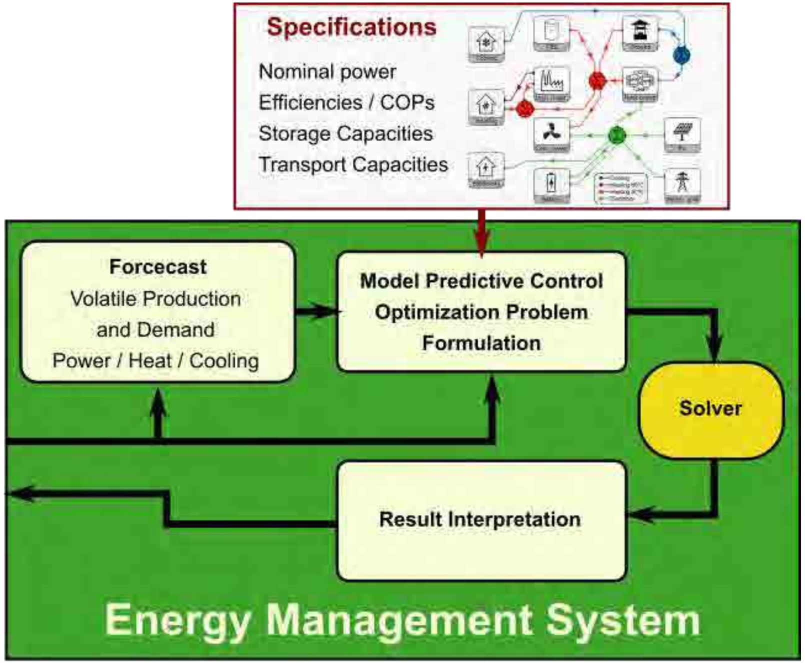
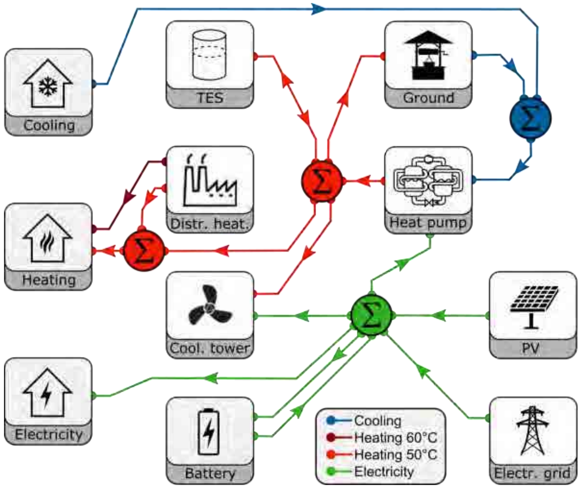
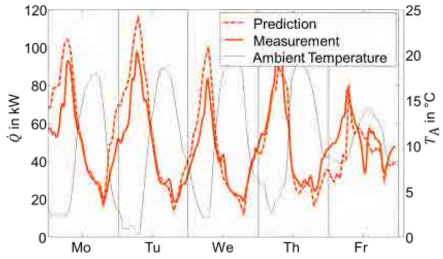




Steps Towards Optimal Operation

- **The operating strategy is** **derived automatically** **from a given configuration**
  - Simply connect **standard building blocks** for typical technologies (gas boiler, CHP, thermal storage , …)
  - **Load and yield profiles are estimated automatically** by self-learning algorithms based on measurement data and weather forecasts





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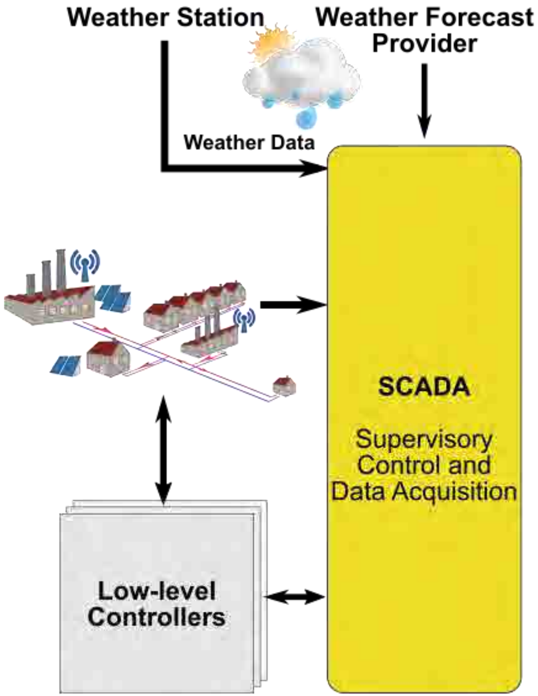

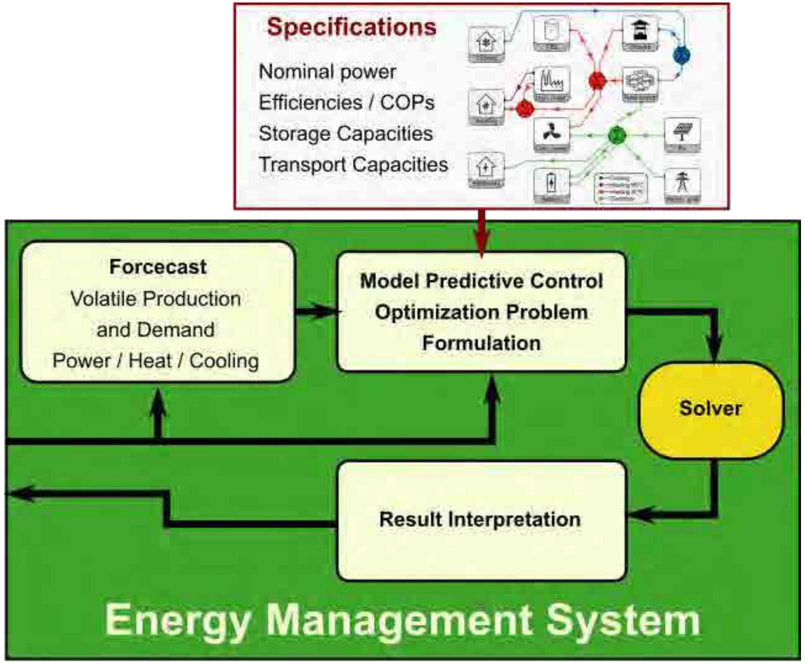

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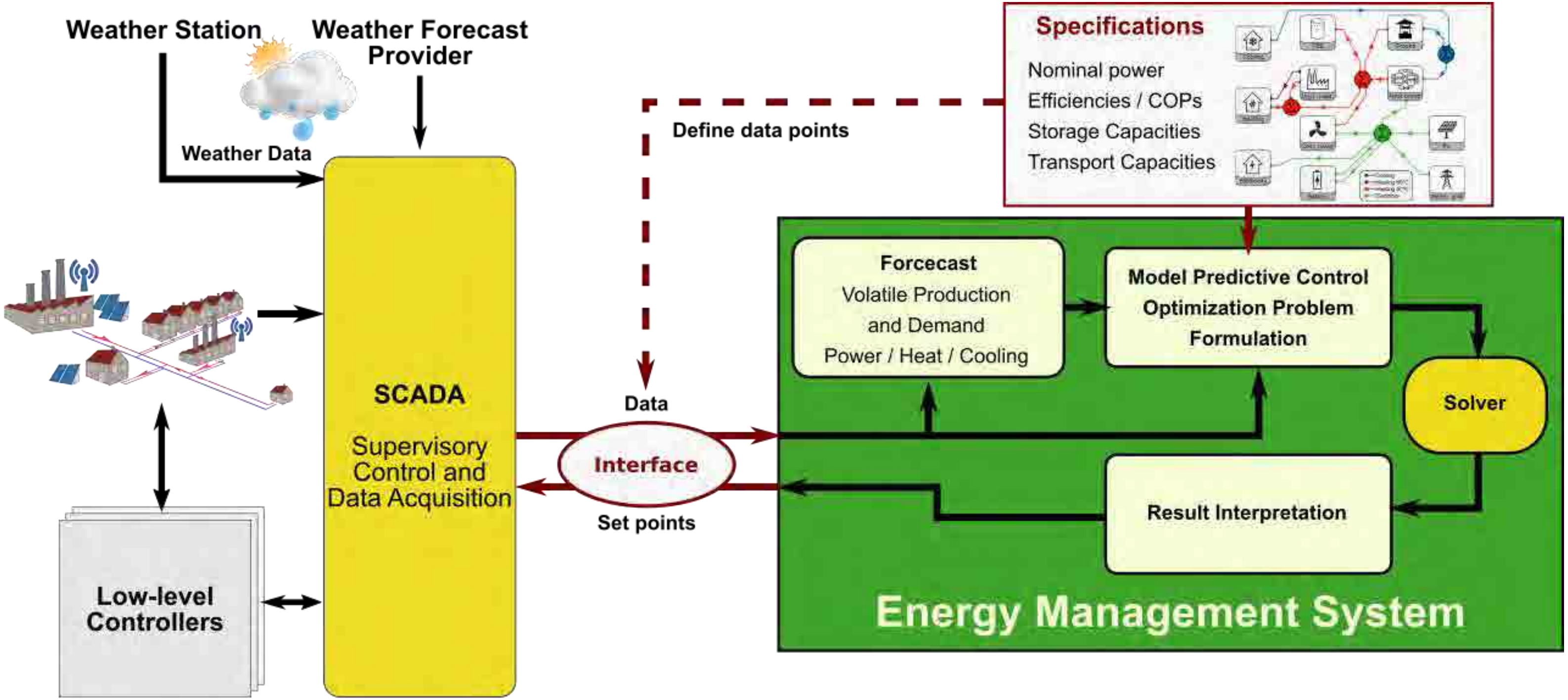

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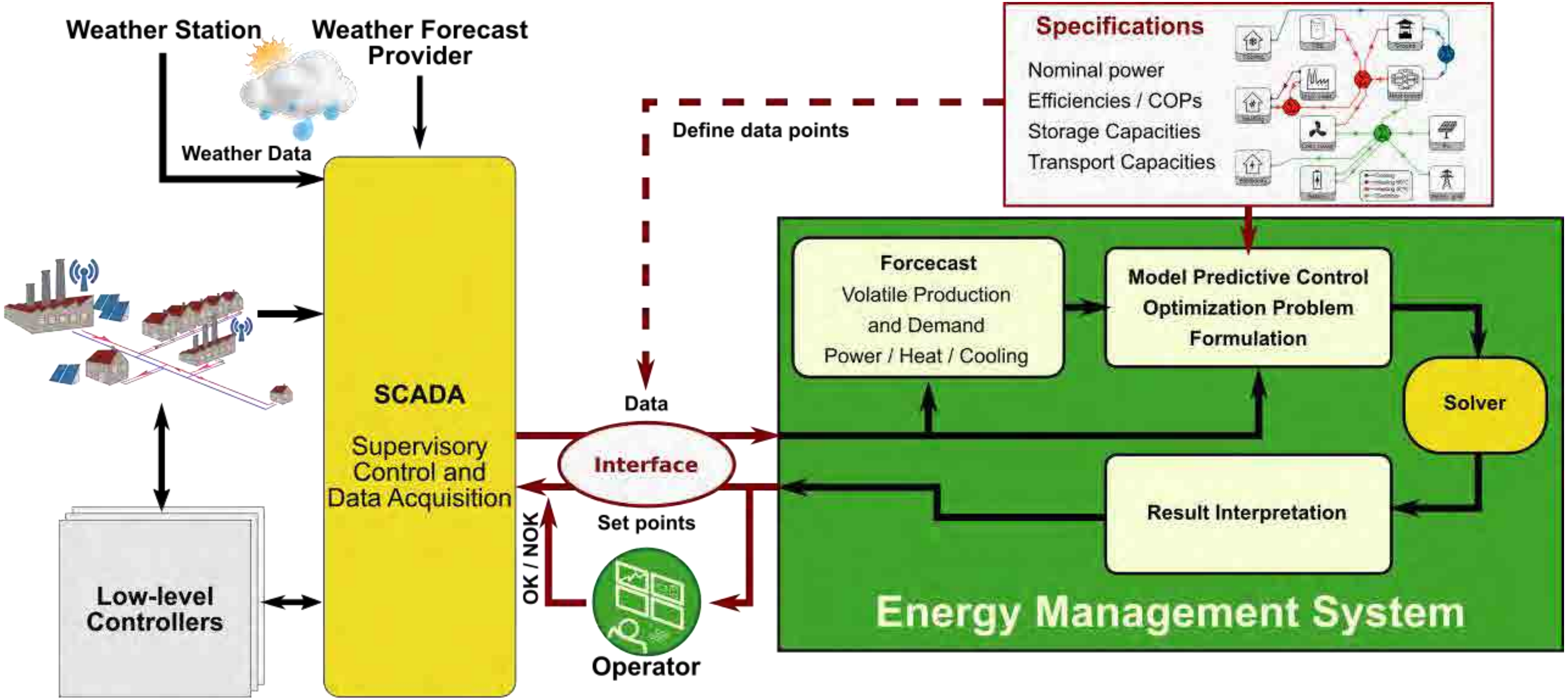

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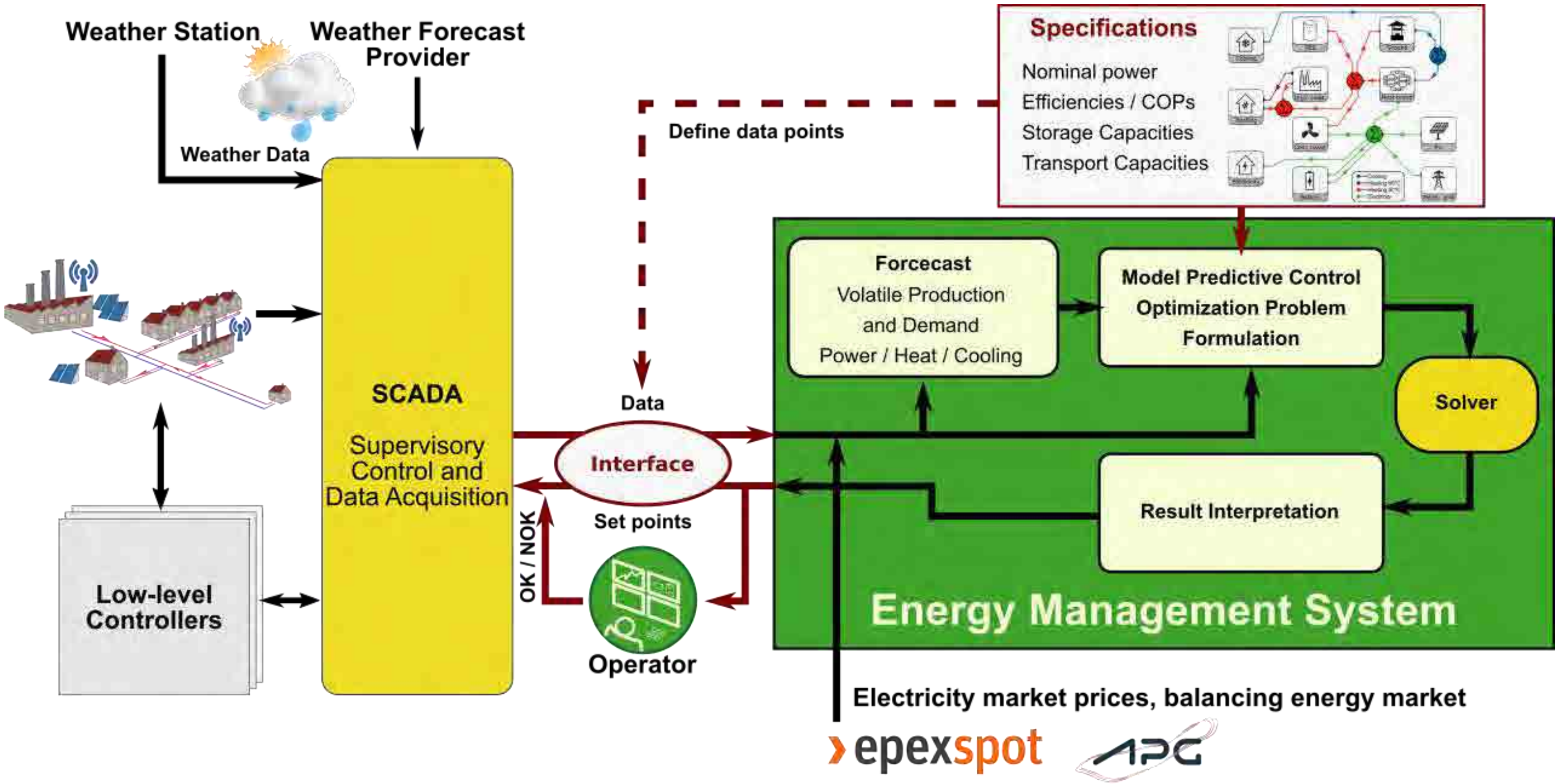

