

SWEET DeCarbCH

Decarbonisation of Cooling and Heating in Switzerland

**28. Tagung des BFE-Forschungsprogramms «Wärmepumpen und Kältetechnik»
22. Juni 2022, BFH Burgdorf**

Martin Patel (UNIGE), Beat Wellig (HSLU), Stefan Bertsch (OST), Gianfranco Guidati (ETHZ)
(Management team)



Zürcher Hochschule
für Angewandte Wissenschaften



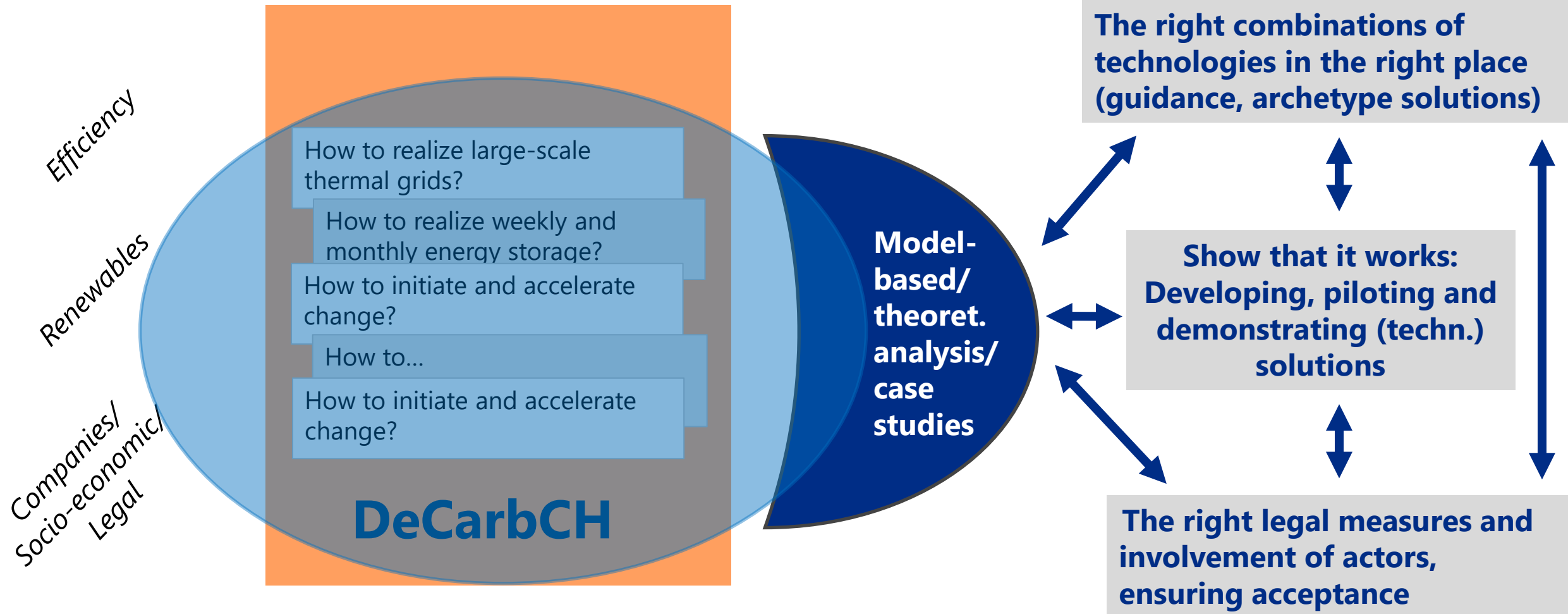
Content

- Intro
- Thermal grids
- Industry
- Case studies
- Legal & Socio-economic
- Organisation