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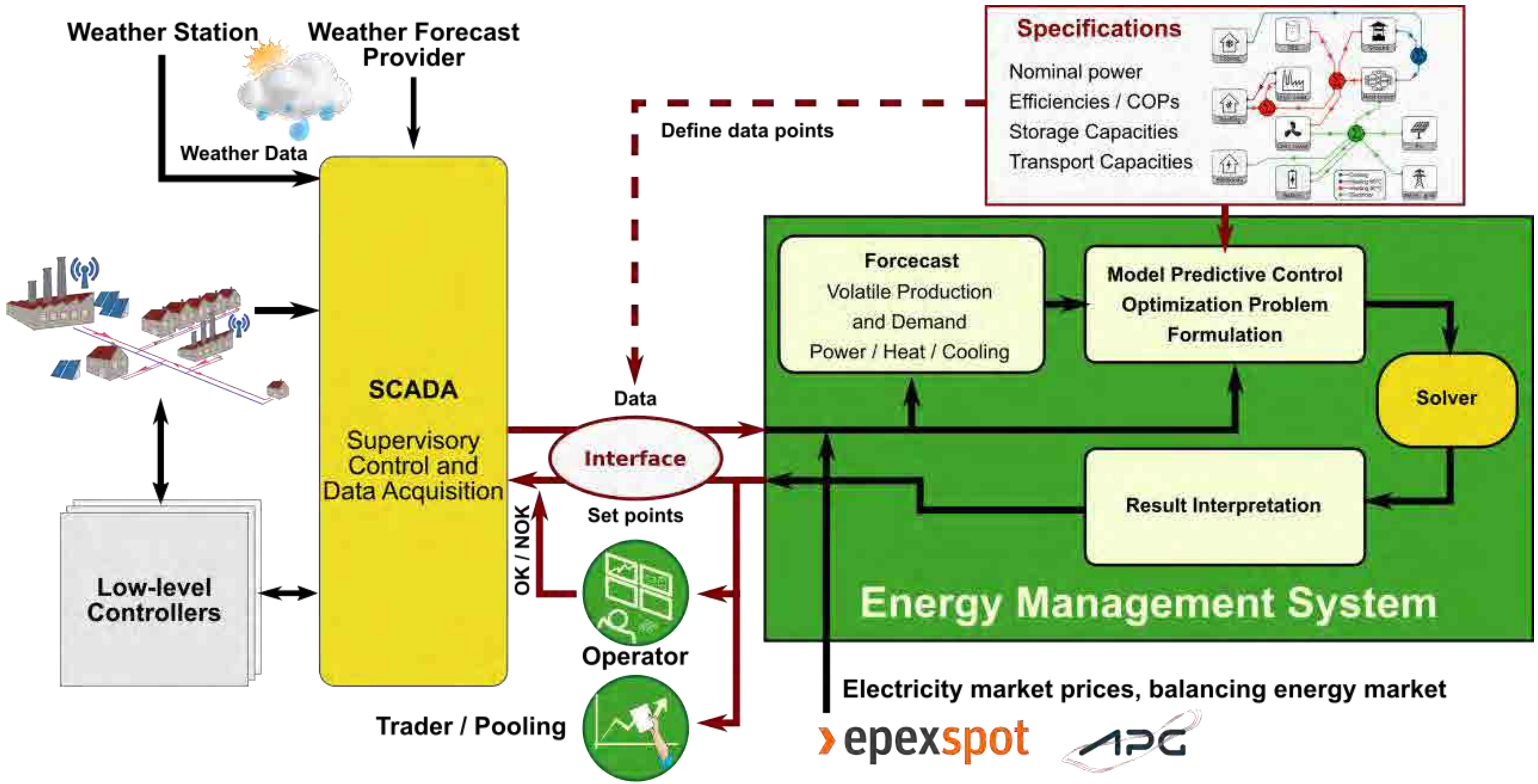
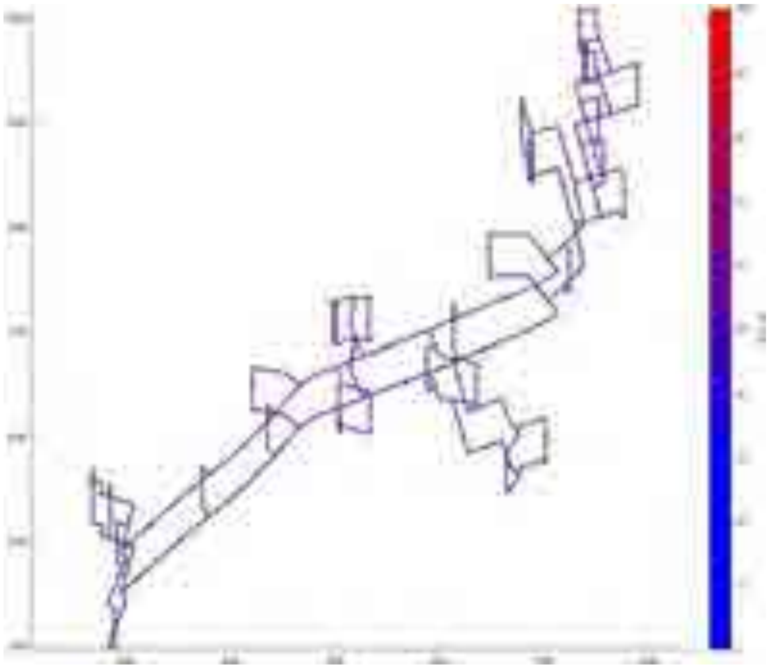


Implementations

- **First demonstrator at small heating grid in Großschönau (Austria)**
  - Proof of concept



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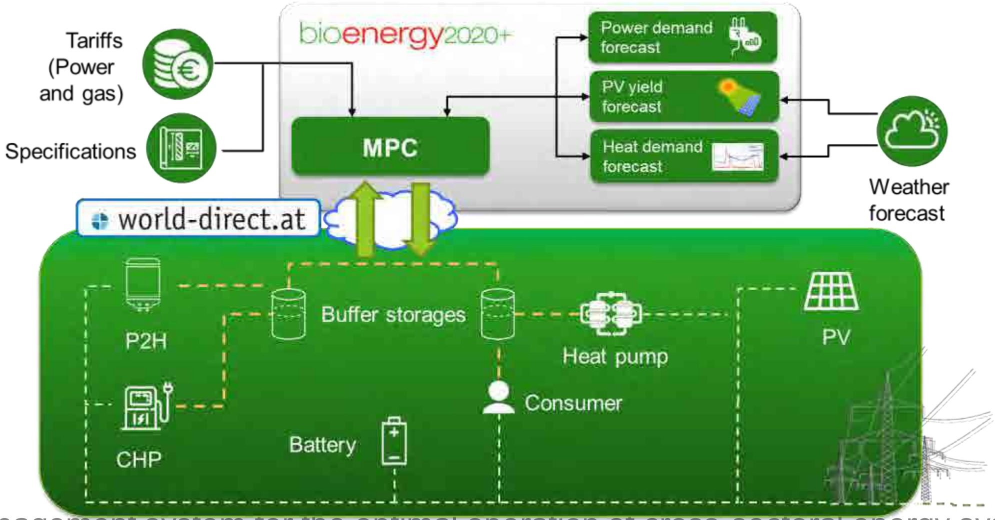
  - Two connected thermal storages, waste water heat pump, CHP, PV, P2H
  - Operational since the beginning of the heating season



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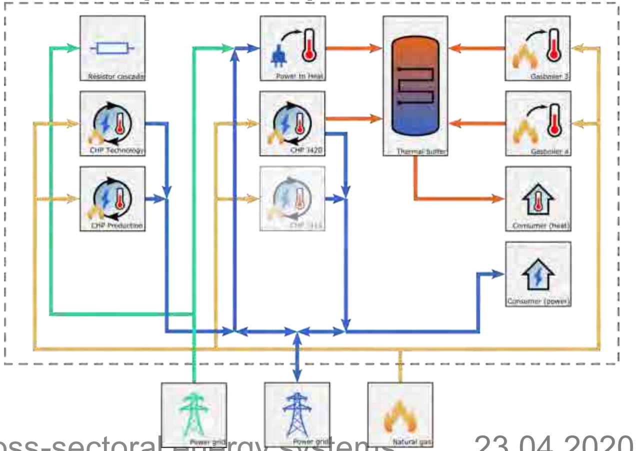
  - Participation in the balancing energy market
  - Handling of uncertainties
  - Further implementations in pilot plants planned



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- **Production Facility Energy Management System (Austria)**
  - Participation in the balancing energy market
  - Handling of uncertainties
  - Further implementations in pilot plants planned
- **… and several others currently under development**
  - from family homes to food and agro industry

Potential for industry

- **Easier integration of renewables to reach climate goals**
  - Optimization-based planning tools (*OptEnGrid*) can propose reasonable technologies and dimensioning
  - Simulations can show potential of extensions and how they should be operated
  - Optimization-based operation makes sure that planned savings can be achieved in real operation
- **Support for participation in (balancing) energy markets with P2H / CHP**
- **Automated operation of energy hubs**
  - Relief for on-call staff

Conclusion & Outlook

- **Modularity enables quick implementation of future multi-energy system planning and operation tasks**
- **Data-driven approaches additionally enable benefits beyond optimal operation**
  - Monitoring, predictive maintenance, fault detection

Conclusion & Outlook

- **Modularity enables quick implementation of future multi-energy system planning and operation tasks**
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  - Monitoring, predictive maintenance, fault detection
- **Ongoing Research**
  - **Technology flexibilization** through controller interaction

Conclusion & Outlook

- Modularity enables quick implementation of future mu
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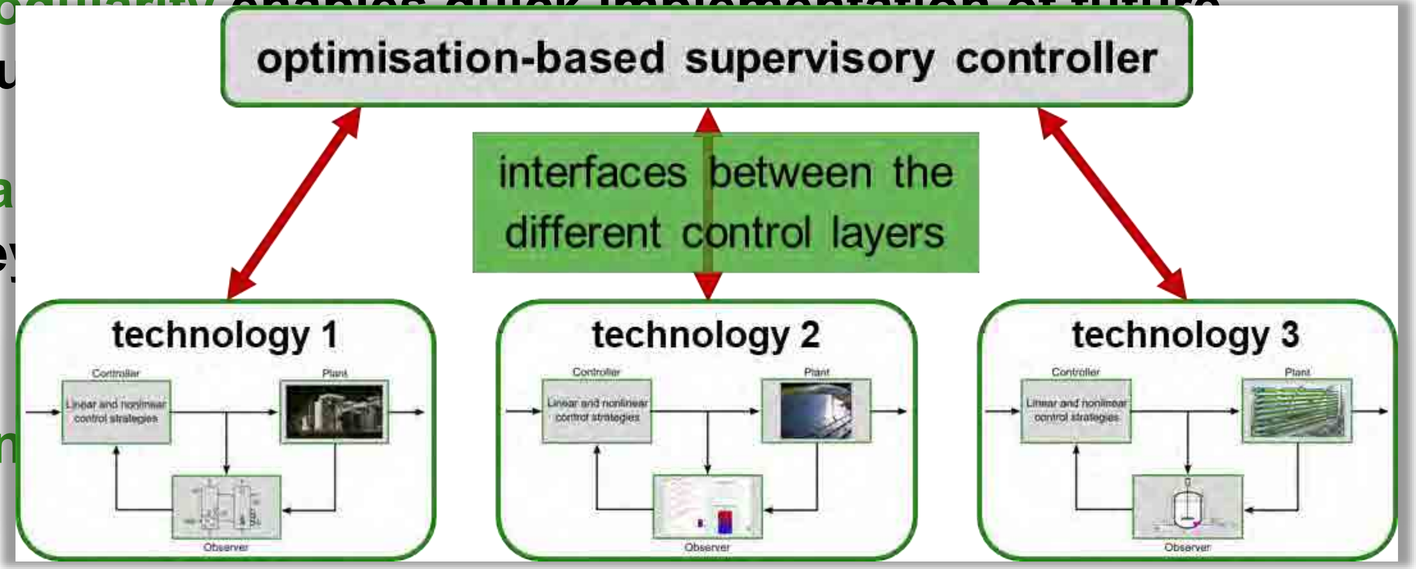

Conclusion & Outlook

- **Modularity enables quick implementation of future multi-energy system planning and operation tasks**
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  - Monitoring, predictive maintenance, fault detection
- **Ongoing Research**
  - **Technology flexibilization** through controller interaction
  - **Demand side management**
  - **Varying temperature levels**

A modular Energy Management System for the optimal operation of cross-sectoral energy systems

IEA DHC Annex TS3 industry Workshop

GotoMeeting, 23rd of April, 2020

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Innovative Cogeneration and Trigeneration concepts using LiBr absorption machines for heating and cooling

(Harald Blazek, Stepsahead)

STEPSAHEAD
OPTIMIZED INDUSTRIAL ENERGY SYSTEMS

Innovative CHP / CCHP concepts with LiBr absorption machines

StepsAhead Energiesysteme GmbH: Harald Blazek, CEO
Webinar for IEA DHC Annex TS3 - Hybrid Energy Networks, April 23rd 2020

- Introduction StepsAhead
- Innovative system concepts
  - Absorption Heat Pumps & chillers
  - Standard versus special machines for Cogeneration/Trigeneration
  - Additional income streams
  - Optimized machine design
  - Optimized system design
- Q&A …

STEPSAHEAD
OPTIMIZED INDUSTRIAL ENERGY SYSTEMS

StepsAhead Energiesysteme GmbH was founded in October 2016

Activities:

- We deliver turnkey solutions for heating and cooling > 1 MW, using Lithium Bromide Absorption Technology
- Including design and physical simulation of:
  - absorption machines
  - complete energy supply systems
- Including manufacturer-independent optimization of complete heating and/or cooling systems

23 MW Absorption Heat Pump, Austria, 2018

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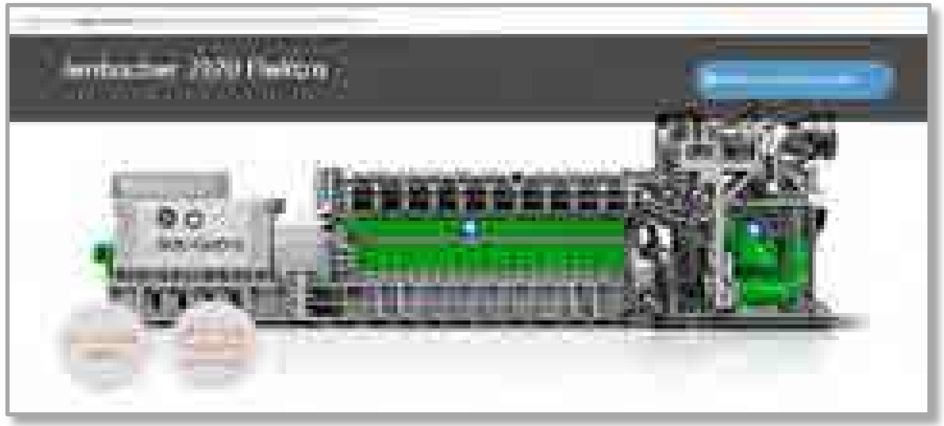
OPTIMIZED INDUSTRIAL ENERGY SYSTEMS

Standard Cogeneration System:



https://www.gepower.com/gas/reciprocating-engines/jenbacher/j920-flextra

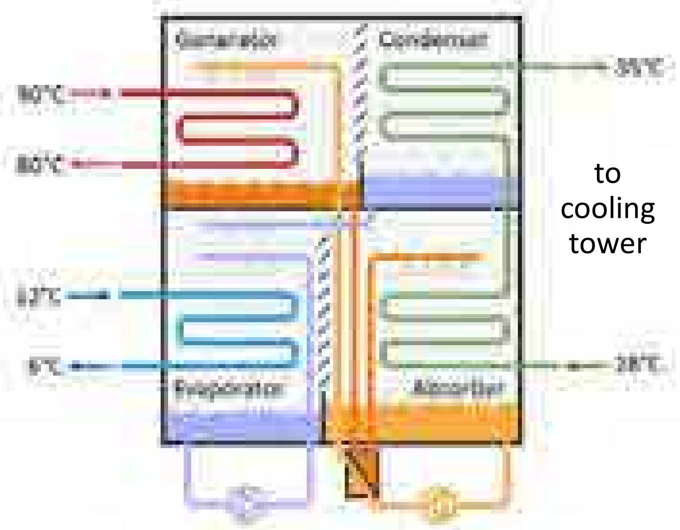
- Electricity production
- Hot water at 90-100°C

Standard Trigeneration System:

https://www.gepower.com/gas/reciprocating-engines/jenbacher/j920-flextra

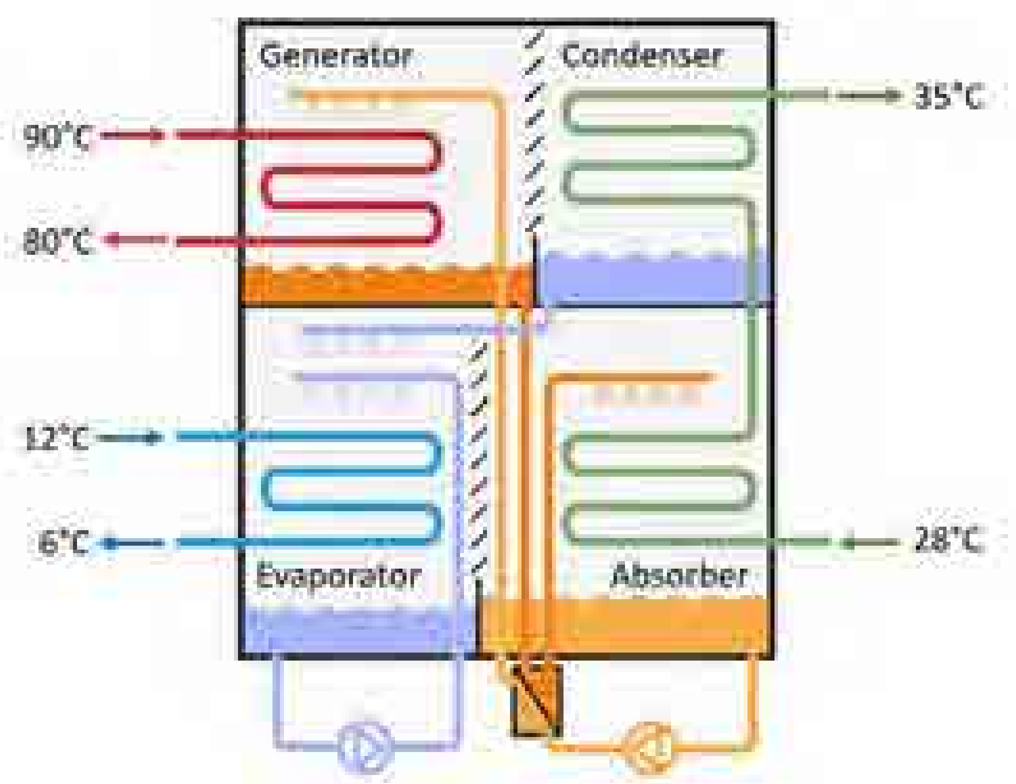
- Electricity production
- Hot water: 90° - 100°C
- Chilled water: 12° - 6°C

Single stage LiBr chiller -- COP 0,7



Working principle of a LiBr-Absorption-Heat Pump:

Step 1, Evaporator & Absorber:
- In order to be able to absorb heat at a low temperature level, water is evaporated in the Evaporator at low pressure.
- This vapour is absorbed in the absorber by concentrated LiBr salt solution.
- A pump brings the now diluted salt solution to the Generator.