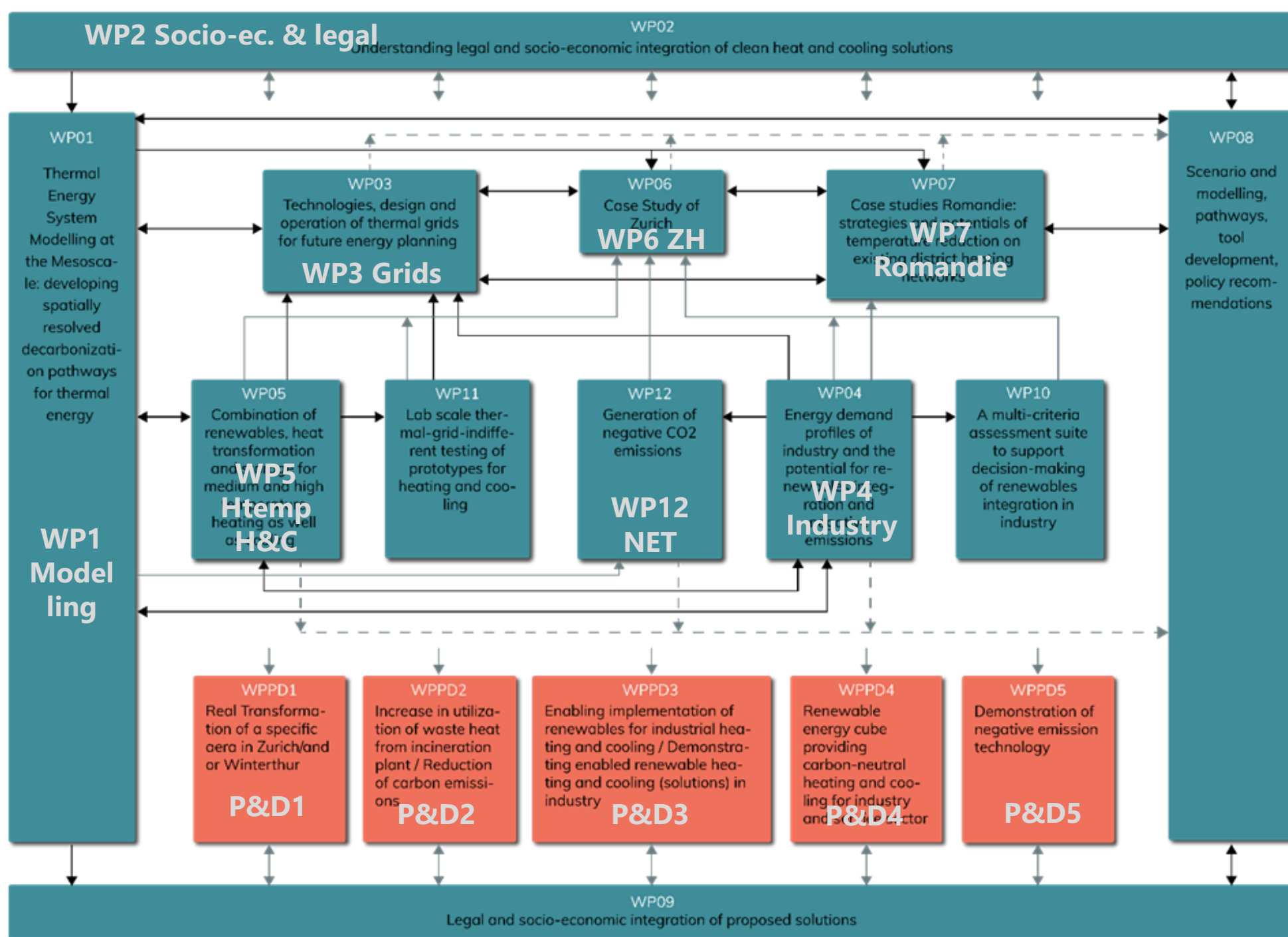
DeCarbCH in a nutshell

Questions

Solutions



➔ **Targeted impact:** **Facilitate, speed up and de-risk** implementation of renewables for heating and cooling in i) **residential sector** and ii) **service and the industry sector**



Thermal Grids

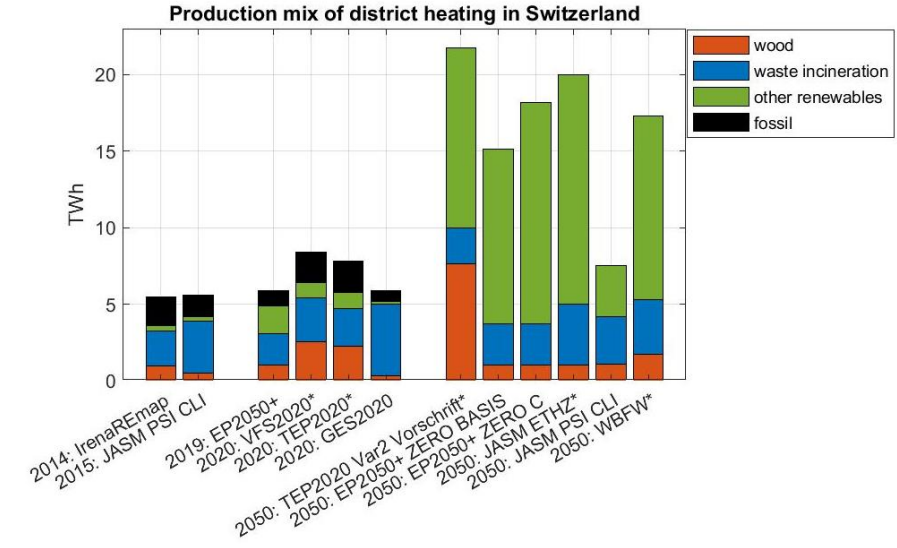
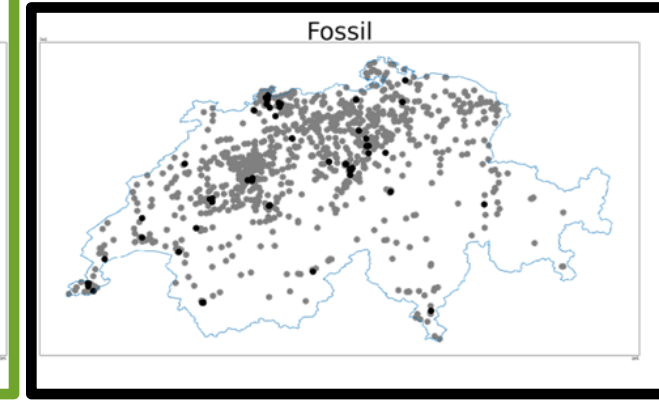
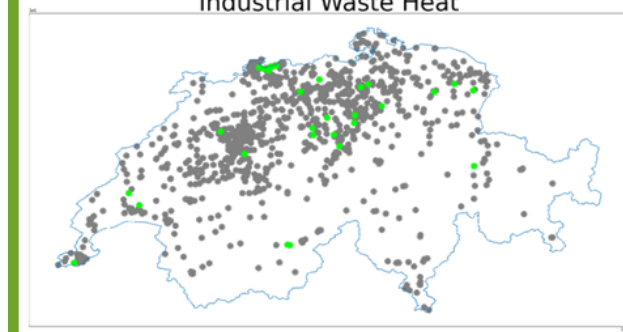
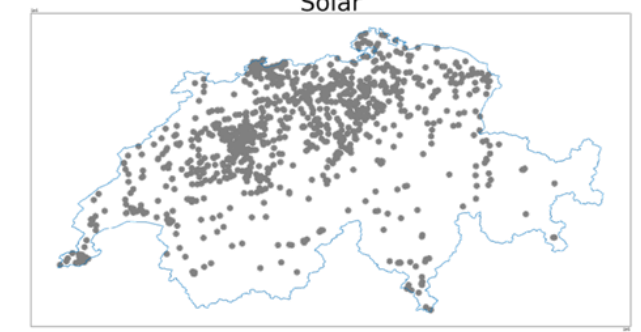
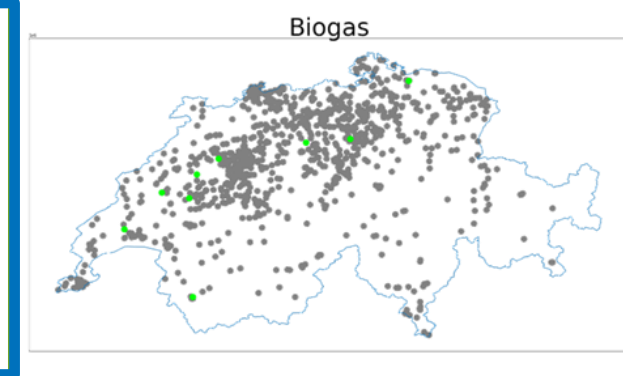
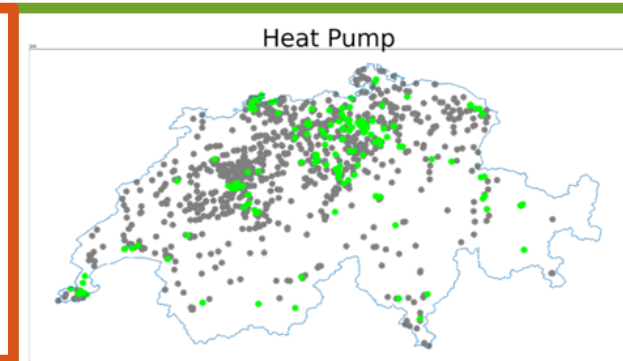
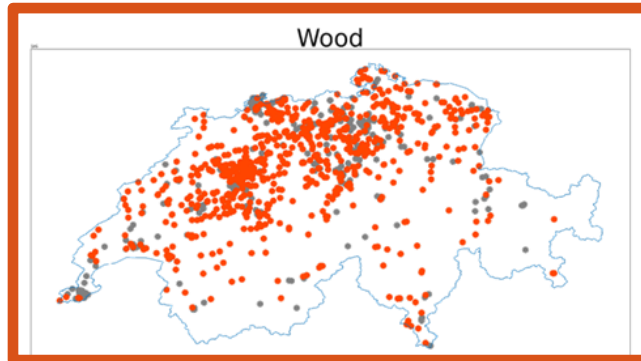
Willy Villasmil (HSLU)

Tobias Sommer (HSLU)

Jonathan Chambers (UNIGE)

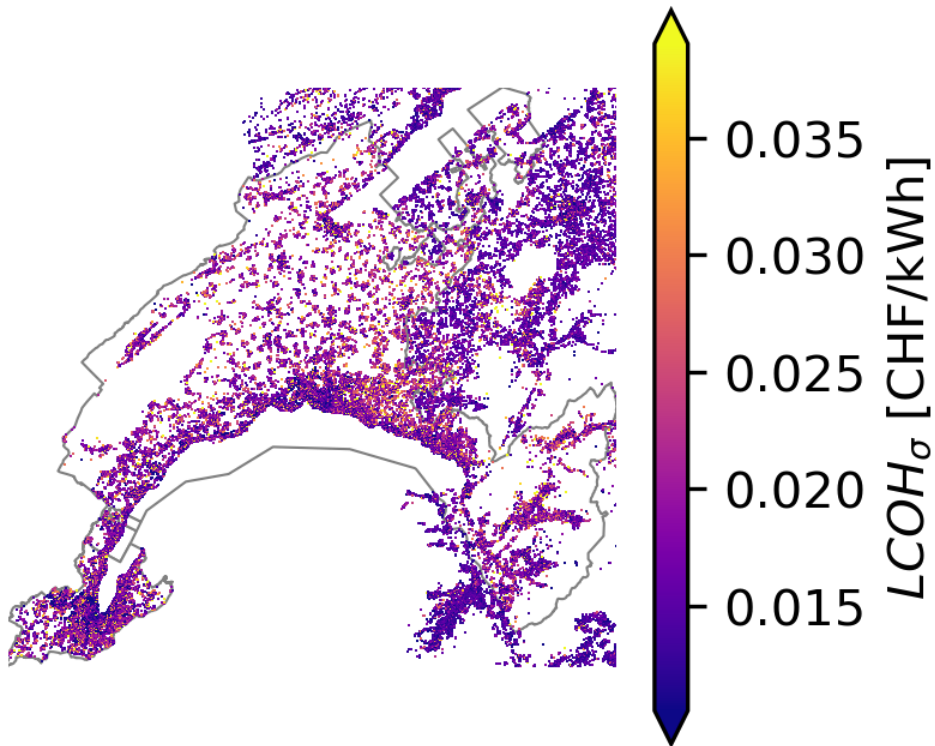


Thermal networks – current status in Switzerland

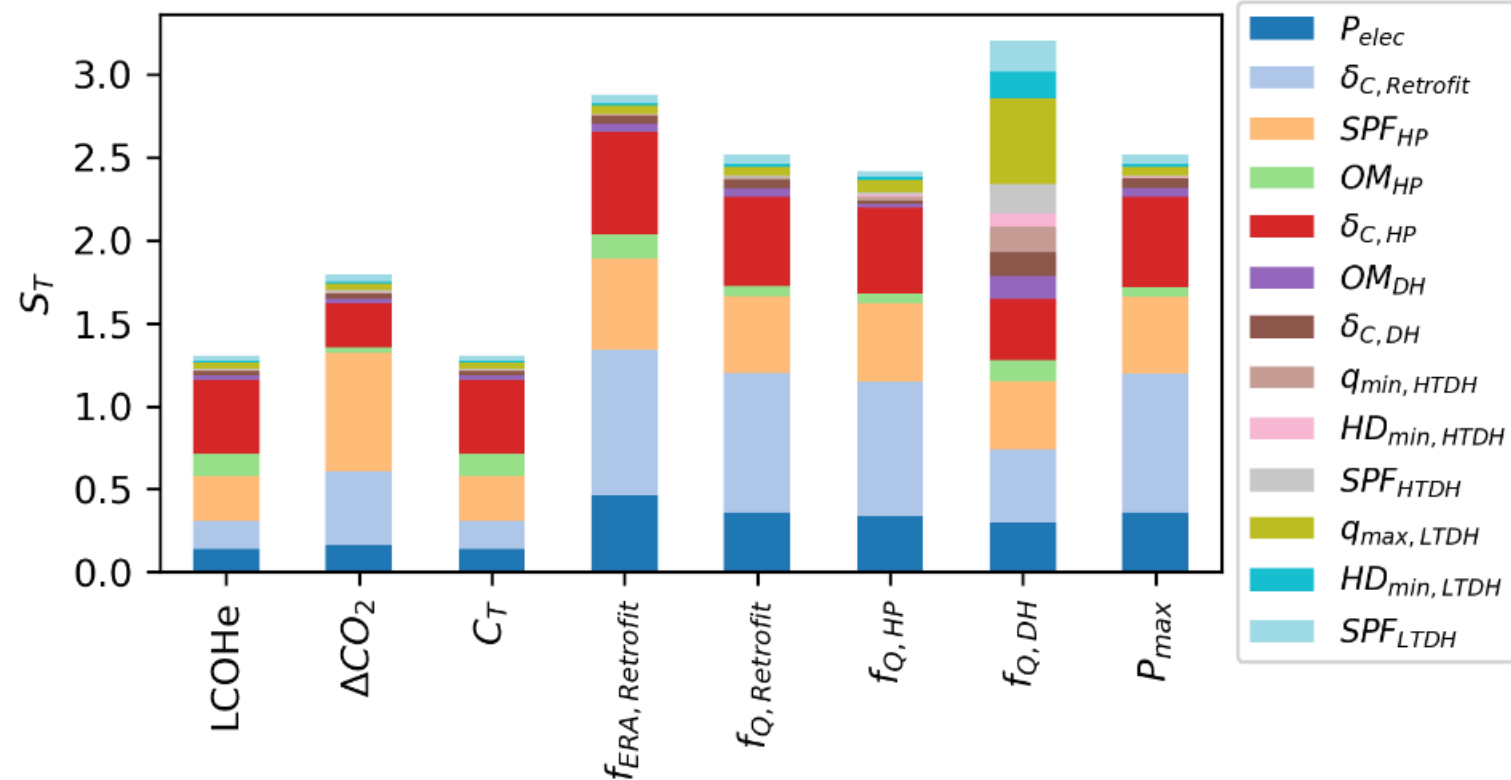


High sensitivity

- Limited usefulness of cost-optimal approach



Spatial variance of LCOH in GSA

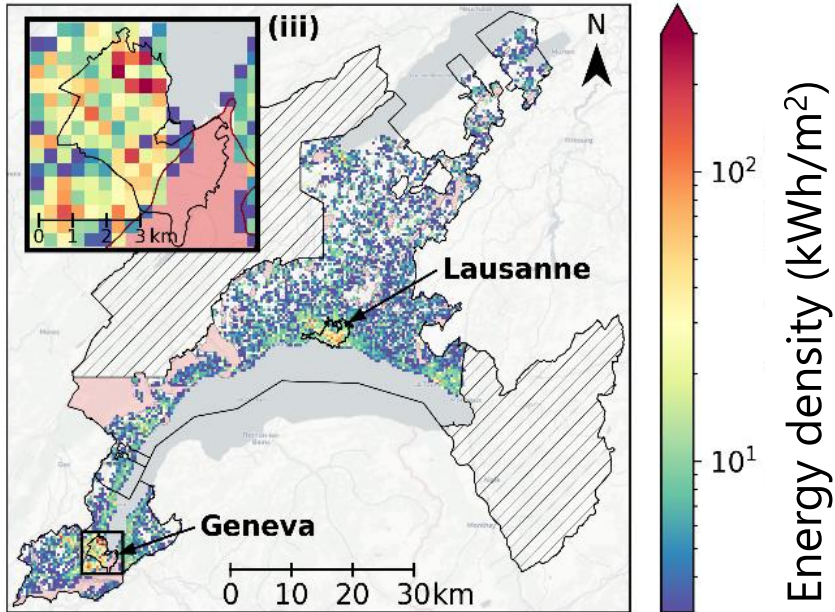


Sobol Sensitivity Index for model KPIs showing high impact of efficiency related parameters

Chambers, J., Zuberi, M. J. S., Streicher, K. N. & Patel, M. K. (2021). Geospatial global sensitivity analysis of a heat energy service decarbonisation model of the building stock. *Applied Energy*, 302, 117592. <https://doi.org/10.1016/j.apenergy.2021.117592>

Benefits of integrating cooling & regeneration GSHP

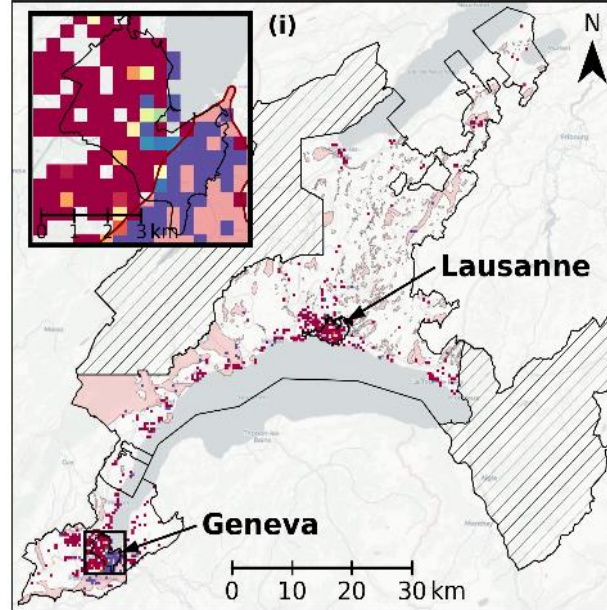