Step 2, Generator & Condenser:
- In the Generator, at higher pressure (below 1 bar absolute), the water is evaporated from the diluted salt solution by heating the solution. The salt solution is thus concentrated and can be reused in the absorber.
- In the Condenser, the resulting steam is condensed on a heat exchanger, so that the water required in the evaporator is available again in liquid phase.

The heat released in the Absorber and Condenser is absorbed by heat exchangers and transferred to the heating system.

Environmental assessment and substances used:
The substances used are water and lithium bromide salt. This heat pump therefore uses neither ozone-depleting substances nor substances that would increase the greenhouse effect.

STEPSAHEAD
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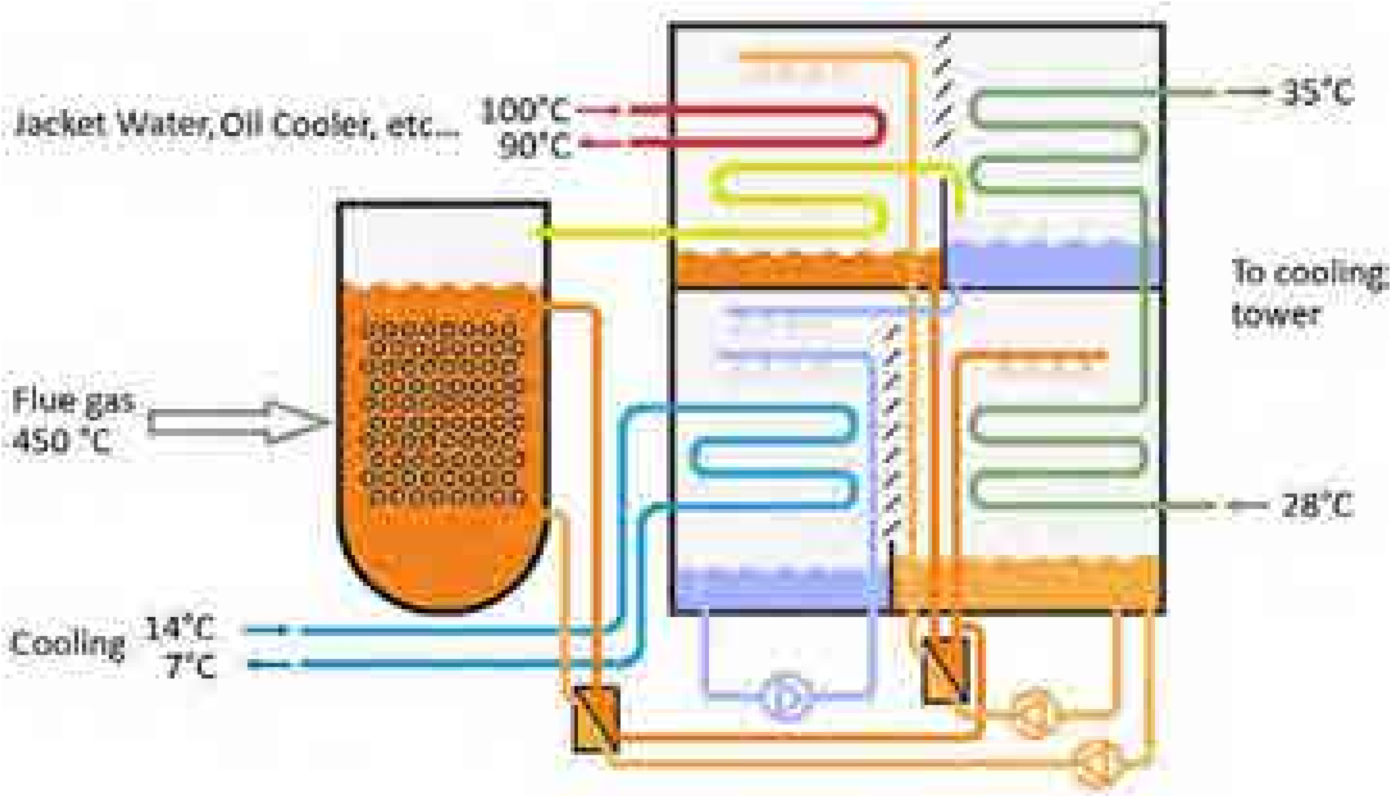
Advanced Trigeneration system, cooling mode:

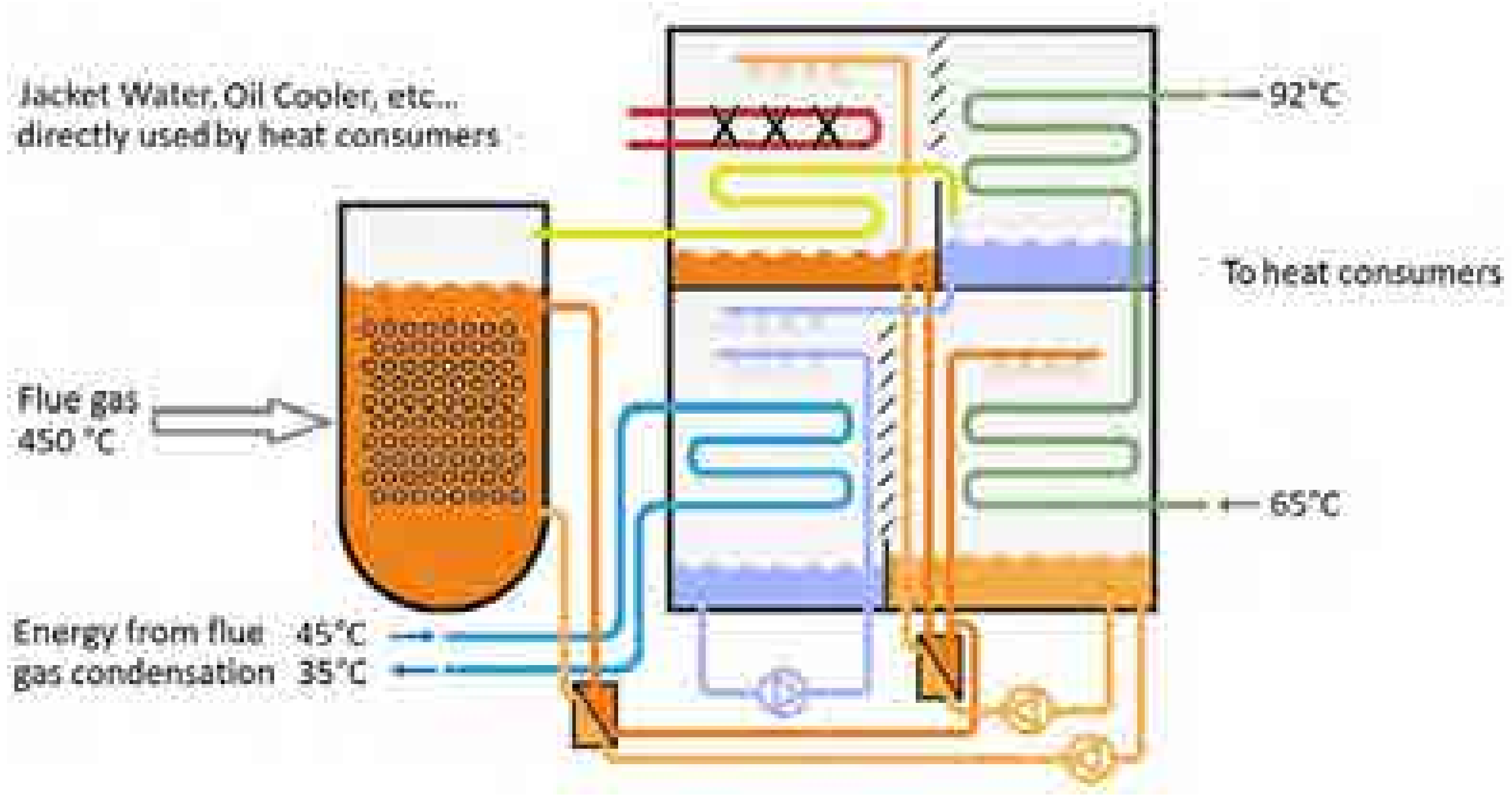
Multi Fuel LiBr machine -- cooling COP approx. 1,0



- Using the flue gas as high temperature driving energy for the high temperature generator. Flue gas temperature can be 350°C - 450°C flow, 180°C return.
- Hot water at 100°C is used in the low temperature generator.
- **40% more cold water production !**
- https://stepsahead.at/en/custom-libr-units/

Advanced Trigeneration system, heating mode:

Multi Fuel LiBr machine -- single stage heating COP 1,7



- Cold water produced by the absorption machine cools down engine's flue gas to condensation.
- Low temperature condensation heat is used as a free heat source, bringing additional 10-12% of the fuel's lower calorific value.
  Fuel efficiency > 100% can be reached
- **20 – 25 % more hot water production !**
- https://stepsahead.at/en/custom-libr-units/

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Industrial process optimization:

Wienerberger brick production, Austria

Absorption Heat Pump: 3,8 MW
Commissioned 2017/2018.

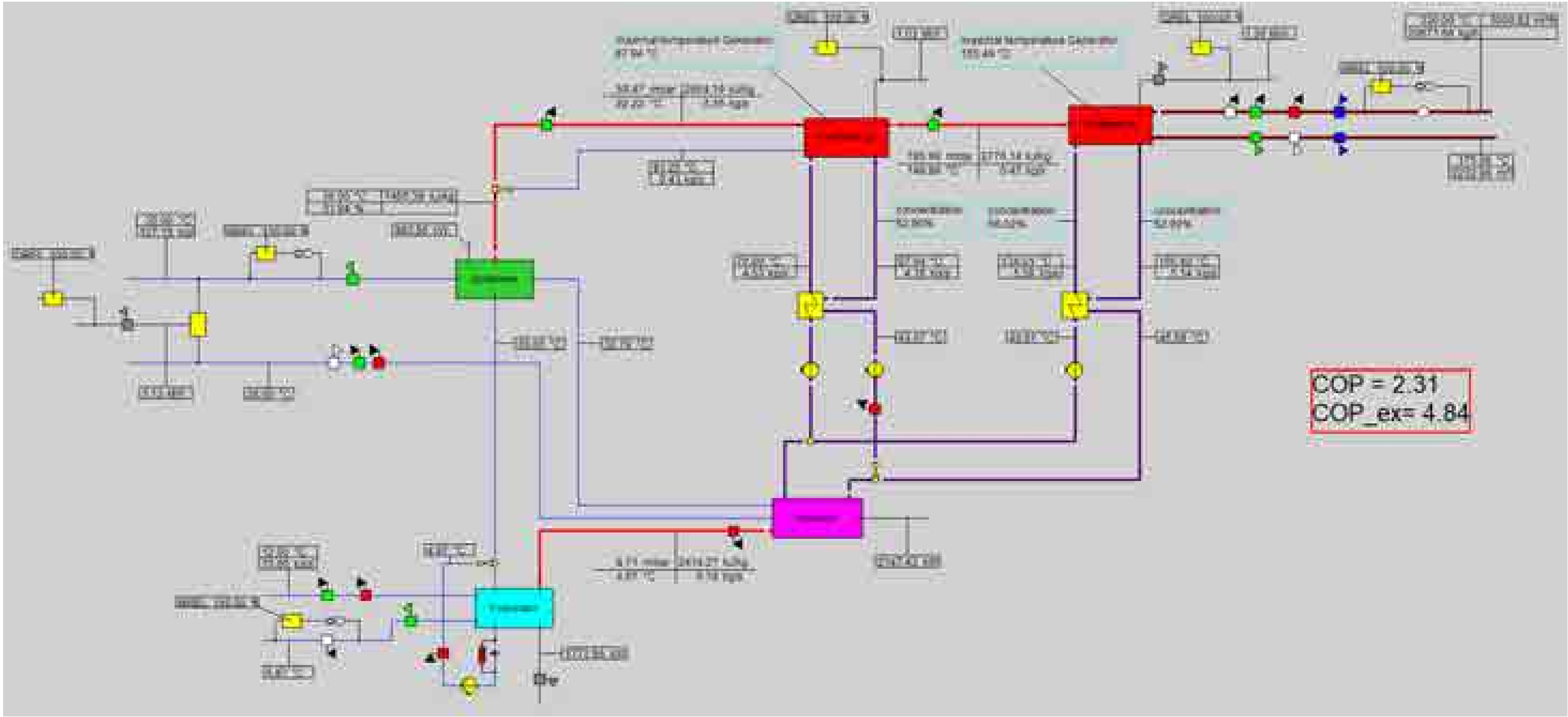
Driving energy:
Hot air: 400°/180°

Low Temp Heat Source:
Condensing humid exhaust air: 36°/26°

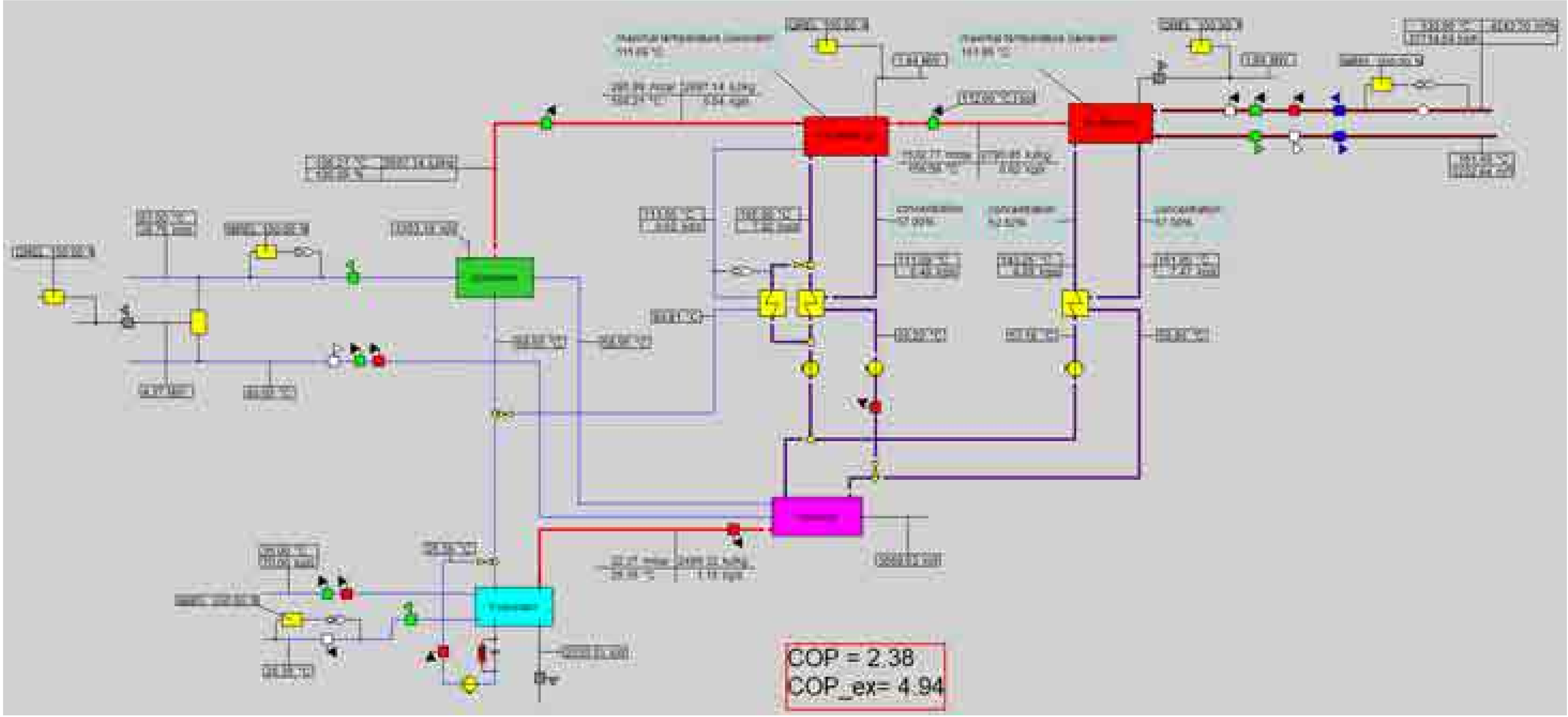
Heat delivered:
Hot Water 60°/90°

https://stepsahead.at/en/references/#plants

Sample simulation Double Stage Chiller

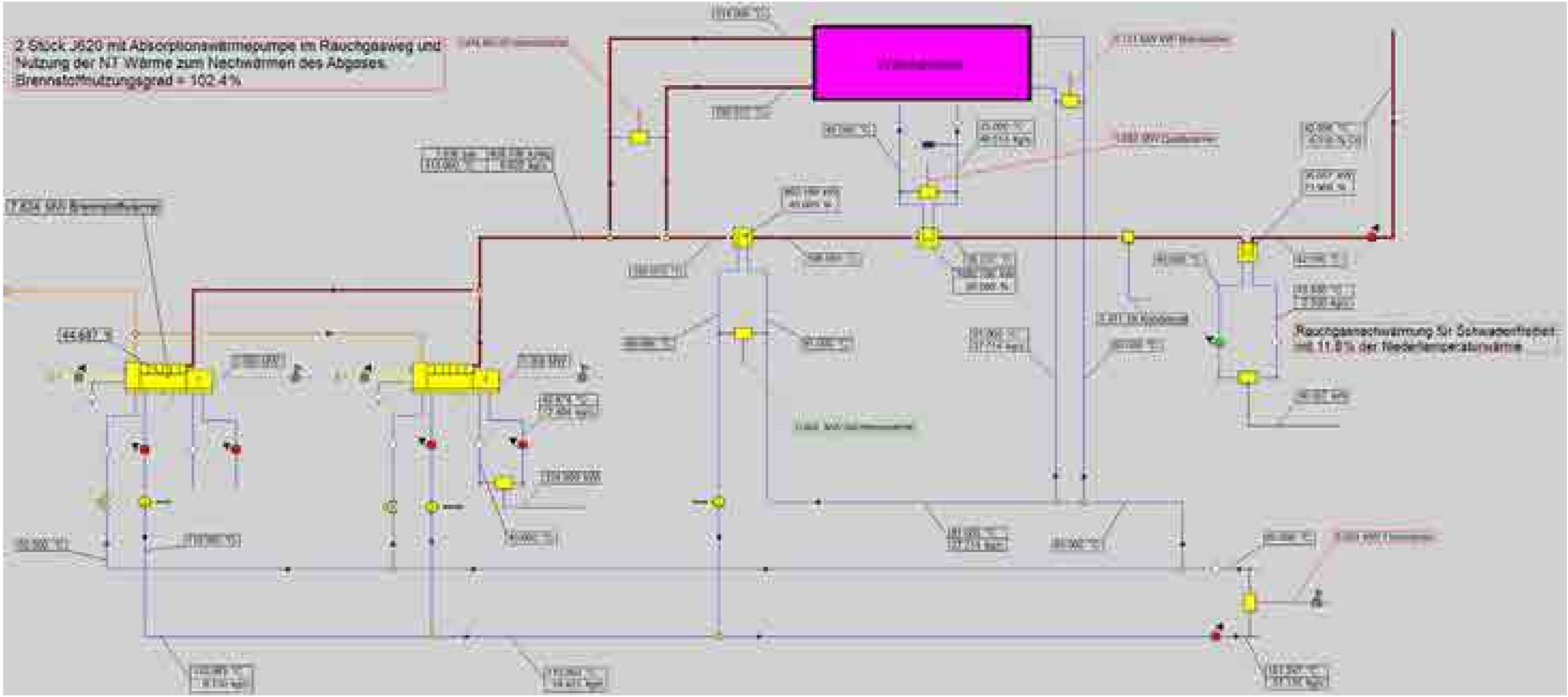


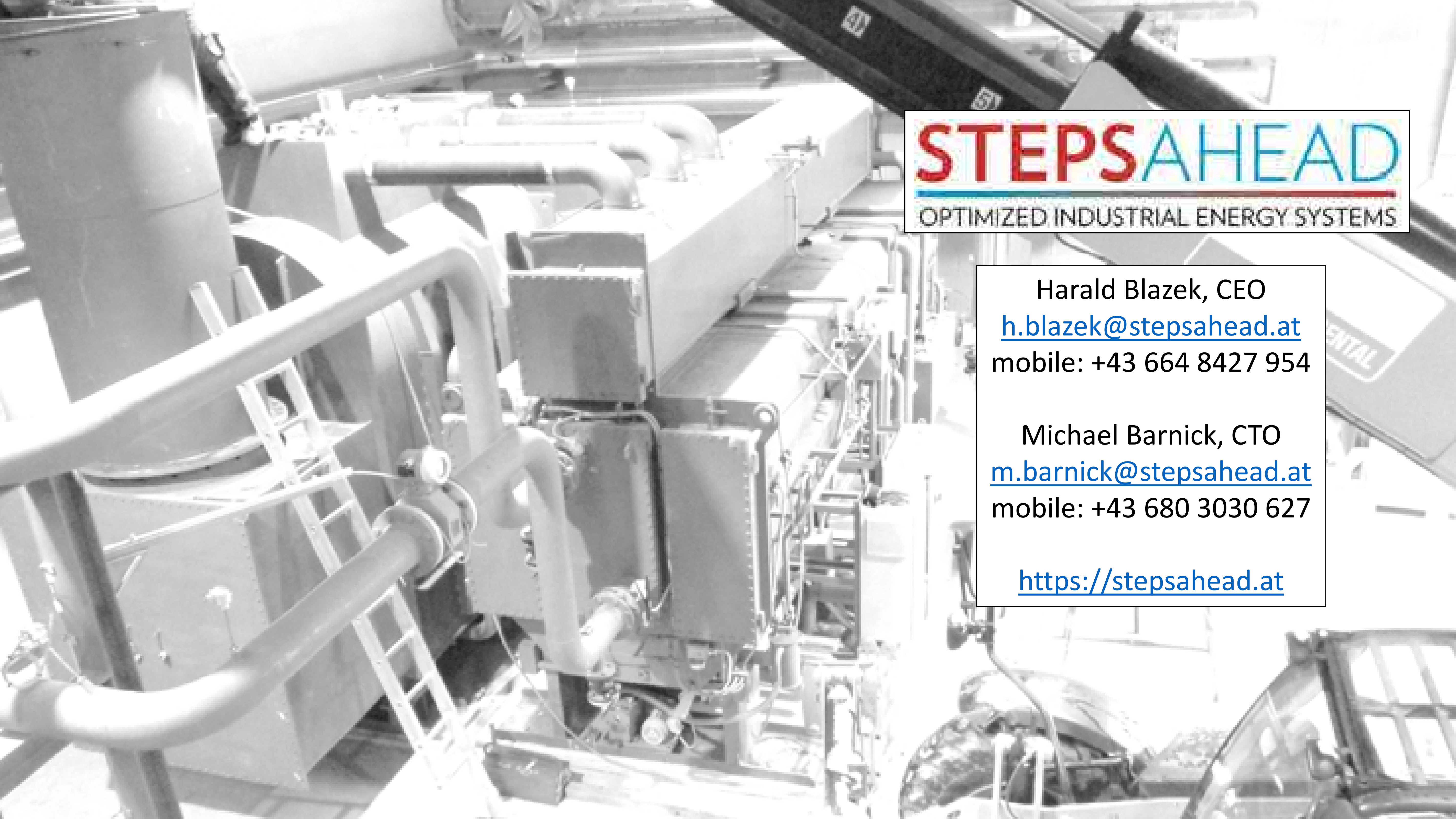
Sample simulation Double Stage Heat Pump



Sample simulation: 2 Jenbacher engines J620, 1 Heat Pump:

flue gas condensation with AHP leads to 102,4 % fuel efficiency





STEPSAHEAD
OPTIMIZED INDUSTRIAL ENERGY SYSTEMS

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Heating and cooling strategies and 2050 scenarios for Austria, results of the Heat Roadmap Europe project

(Peter Sorknæs, Aalborg University)

Heat Roadmap for Austria (Decarbonization scenarios for Austria)

April 23rd, 2019

Peter Sorknæs
sorknaes@plan.aau.dk

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 695989.

Our purpose in HRE4

- Creating scientific **evidence** to support long-term energy strategies at local, national, and EU level and empower the transition to a **low-carbon** energy system (according to the Paris Agreement goals)
- By **quantifying** the impact of various alternatives for addressing the heating and cooling sectors
- 3 year project with 24 partners and advisors with expertise in different areas (building performance, heating systems incl. DH, HPs, geographic modelling, etc.)

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Heat Roadmaps for transitions

Everywhere

- Deep energy savings
- Combine savings and supply
- ~30-50% demand reduction

Urban areas

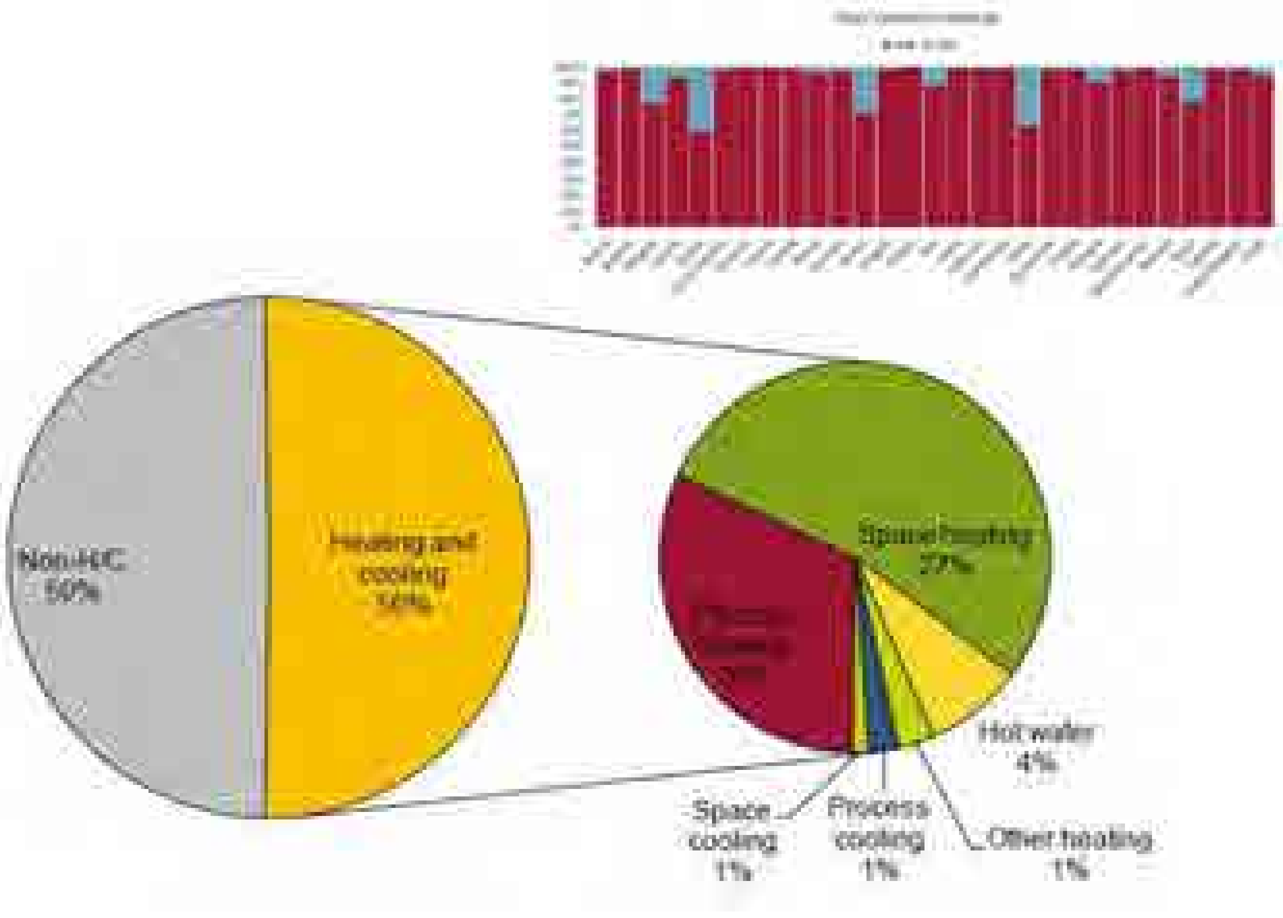
- District energy networks
- High demand density areas
- Supply ~50% of energy demand

Rural areas

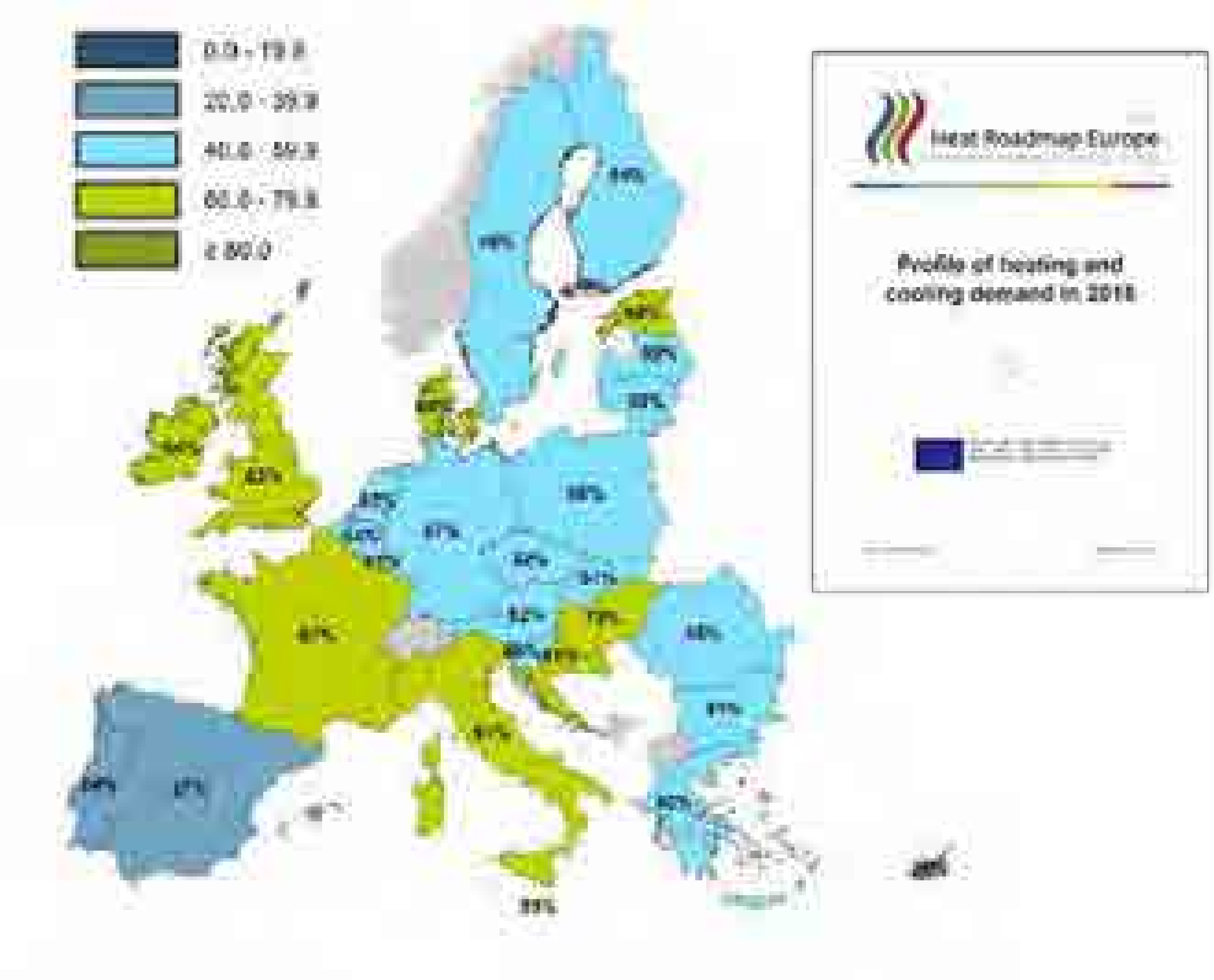
- Mainly heat pumps
- Low demand density areas
- Remaining ~50% of the energy demand

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 695989.