Technical potential for heating



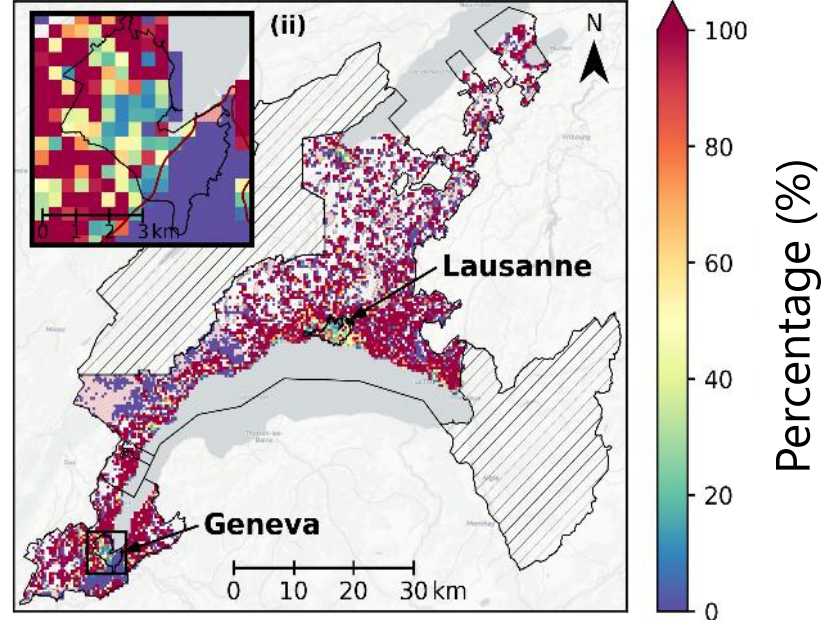
Conversion rate 90%
Max heat injection > 330 kWh/m²
Max heat extraction > 300 kWh/m²

Useful potential to supply heating and cooling demands

Cooling



Heating



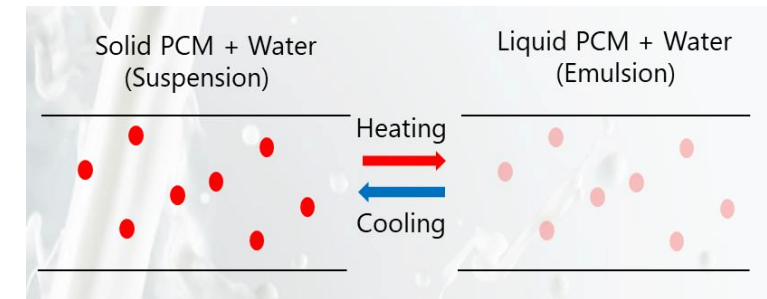
Seasonal regeneration and DHC covering up to ~85% of
heating and cooling demands

Walch*, A., Li*, X., Chambers, J., Mohajeri, N., Yilmaz, S., Patel, M., & Scartezzini, J.-L. (2022). Shallow geothermal energy potential for heating and cooling of buildings with regeneration under climate change scenarios. Energy, 123086. <https://doi.org/10.1016/j.energy.2021.123086>

Thermal grids and energy storage

Online (Mini-)Workshop on District Heating and Energy Storage, 6 April, 2022, 14:00-16:00