Heating is key to the energy system



Heating and cooling demand in 2015 in the EU28 by end-use compared to total final energy demand



Heating and cooling demand in 2015 in the EU28 by end-use compared to total final energy demand

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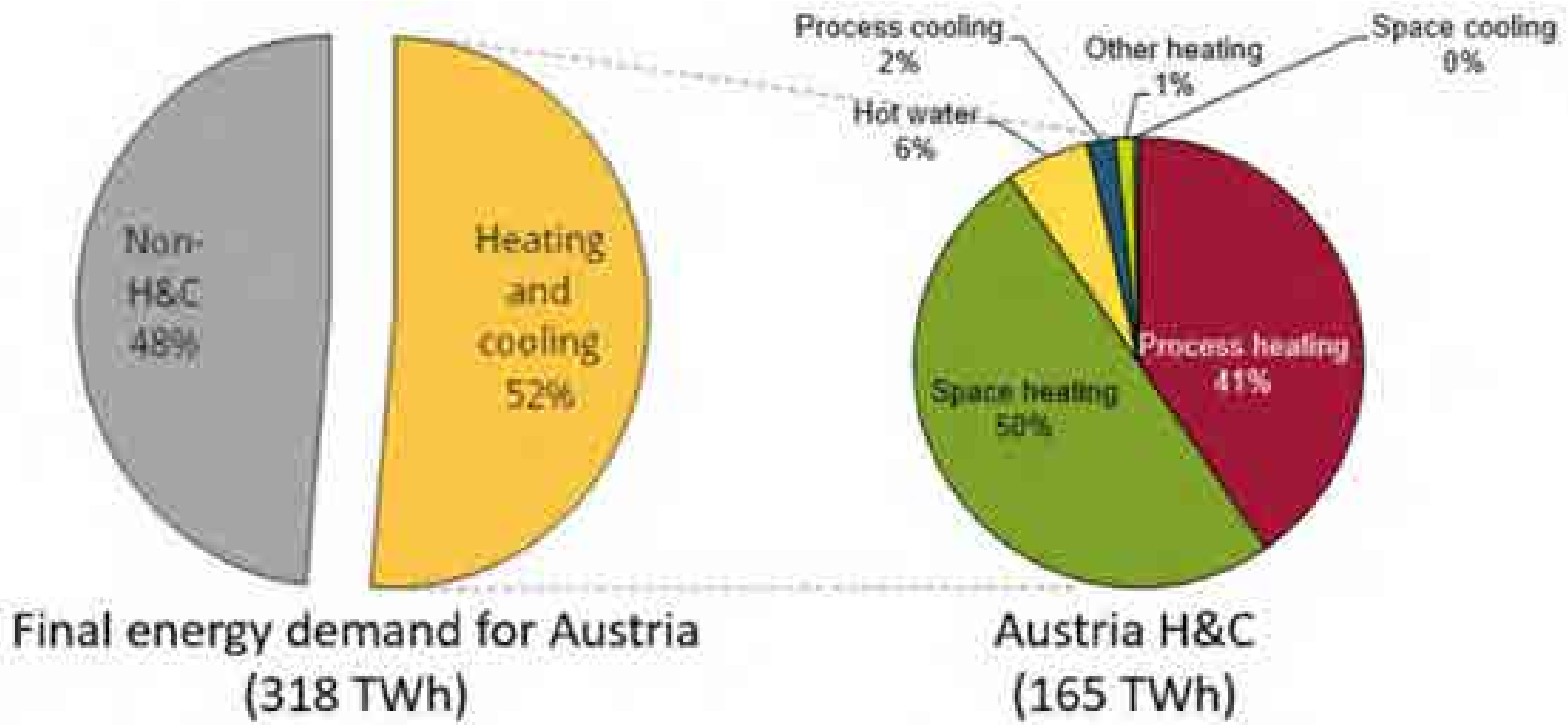
The heating and cooling demand in Austria



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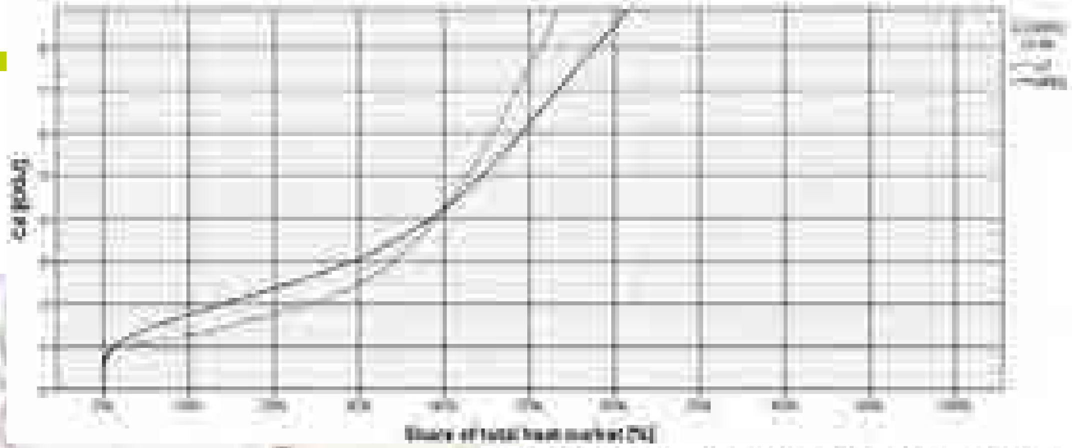
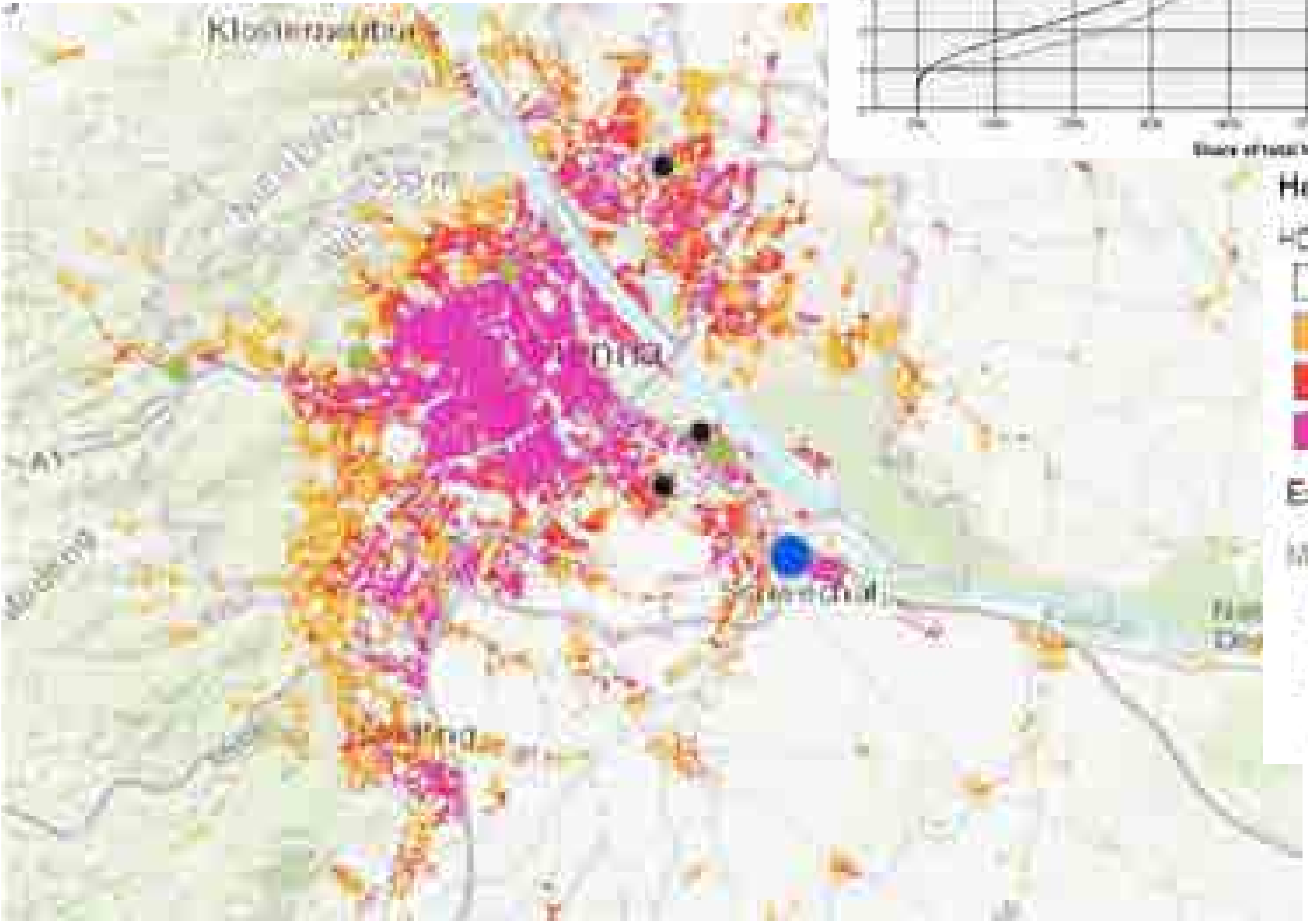
Mapping of heat

- Layers with demands and potentials
- Example of Vienna, Austria:





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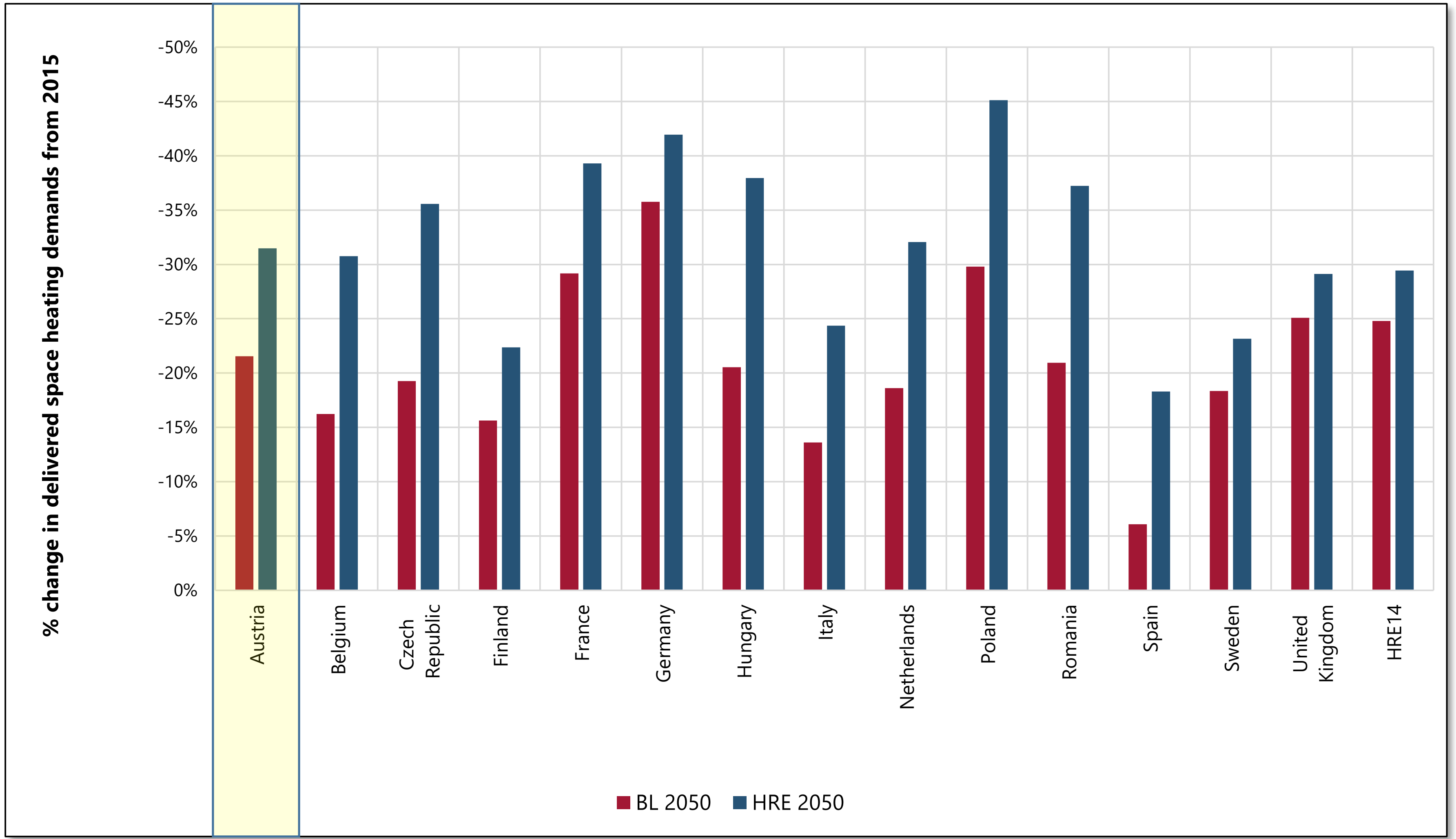
End user energy savings versus district heating share

Total energy system costs (M€/year)		Residential sector space heating savings (additional to a 25% reduction already in the Baseline)					
		0	5%	10%	15%	20%	25%
Percentage of technical potential of DH realised	0%	29394	29391	29400	29581	29843	30043
	10%	29381	29376	29383	29560	29820	30018
	20%	29335	29327	29332	29507	29764	29959
	30%	29323	29313	29314	29488	29743	29936
	40%	29301	29288	29288	29458	29710	29901
	50%	29289	29273	29270	29438	29688	29876
	60%	29275	29257	29252	29418	29665	29850
	70%	29345	29324	29316	29479	29724	29907
	80%	29489	29466	29455	29616	29858	30039
	90%	29727	29702	29689	29847	30087	30265
	100%	31208	31180	31164	31321	31556	31734

This project ha[...] the European Union's Horizon 2020 research and innovation programme under grant agreement No. 695989.

Energy savings in Austria

- Baseline: 21% reduction compared to today
- HRE: 31% reduction compared to today
- Largest investment
  - EUR 6.4 billion annually



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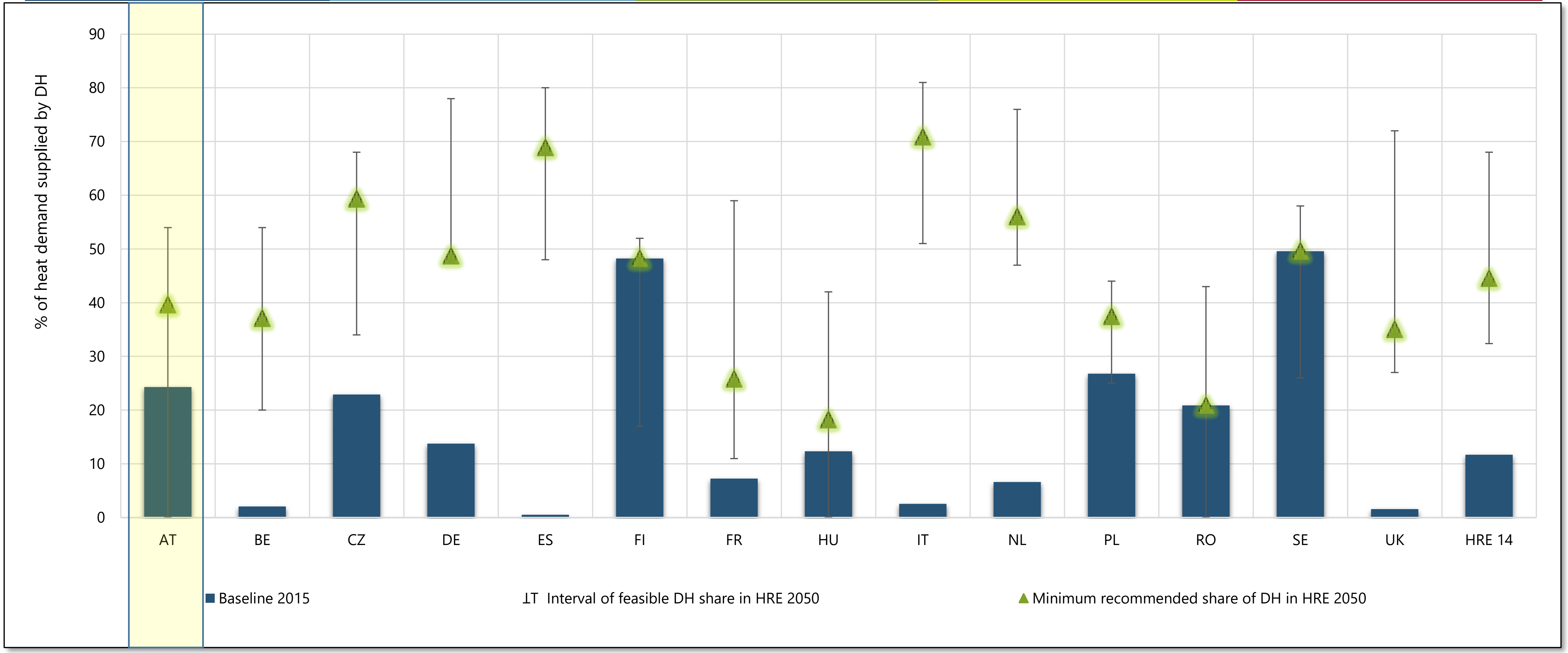
Total heat supply



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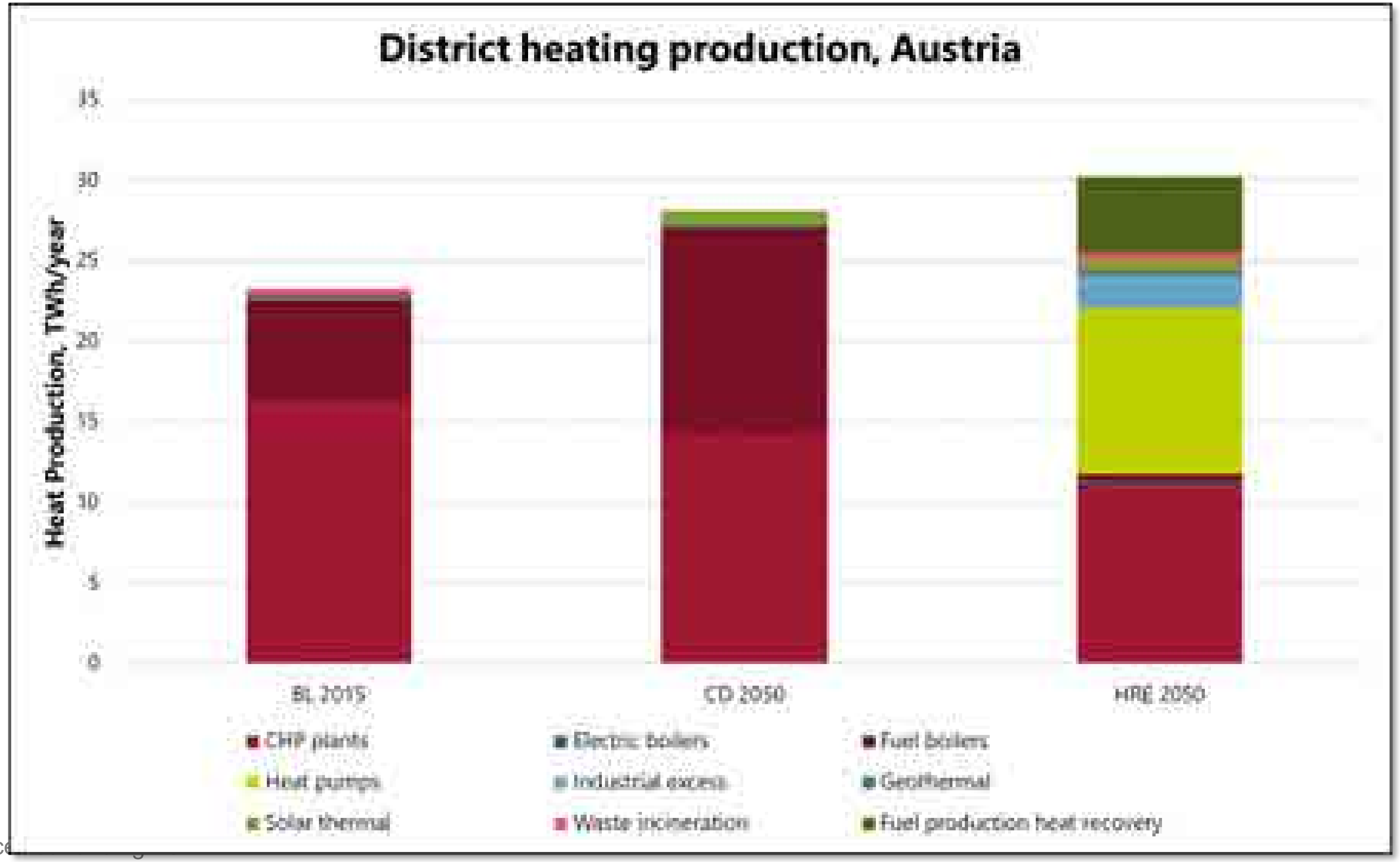
District heating production in Austria



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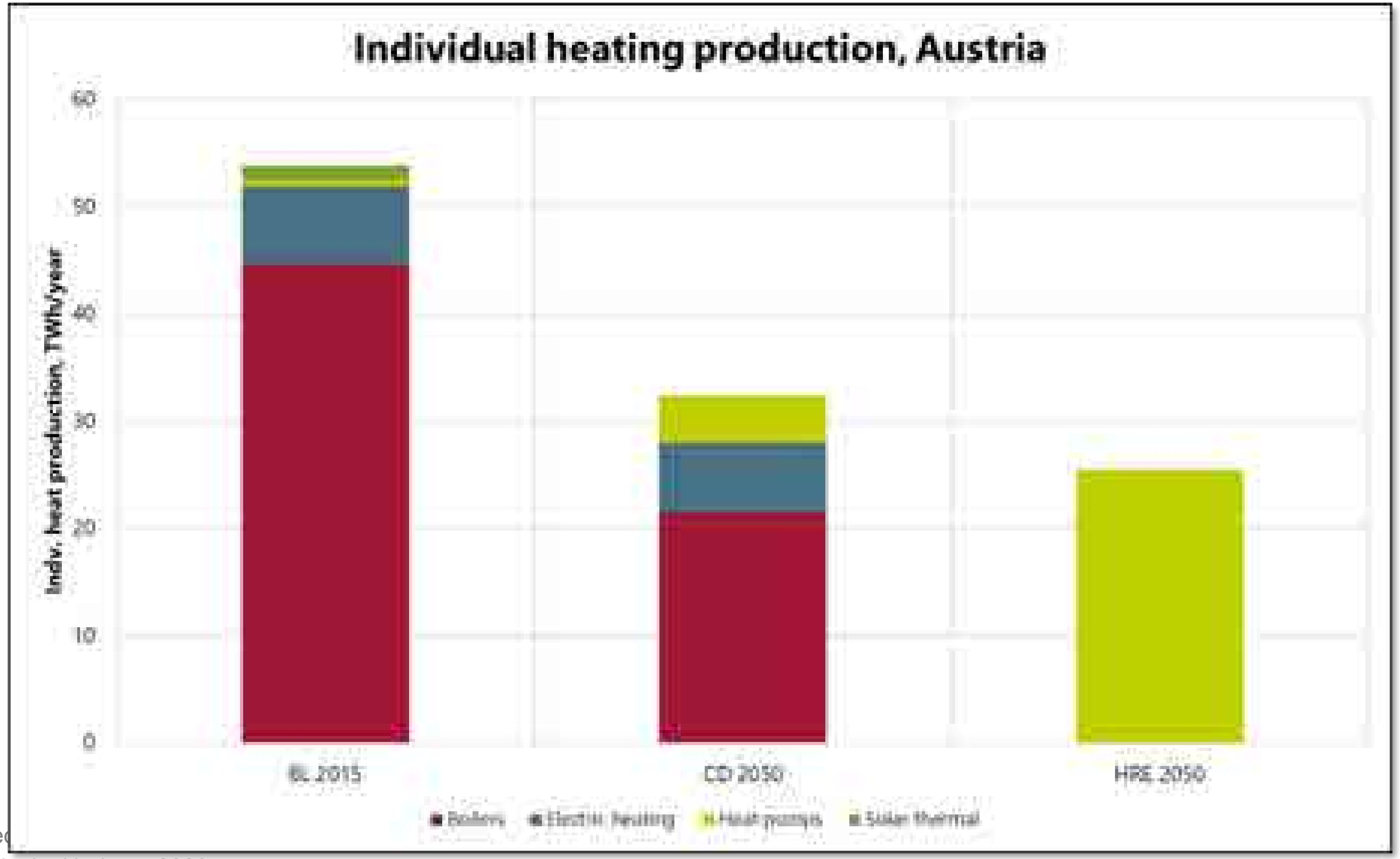
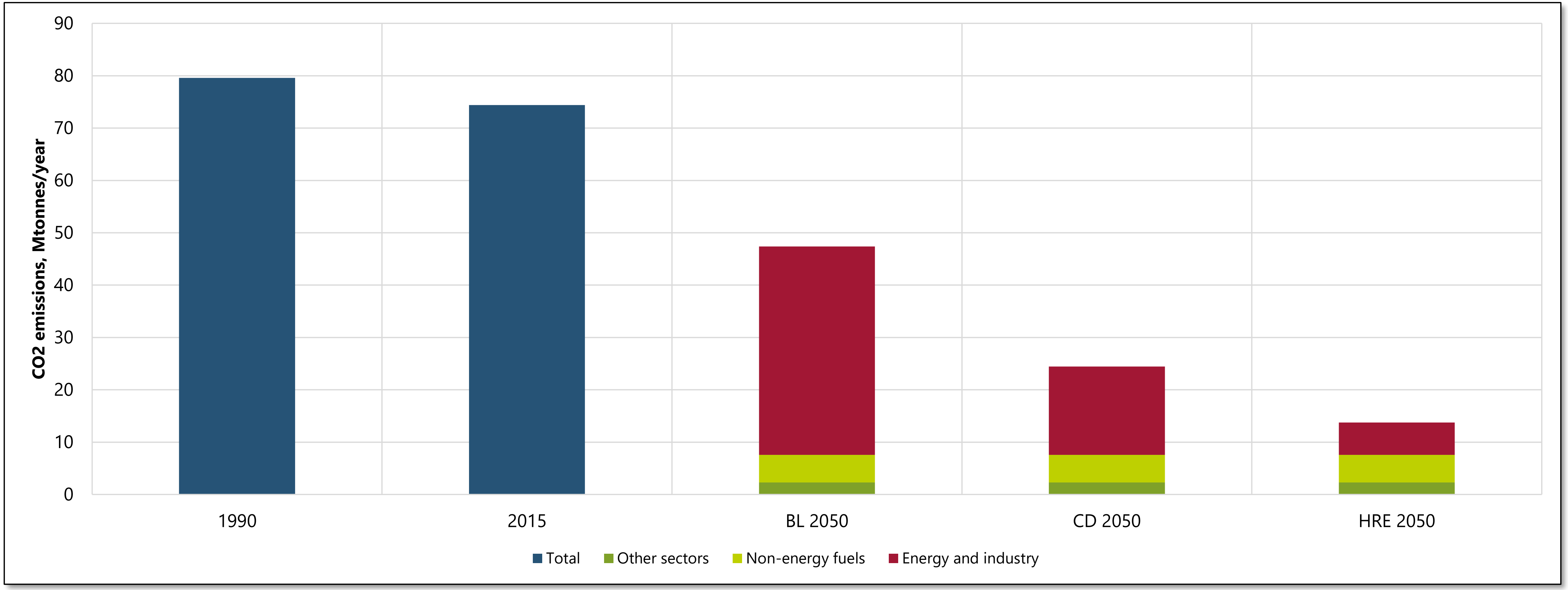
Individual heating production in Austria



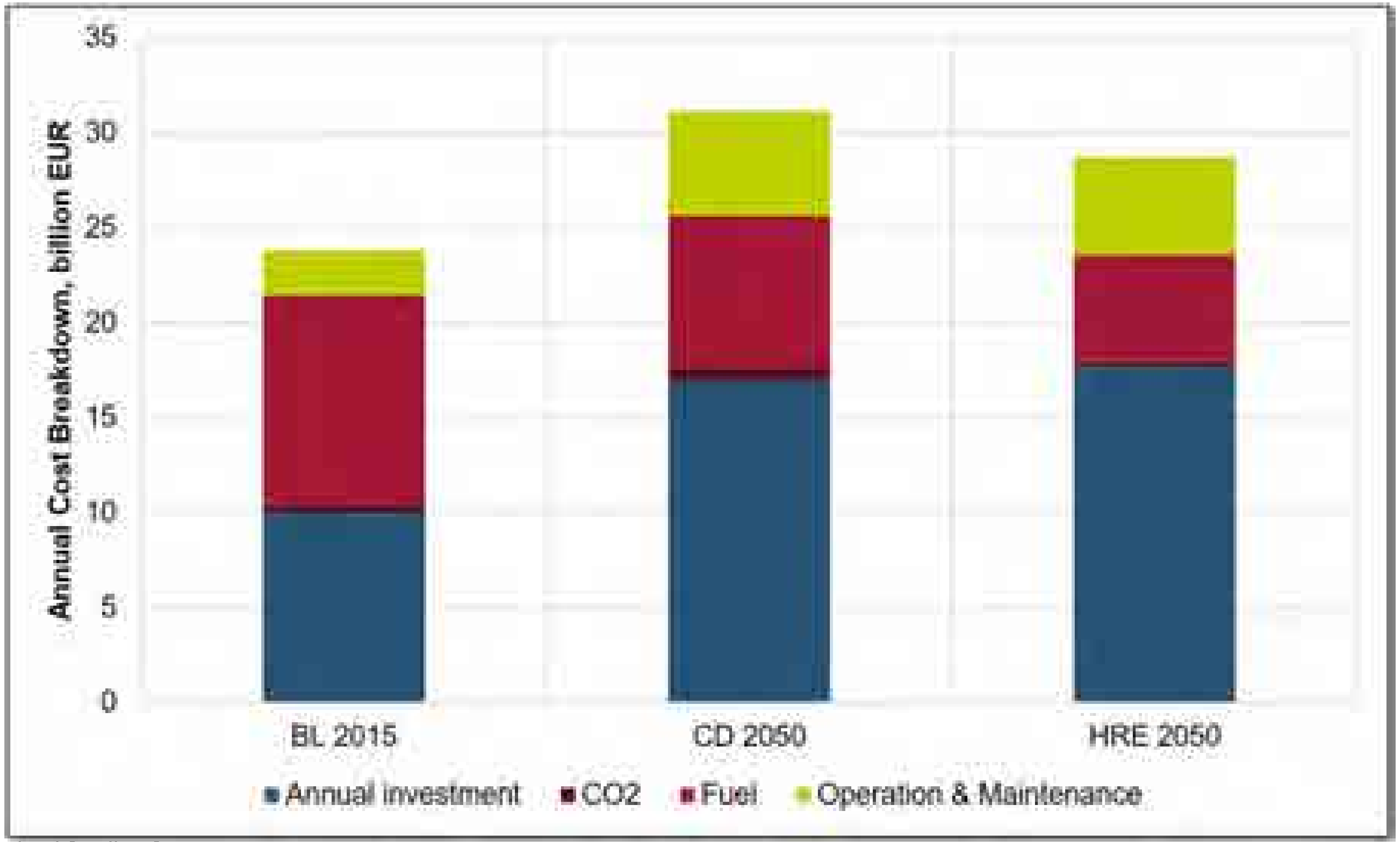
This project has rec
the European Union's Horizon 2020
research and innovation programme
under grant agreement No. 695989.

CO_2-emissions in Austria



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 695989.

Annual socio-economic costs for the heating, cooling, electricity, industry, and transport sector in Austria



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 695989.

Thank you!

- Country and general Heat Roadmaps
- Guidelines: planning, business models/cases
- Maps: Pan-European Thermal Atlas 4.2
- Energy models
- Available spreadsheets
  - Profile of H/C
  - Baseline developments for H/C
  - Scenario results
- Factsheets, Webinars, Videos, etc…

Contact: sorknaes@plan.aau.dk

Heat Roadmap Europe: www.heatroadmap.eu

Peta

Pan-European Thermal Atlas: www.heatroadmap.eu/maps

Twitter: @HeatRoadmapEU

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 695989.