- Martin Jutzeler, ewb: Daily, weekly and seasonal energy storage
- Matthias Sulzer, EMPA and Jörg Worlitschek, HSLU: Heating fluids with liquid-viscous phase change in thermal grids
- Fabrice Bentivoglio, CEA: 180 kWh PCM heat storage at the Flaubert substation of the
- Remo Waser, Cowa Thermal Solutions (Spinoff of HSLU): Encapsulated phase change materials for thermal grids
- Florian Hemmerlein, ecoenergy systems: Design and operational experience with Energy Tower Schwyz



Flaubert PCM storage



Energy Tower Schwyz



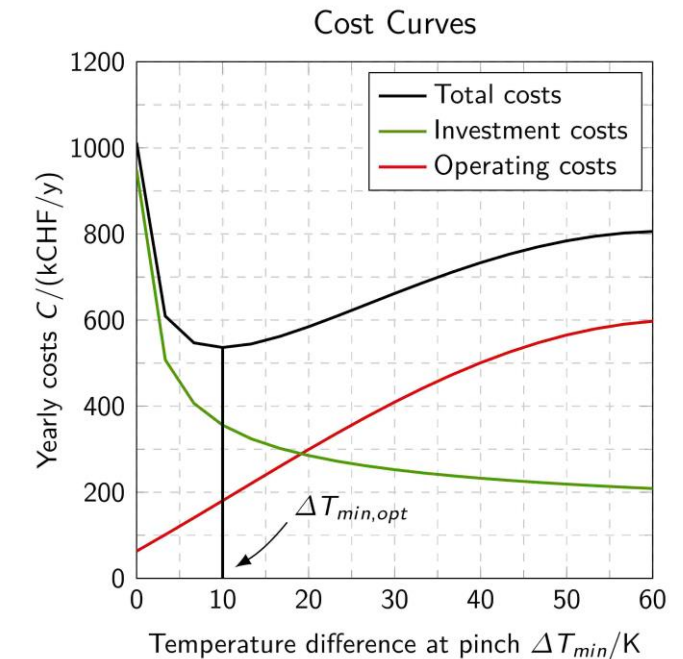
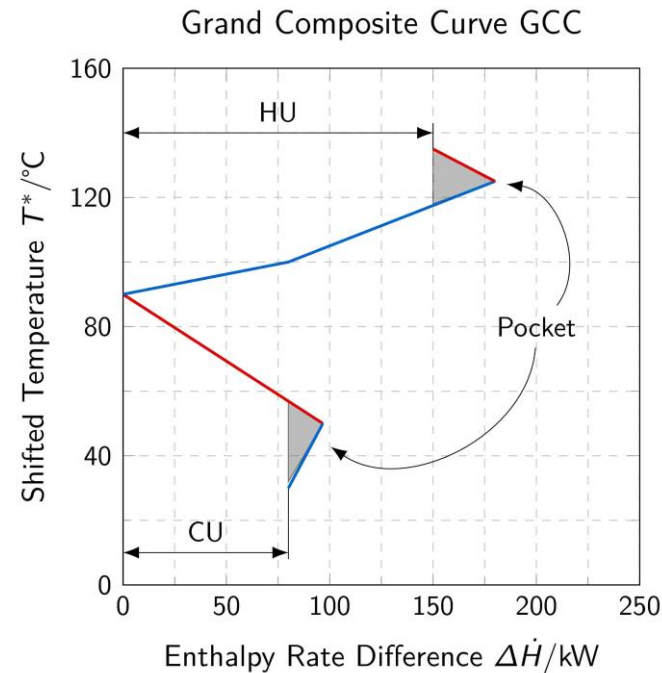
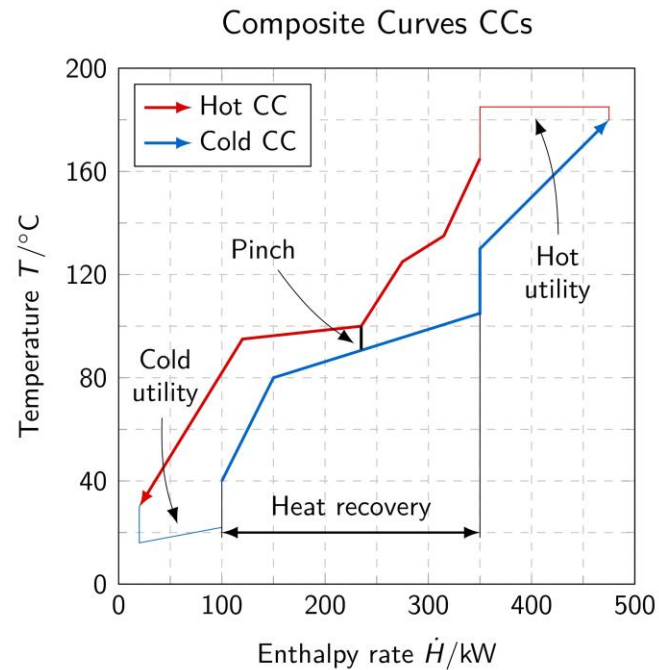
Industry

Beat Wellig (HSLU)
Stefan Bertsch (OST)



Process Integration is key to decarbonizing industry

System orientated method to determine the optimal energy input and plant design under the condition of minimal cost. **Pinch Analysis** is the most mature tool for energetic Process Integration.



Process Integration is (by far) the most effective method to save energy and reduce CO₂ emissions in industry

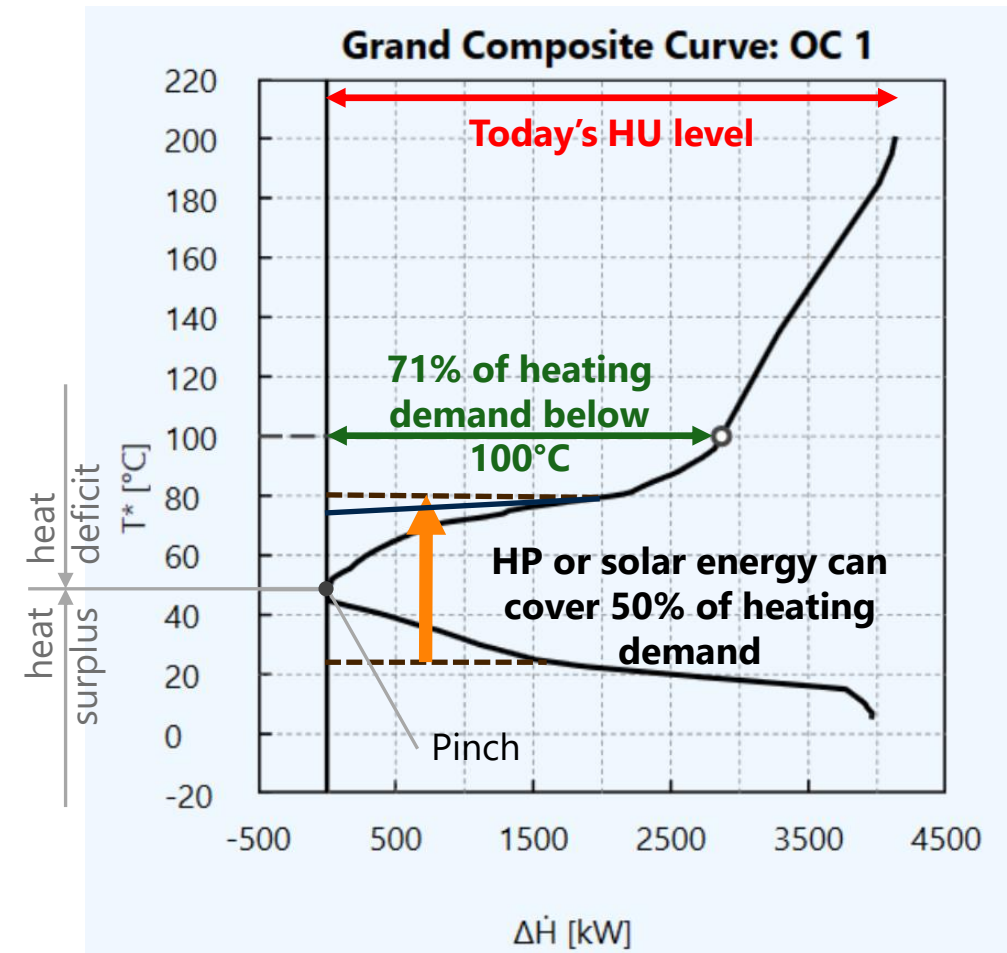
Typical saving pot. 10-40%, economic saving pot. min. 3 TWh/a, net savings per reduced tonne of CO₂ approx. 380 CHF/t CO₂

Role of Process Integration for renewables integration

Process Integration provides the basis for the **optimal integration and implementation** of

- **energy efficiency measures**
- **renewable energy sources**
- excess heat use (e.g. in thermal grids)
- Negative Emissions Technologies (NETs)

Process Integration provides a systematic approach which supports a well-informed decision-making process!



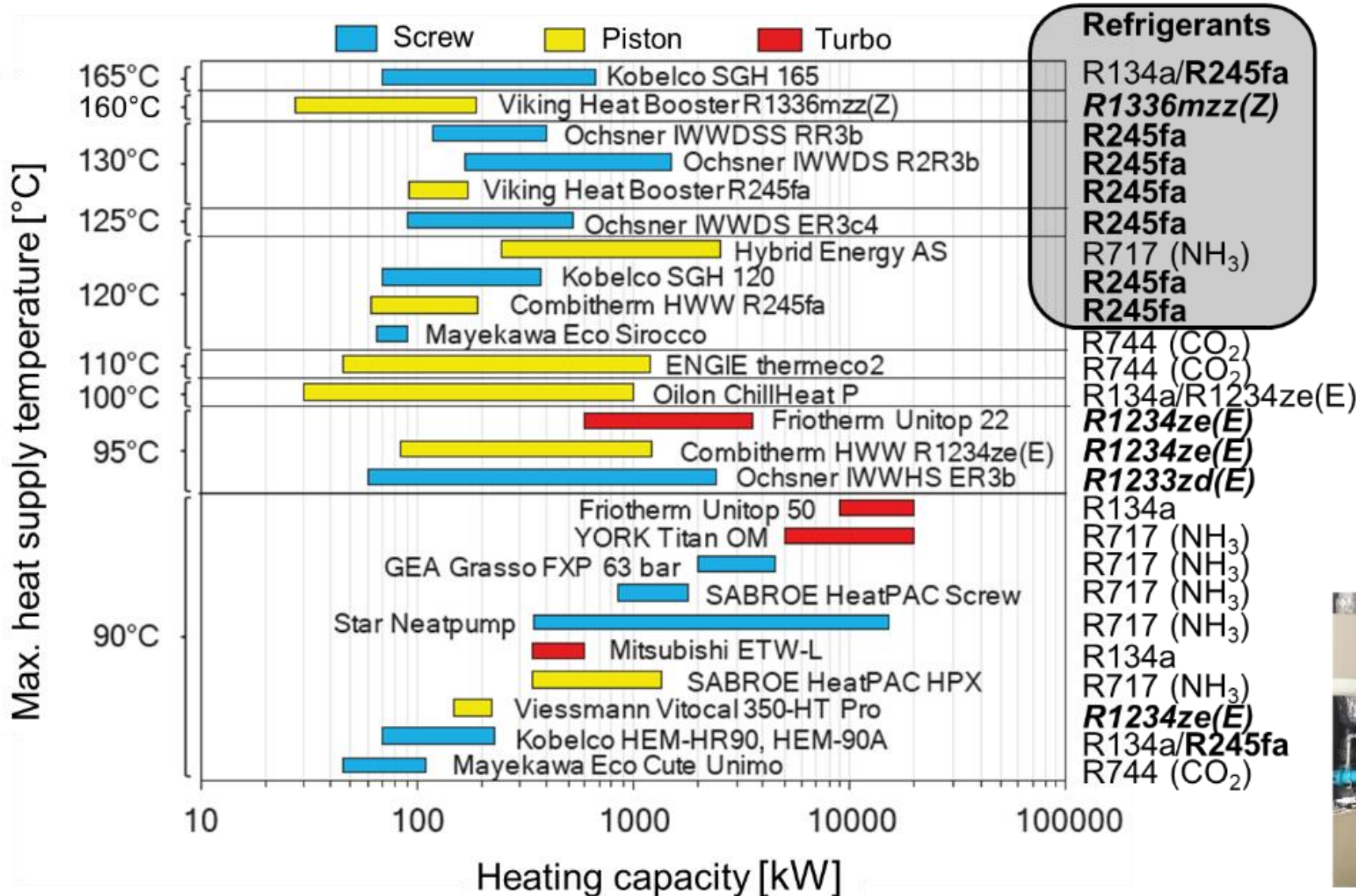
GCC of a dairy company

Expected results until the end of 2024

Quantify and assess the **integration opportunities** for renewables and excess heat usage based on the energy demand profiles and Process Integration techniques:

Industrial Company				
First priority: Energy Efficiency Measures (EEMs), <u>always</u> reduce heating and cooling demand, as well as excess heat				
Renewable Heating		Renewable Cooling		Excess heat (that cannot be used internally)
< 150 °C ¹⁾	> 150 °C	< T "ambient"	> T "ambient"	
• Heat pumping ²⁾: process-integrated or using renewable heat sources • Thermal grids ³⁾ • Solar thermal • Geothermal	• Fuel shifting: combustion, CHP: - Biomass* - Biogas - Wastes - Hydrogen • Thermal Grids ⁴⁾ • P2H • Deep geothermal	• Refrigeration technologies ²⁾	• Free cooling - Air - River water - Lake water - Ground water • Low-temperature thermal grid as heat sink	• Direct use or with temperature lift, e.g. for thermal grids • Conversion into electricity e.g. ORC • Conversion into cold, e.g. absorption chiller

Status of high temperature heat pumps



HeatBooster S4
(Viking Heat Engines AS)

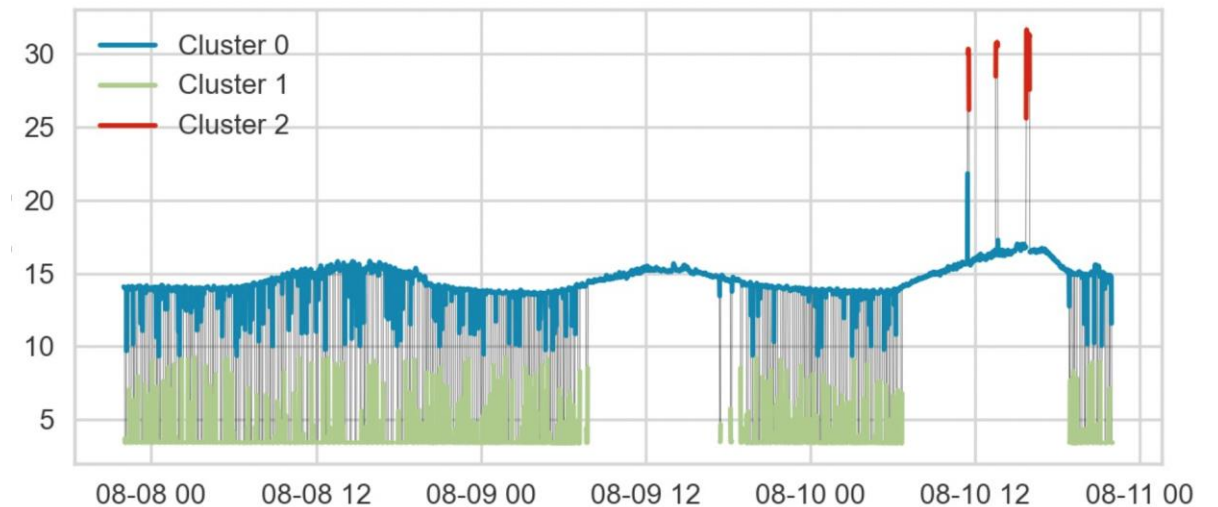
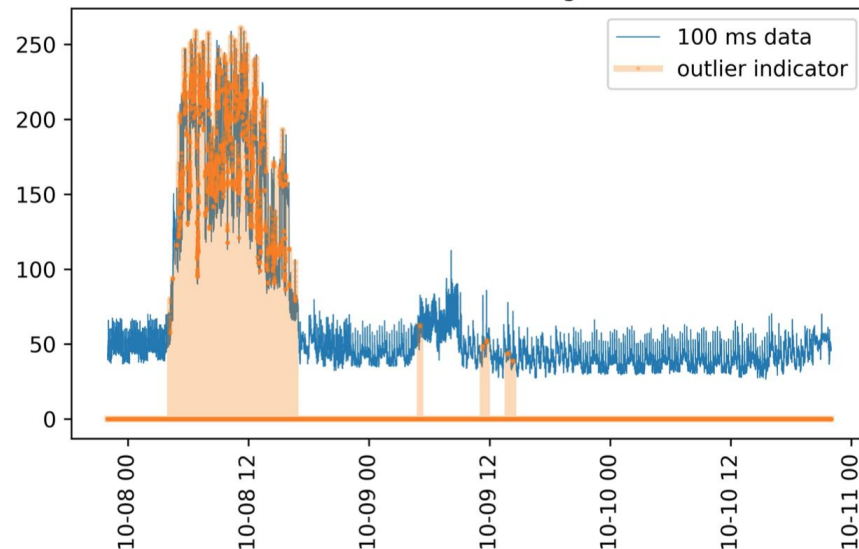


Kobelco SGH 120/165
(Steam Grow Heat Pump)



Further studies

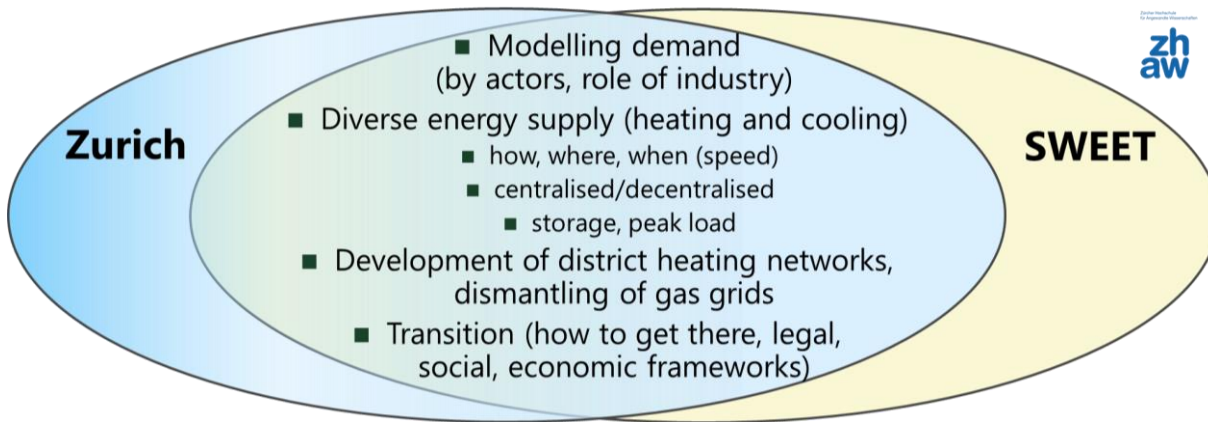
- Solar thermal systems for industrial heat
- Digital twins to optimise processes
- New finance models for decarbonization
- Combination with storage of medium and high temperature heat



Case studies

Pierre Hollmuller (UNIGE)

Armin Eberle (ZHAW)



Legal & Socio-economic

Matthias Speich (ZHAW-INE)
Silvia Ulli-Beer (ZHAW-INE)
Beatrix Schibli (ZHAW-ZOW)
Reto Walther (ZHAW-ZOW)
Andreas Abegg (ZHAW-ZOW)



District Heating (2022)