Decarbonising the Austrian space heating sector: a transition scenario for 2050

(Lukas Kranzl, TU Wien)

TECHNISCHE UNIVERSITÄT WIEN

Decarbonising the austrian space heating sector: a transition scenario for 2050

Project carried out by TU Wien for „Renewable Energy Austria“

Lukas Kranzl (TU Wien), Andreas Müller (TU Wien)

Hybrid Energy Networks, IEA DHC Annex TS3 Webinar, 23 April 2020

Heat-Transition 2050: Analysis of the requirements and implications of full decarbonisation of the heat sector in Austria (focus on buildings)

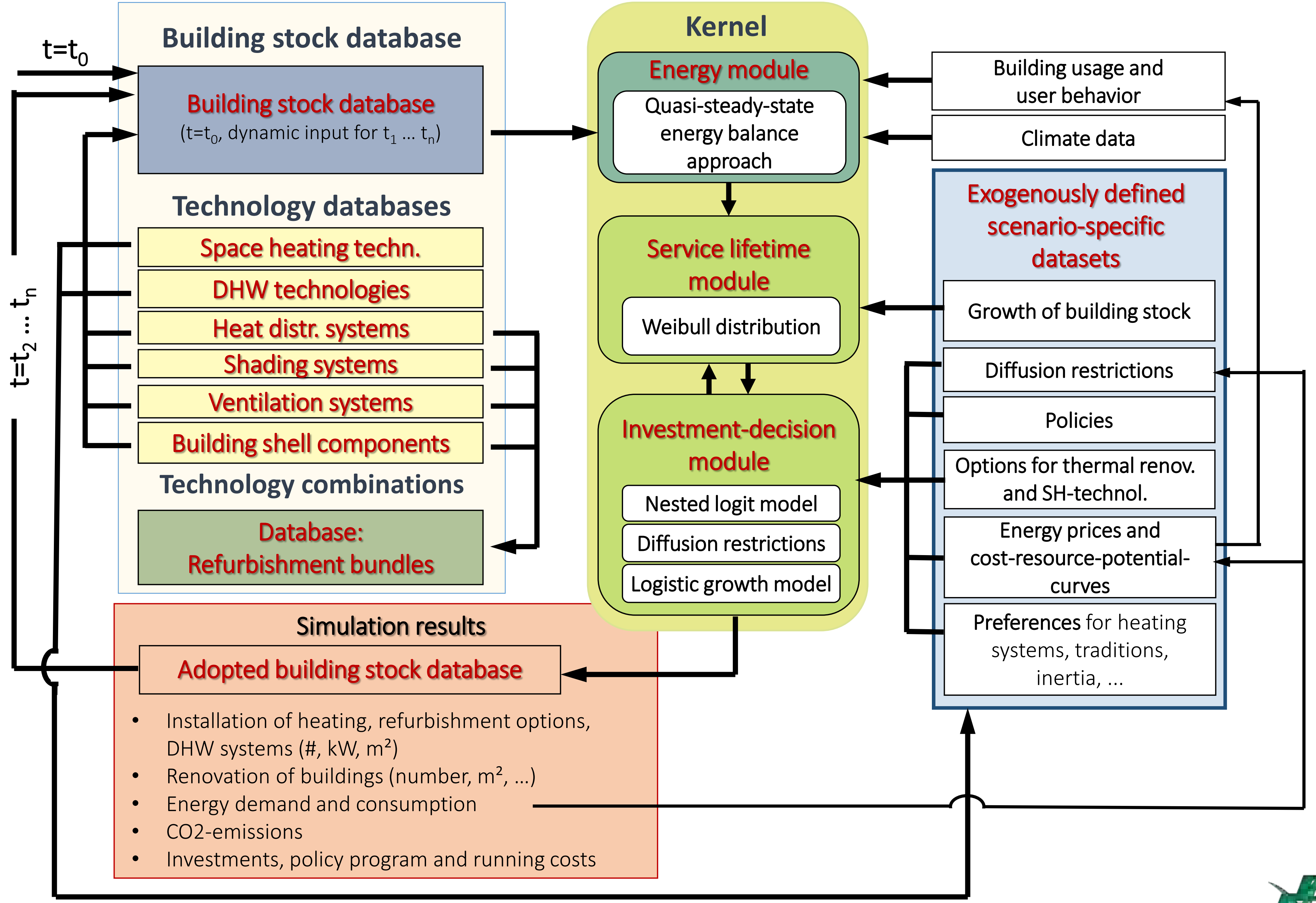
What are requirements and implications of a heat-transition towards 100% renewable supply of the space heating and hot water demand?

- What is a feasible path for achieving the decarbonisation in the heating sector (focus on buildings)?
- Which heating system replacement rates and investments in heating systems are required?
- Which building renovation rates and related investments are required?
- Which reduction of the space heating demand is feasible and required and what are the implications on annual heating costs?
- What is the role of different renewable heating systems?
- What is the role of heat pumps and sector coupling between heating and electricity supply?
- What about the overall economics of such a heat-transition scenario?
- Which policy instruments are recommended and required to achieve this scenario?

Key messages

- A heat transition with very strong decarbonisation until 2050 is feasible, but depends on several factors:
  - Overcoming the high inertia in the stock, of heating systems and buildings
  - Decarbonisation of the electricity and district heating sectors
  - Can the remaining, low gas demand be covered by renewable, green gas?
- Different regions in Austria have different challenges to overcome.
- RES-H are usually very close to the economic competitiveness with fossil heating systems. The uncertainty regarding future energy price developments should be considered as an important impact factor.
- The heat transition requires higher investments in building retrofitting and RES-H and leads to substantially lower running costs for heating.
- Sector coupling of electricity and heat sectors is a core component of the heat transition, which requires certain provisions and measures.
- A broad package of policy instruments is required for the implementation of the heat transition.

Invert/EE-Lab



Source: Müller, 2015; www.invert.at

Key assumptions of the heat-transition scenario

- The scenario is embedded in a European development towards strong decarbonisation of the economy
  - CO_2-tax (and/or price) on fossil emissions
  - Policy makers are committed to a long-term target of high emission reductions. By communicating this target, investor's uncertainty is reduced.
- Growing requirements regarding the share of RES in case of new building construction, building retrofitting and (from 2030 onwards) also in case of boiler replacement
- Oblivation for energetic retrofitting within 12 years for buildings with very bad energy performance
- Restrictions of new installation of natural gas after 2025
- Gradual phase-out of oil and coal
  - After 2021 in new buildings
  - After 2026 existing boilers have to be gradually replaced

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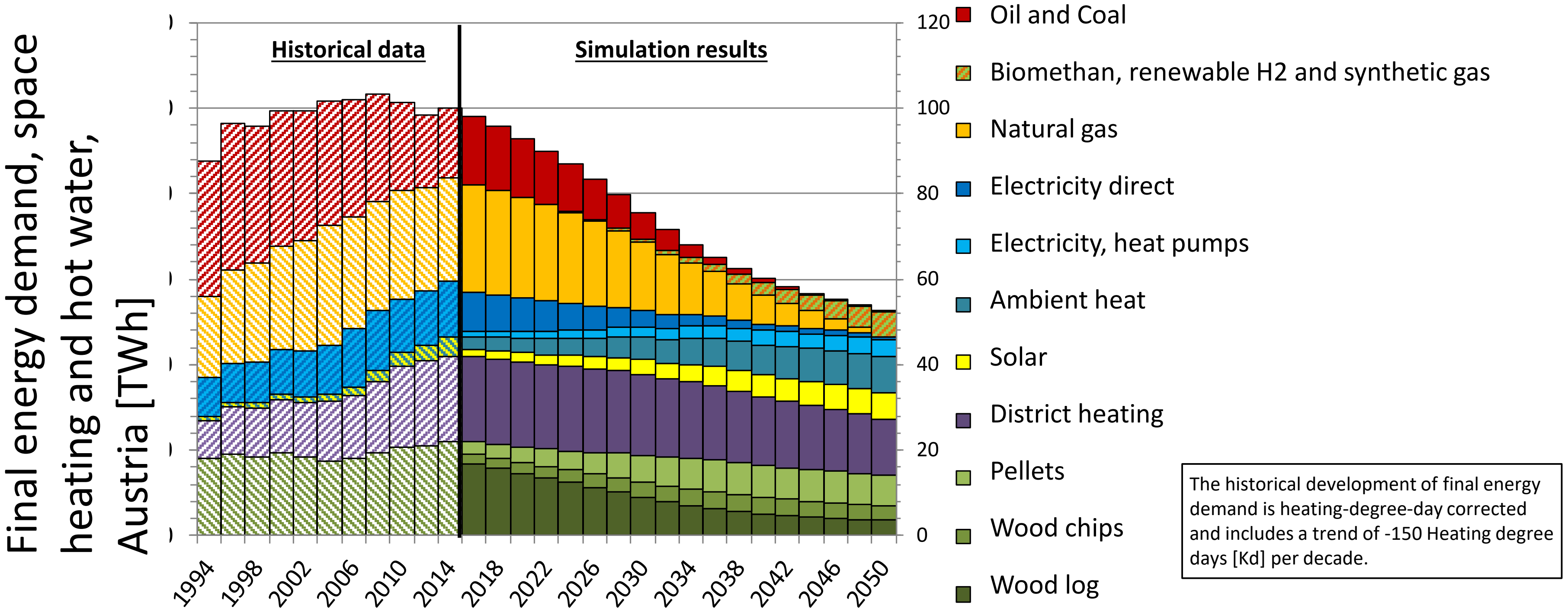
Heat-Transition scenario - results

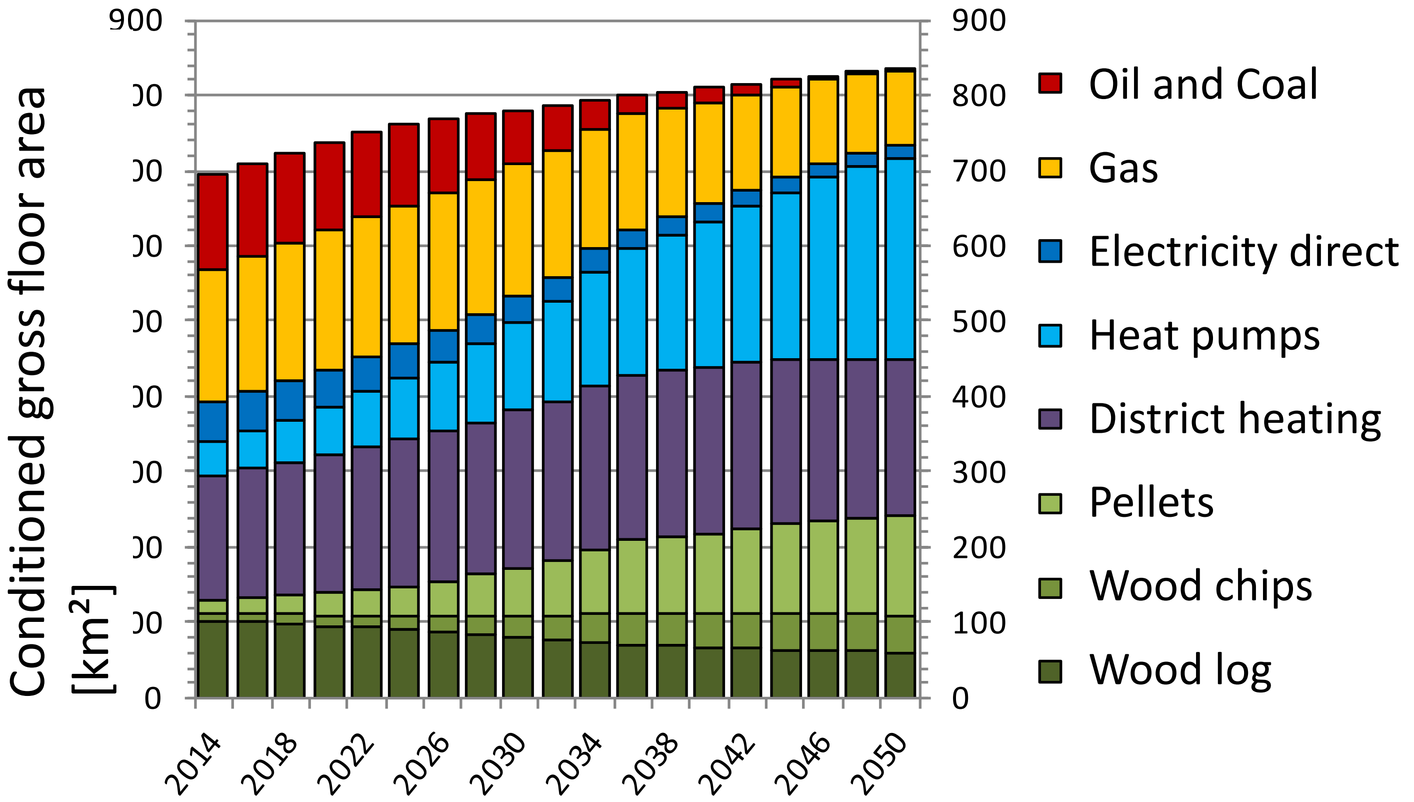
Final energy demand



- Reduction of final energy demand for space heating and hot water by ~ 50%
- Biomass and district heating most relevant energy carriers, followed by heat pumps;
- Remaining share of natural gas gradually replaced by „green gas“

Heat-Transition scenario - results

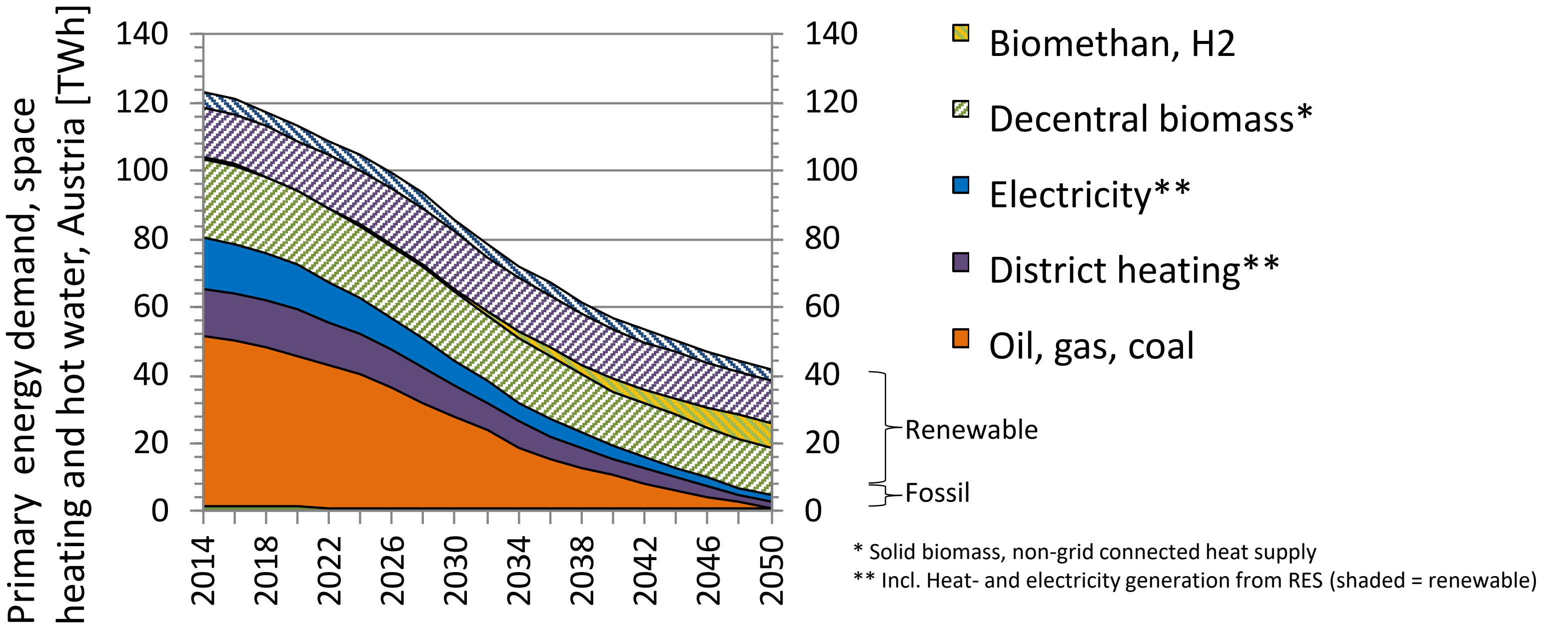
Conditioned gross floor area



- Heat pumps: high share of floor area, but mainly in buildings with low specific energy demand (and low required temperature levels and high COPs!)

Heat-Transition scenario - results

Primary energy demand



- Primary energy demand is reduced by 2/3 to about 45 TWh
- RES share in primary energy increases from 35% (2016) to 50% (2030) and 90% (2050)
- CO2-emission reduce by around 95% compared to 2016.

Key messages

- A heat transition with very strong decarbonisation until 2050 is feasible, but depends on several factors:
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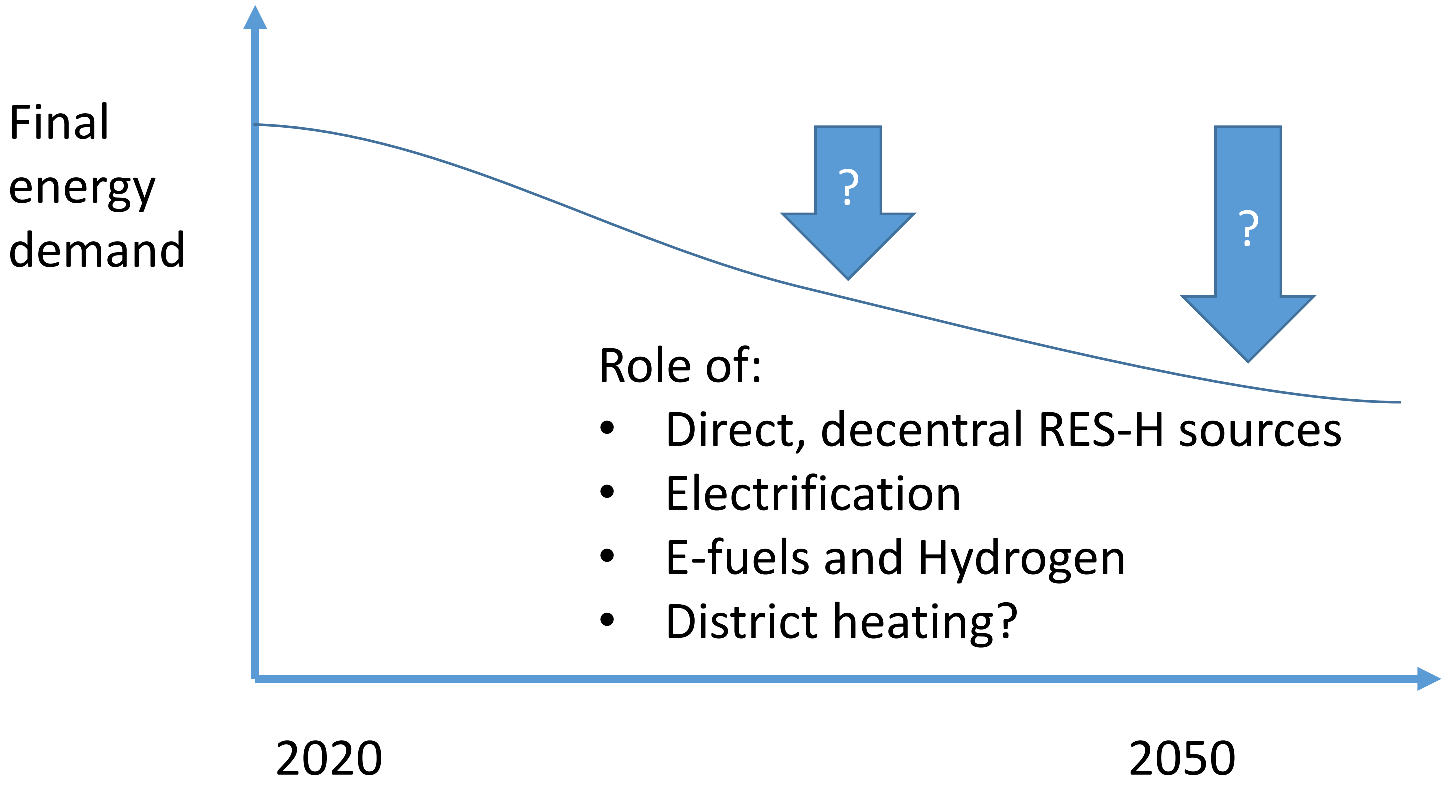
Heat pumps in the heat transition scenario - conclusions

- Heat pumps will deliver a significant contribution to the decarbonisation of the heat sector. Preconditions:
  - Simultaneous decarbonisation of the electricity supply
  - Restricting the use of heat pumps for low supply temperature levels

- Despite a growing share of heat pumps, a reduction of the electricity demand in the building sector is feasible. Preconditions:
  - Replacement of electricity direct heating
  - Restricting the use of heat pumps to efficient cases
  - In particular for air-source heat pumps measures for reducing simultaneity of electricity peak loads is important (and feasible).

- There are large flexibility potentials for reducing peak loads which can be used for integrating volatile renewable electricity.
  - Partly, required infrastructure is available.
  - Financial incentives for consumers often not sufficient to be the main driver.

Pathways for decarbonising the heat sector?



Ongoing project carried out for the European Commission:
Renewable Space Heating under the Revised Renewable Energy Directive.
Tender ENER/C1/2018-494

Thank you!

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Orig. Photo: Patrick Stargardt

An analysis of strengths, weaknesses, opportunities and threats of DHC networks within an integrated energy system

(*Ralf-Roman Schmidt, AIT*)

SWOT Analysis* for coupling of electricity grids with district heating and cooling networks

Analysis of the strengths, weaknesses, opportunities and threats, a joint analysis from IEA ISGAN Annex 6 and IEA DHC Annex TS3

Ralf-Roman Schmidt (AIT)

- **With contribution from:** Oddgeir Gudmundsson (Danfoss A/S); Andrej Jentsch (IEA DHC TCP); Ingo Leusbrock (AEE Intec); Daniel Muschick (BEST research); Anna Nilsson (IVL Swedish Environmental Research Institute); Juien Ramousse (Polytech Annecy Chambéry); Joni Rosi (RISE); Daniel Trier (PlanEnergi)

AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY

Hybrid Energy Networks, Examples

- combined heat and power (CHP)
- power-to-heat (PtH)
- heat pump (HP)
- electric boilers (eB)
- power-to-gas (PtG)

- Using biogas from local biomass in micro **CHPs** for supplying to rural DHN
- Decentralized **eBs** in domestic hot water storages for using local PV energy
- Waste heat from data centers supplied via **HPs** or directly to the DHN
- Small scale DHN supplied by central **HPs** using ambient energy
- Integration of **CHP** via ORC (Organic Rankine Cycle) in biomass-based DH networks for producing electricity
- Large scale **eBs** centrally integrated in DHN for participating on short term electricity markets
- Low temperature DHN using electric booster **HPs** for domestic hot water preparation
- Anergy networks using “neutral” supply temperatures between 15 and 25°C (up to 40°C) and **HPs** in each building
- Cooling networks with central adsorption chillers, electric chillers (reverse **HPs**) and cold storages
- Using waste heat from the **P2G** re-conversion of hydrogen via **CHP** plants in DHN
- Using waste heat from **P2G** / electrolysis processes in the DHN
- …

Hybrid Energy Networks, Definition (DRAFT)

	Level of energy system integration	
	min	**max**
Technology layer (e.g. density and diversity of coupling points (CHP, PtH, PtG …), system flexibility/ storage integration, advancement of controls and analytics)	Single coupling points, delivering high shares of heat, central controls of network and coupling points	Multiple and diverse coupling points, each of them able to deliver high shares of heat supply, advanced controls, automation and analytics (e.g. IoT platforms, model predictive controls, forecasting of electricity prices and head demand)
Strategic layer (e.g. integration of (distributed) renewables and waste heat, transformation strategy and integrated planning)	Central structures, integration of coupling points only as a reaction on (short-term) market pressure	Decentralized structures, integrated and forward-looking planning and design of the energy system, optimized interaction within the different networks, considering decarbonization scenarios (urban/ national)
Organization layer (e.g. innovation in business models and services offered, level of consumer / prosumer integration, ownership/ acceptance)	minimum permissible ownership of coupling points and network assets, traditional business models (e.g. direct energy sales)	Maximum permissible ownership of network assets and coupling points, high share of prosumers, innovative business models and services offered (e.g. dynamic pricing, establishing local energy markets, enabling prosumers to participate at different el. markets)

SWOT analysis

- the **level of system integration doesn't necessarily correlate with system and / or costs efficiency** (increasing level of complexity).
- For reaching an optimized connection an **interdisciplinary approach** is required
- In 2018, a **cooperation between IEA ISGAN Annex 6** "Power Transmission and Distribution Systems" **and IEA DHC Annex TS3** „hybrid energy networks" started.
- A **first shared document is a SWOT analysis** → a review process is currently ongoing!
- Focus is the **integration between the DHC and the electricity network** (other sectors will follow)

First results

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Strengths I/III

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energy system point of view:

- More options for system design due to **higher degree of freedom**
- utilization of **(cost) efficient technologies** (HPs, heat storages/ eBs) compared to batteries/ P2G
- Using hydrogen / biogas in CHP processes has a **higher energy system efficiency** than using them for heating or el. generation only.
- Increasing the system **flexibility** on different time scales enables one to
  - better managing temporal **imbalances** of el. production (PV or wind) and demand
  - use locally produced el. directly in the DHN → **min imports**, max self-consumption
  - better react on **fluctuating energy market prices** (optimize the revenues).
- increase system resilience via **distributed** PtH units and storages towards external disturbances

Strengths II/III

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electric grid point of view:

- CAPEX for **network extensions** might be reduced and oversizing avoided, if planned properly
- reduce the need for investments into **alternative storages**, i.e. batteries, and **power line extensions** and reduce **grid losses** by
    - **local** utilization of electricity sources
    - connecting **central** p2h units on the **high voltage** grid compared to individual HPs on the distribution grid
- decrease the costs for **ancillary services** (frequency regulation) provision (TSO)
- reduce **grid constraints** (incl. over/ under voltages, capacity limitations, transformer flowbacks, curtailment)

Strengths III/III

DHC network point of view:

- **decarbonize** the system (if using renewable electricity / gases) + reducing local emissions.
- increase the supply **security**
- Reduce the **back-up requirements** when designing the system based on smaller, distributed units
- to (locally) adapt the **temperature level** to the demand side requirements via booster HPs / electric boilers
- District cooling via compression chillers benefit from the **coincidence of peak PV supply and maximum cooling demand**

Weaknesses I/III

- high **complexity** for planning, designing and operating, due to
  - a higher number of **optimization parameters** and the related insecurity + various time responses and operating constraints, including the **demand side flexibility**
  - multiple **stakeholders** with individual (regulatory) boundary conditions
  - little **experience**, lack of experts in all energy sectors + little diffusion of suitable **products /services** (e.g. planning tools, HEN controller) + limited **interoperability**/ little standardization activities
  - the need to introduce proper **metrics** (including the sensors) in order to capture and allocate costs and benefits
  - The need for each energy system to **work independently** in case of a disruption

Weaknesses II/III

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- Pth processes could be a **competitor** to (other) renewable heat sources, especially in summer time.
- CO_2 emissions will only decrease, if the use of **renewable electricity can be guaranteed**
  - currently, the electricity mix in many countries is still dominated by **fossil** fuels.
  - the heating peak demand, tend to coincide with **low availability** of PV power.
- the **seasonality** of the heat demand may lead to price surges on the electricity market
- the efficiency of HP is dependent on the **availability and temperature of local heat sources**.
- Reduced **exergetic efficiency** if using electric boilers.

Weaknesses III/III

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- DHC infrastructure is **not available everywhere** / requires **retrofitting** before HP integration (du to high temp. levels)
- **higher CAPEX** due to the investments into coupling points (if not balanced with reduced investment from an electric grid point / other DHC supply units)
- The economics of the HEN are **very site-specific** (depending on taxes, subsidies, electricity prices, availability of sources for the HP…)
- **Regulatory restrictions** (unbundling) for the DSO/ TSO to access the flexibility in the heat sector
- Markets for electricity and ancillary services do **not take local needs into account** (grid constrains and local demand).

Opportunities I/II

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- higher shares of PV and wind leads to **more incentives for flexibility services** and thus supports the sector integration
- higher shares of (decentralised) renewable heat sources benefit from **low network temperatures + higher storage capacities + bi-directional structures**. Such conditions also enable the integration of (decentralised) HPs / eBs
- **decarbonization** incentives and measures can directly or indirectly support the sector integration.
- **Upcoming regulations** for energy communities can support sector integration.

Opportunities II/II

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- **green financing options**, a raising interest in **civic participation** + customers demanding zero-CO2 energy, favors investments into renewable energy projects with higher CAPEX
- Adapted **business models and revenue streams** for utilities and network operators (e.g. ancillary services) → faster amortization times.
- More **choices and opportunities** for the end users, customers and prosumers (e.g. el. market participation).
- increased focus on HEN networks in **research, industry and policy**
- More **training and education programs** upcoming as well as **an increasing number of projects on sector coupling** realized results in more knowledge and job opportunities
- **Digitalisation** could open many opportunities in network design and operation

Threats I/II

- **Silo thinking** of many actors might reduce the interest to invest in HEN
- existing **value chains** in the energy system might change
- reduced **social acceptance** due to
  - low **understandability** of the coupled system
  - Centrally coupled system could take away the **power from the individual consumer** (e.g. home batteries or individual HPs)
- High **interdependency** of the different sub-systems (a “shock” on one domain might affect the other)
- The overall **higher el. demand** will require additional CO2 free electricity supply (+ transport/distribution infrastructure) → higher CAPEX (if not planned properly)
- threat to **cybersecurity** due to multiple gateways for attacks
- **Local variable costs** of energies as a function of the locally available resources.

Threats II/II

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- Risk of stranded investments in HEN due to **uncertainties** of the future development of key factors
  - Political situation/ framework: **Subsidies, taxes**.
  - Regulatory framework/ market design: **CO2 pricing**/ implementation of ETS in the heating sector?; **ownership** of HEN; possibility for HEN technologies to **participate** in specific markets; availability of network **tariffs** rewarding flexibility services.
  - **Market** development: average electricity **prices** / times with low (or negative) electricity prices, number of flexibility providers / diffusion of coupling points and resulting **competition**.
  - **competition** with other sources of flexibility that have shorter payback times (e.g. el. Vehicles)
  - **Competition** with other energy sources, i.e. hydrogen and green gas.
  - Availability of **sources** for HPs (especially waste heat)

Live voting

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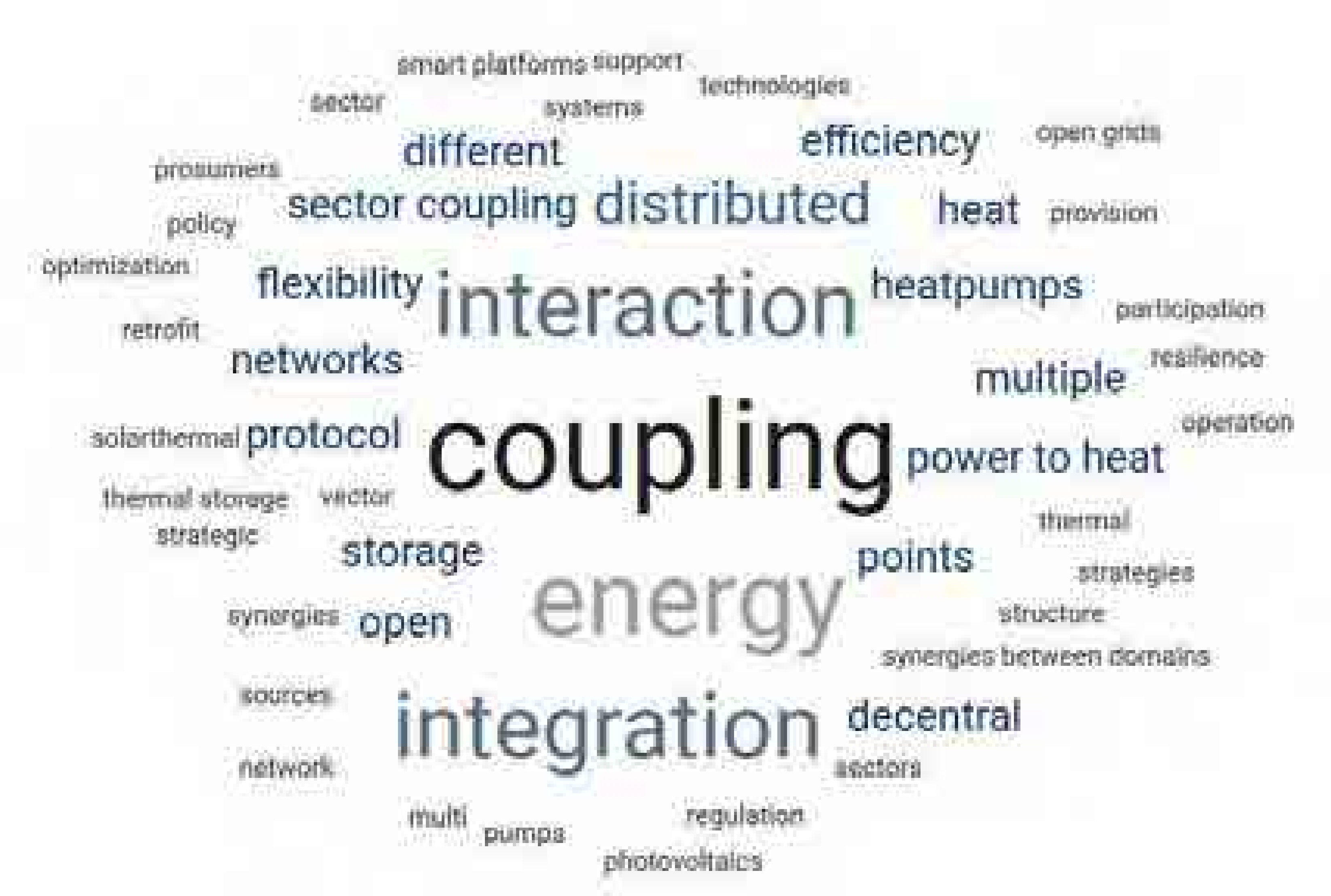
Please vote online,
multiple answers are possible

1. What are **key elements** of "hybrid energy networks" from your point of view?
2. What are the most important **strength (S) and opportunities (O)** / **weaknesses (W) and threats (T)** of Hybrid Energy Networks from your point of view?
3. What would be the **most important measures** (policy, regulation, market, awareness, training, technology/ tools …) for **improving and accelerating the implementation** of Hybrid Energy Networks?

What are key elements of "hybrid energy networks" from your point of view?



What are the most important strength (S) and opportunities (O) / weaknesses (W) and threats (T) of Hybrid Energy Networks from your point of view?

What would be the most important measures (policy, regulation, market, awareness, training, technology/ tools ...) for improving and accelerating the implementation of Hybrid Energy Networks?

Summary and next steps

- We will make the **recording of the webinar** available on YouTube and send out the **presentation slides**

- If you want to **join the IEA DHC Annex TS3**
  - talk to me to discuss your participation in terms of context
    ralf-roman.schmidt@ait.ac.at
  - Contact your national IEA DHC representative for funding opportunities
    https://www.iea-dhc.org/home/

Selected group photos

+ many others without webcam (in total about 80 participants)

Thank you for your attention!

Webinar "Hybrid Energy Networks" - Austria Goes International - Block II",

23rd April 2020

Ralf-Roman Schmidt AIT, Austria

Contact: ralf-roman.schmidt@ait.ac.at

More information at

https://www.iea-dhc.org/the-research/annexes/2017-2021-annex-ts3-draft.html

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