- Journal article on district heating (2022): «Andreas Abegg/Nagihan Musliu, Die Fernwärmeversorgung – eine rechtliche Einordnung, sui generis 2022»
- Doctoral thesis by Annette Zoller-Eckenstein on the construction of thermal grids (ZHAW/University of Lucerne): Work in Progress

1. Background

2. Planning, Construction and Running

1. Competences
2. Energy planning
3. Structure plan (Art. 8 Spatial Planning Act)
4. Land use plans (Art. 14 Spatial Planning Act)
5. Building permits / Use / Procedure



3. Compulsory connection and right to connection

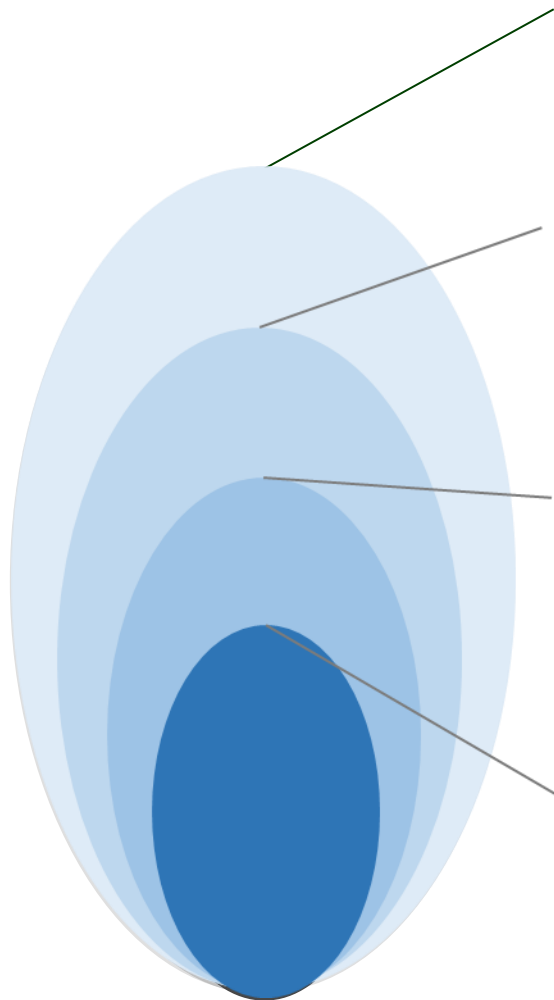
Current research foci

Zürcher Hochschule
für Angewandte Wissenschaften



School of
Engineering

INE Institut für
Nachhaltige Entwicklung



**Public /
societal value**

**Ecosystem
value**

**Business
value**

**Customer
value**

**Fair tariff
models
for district
heating**

**Intermediary
resources to support
decarbonization**

**Options to valorize
circular energy use in
multi-actor systems**

KTТ (Knowledge and Technology Transfer)

- Website www.sweet-decarb.ch
- Newsletter
- Lunch lectures

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Home Consortium Work Packages Events News Further Info

Lunch Talk - Negative Emission Technologies

10.05.2022 12:00
Time: 12:00 to 12:45 (CET)
Venue: via Zoom

Negative Emission Technologies, presentation given by [Gianfranco Guitdati](#) (ETH)

Negative Emission Technologies (NET) remove CO₂ from the atmosphere and lock them away for a sufficiently long time. The two main ways to extract CO₂ are biomass and technical means such as Direct Air Capture (DAC). The main sinks are the subsurface, for instance depleted oil and gas fields, the soil via biochar production and wood that is used for construction. NET is needed to achieve our ambitious climate goals, however, it cannot be considered in isolation but in all its interactions with the rest of the energy sector.

The talk will present various scenarios how we can achieve net-zero GHG emissions for Switzerland, highlighting the role of NET.

Soon on our YouTube channel



Lunch Talk - Long term thermal energy storages

18.01.2022 12:00
Time: 12:00 to 12:45 (CET)
Venue: via Zoom

Long term thermal energy storages: Opportunities for Switzerland, presentation given by [Jörg Worlitschek](#) (HSLU)

Aiming for complete decarbonization of the heating and cooling sectors will lead to a series of major challenges, as we highlight within our SWEET DeCarbCH project network.

One of these major challenges is based on the seasonal occurrence of space heating in winter. This challenge is of even stronger importance with solar power being foreseen to play a major role in Switzerland, and its production peak in summer. Recent Swiss energy system simulations and considerations show opportunities in the order of magnitude around 5 TWh of heat to be shifted to satisfy peak demands in winter.

Therefore, long-term thermal energy storage is one of the key enabling technologies tackling this summer/winter mismatch of energy supply and heat demand.

Countries like Denmark have shown that massive long-term seasonal storage installations can be applied on district and even town levels. The 'economy of scale' has been proven to play a major role for these installations. Regarding a push of long-term thermal storage in Switzerland, economical, sociopolitical, and technological aspects will be of importance.

This talk will focus on:

- opportunities and challenges for long term thermal energy storage in Switzerland,
- technological possibilities for different scales and their application will be presented,
- new developments including works at our group will be shown, and
- an outlook on future requirements and steps will be suggested.



Watch on YouTube

Lunch Talk - Industrial Heat Pumps

09.11.2021 12:00
Time: 12:00 to 12:45 (CET)
Venue: via Zoom

Industrial Heat Pumps - State-of-the-Art in Research and Market, presentation given by [Cordin Arpagaus](#) (OST)

Heat pumps in industry enable increased energy efficiency and drive decarbonization to ensure a reliable heating and cooling supply. Moreover, they represent an environmentally friendly and economically attractive alternative to conventional heating systems thanks to their efficiency. Therefore, large heat pumps are attractively used in district heating networks of municipalities and industrial heat pumps mainly in waste heat recovery.

The first part of this lunch talk gives an overview of industrial heat pump technologies already on the market and also provides guidance to best select and plan the installation. The major barriers are discussed, and numerous realized application examples of integrated industrial heat pumps from Switzerland are presented.

The second part is about the research activities in the field, in particular:

- steam generating heat pumps,
- heat pumps with synthetic HFO refrigerants,
- heat pumps with refrigerant mixtures for large temperature glides,
- transcritical heat pumps,
- heat pumps with inert gases, and
- heat pumps for both heating and cooling.

The advantages and disadvantages of each technology are discussed.

Finally, some related research projects at OST will also be shown.



View on YouTube

Core, associate and cooperation partners

10 Core

1	Université de Genève	UNIGE (UNIGE-EE, Patel)
2	Eidgenössische Material- und Prüfungsanstalt	EMPA (Orehounig)
3	Eidgenössische Technische Hochschule Zürich	ETHZ (Guidati)
4	Hochschule Luzern	HSLU (HSLU-IGE, Villasmil/Mennel)
5	Hochschule Luzern	HSLU (HSLU-TES, Stamatiou/Worlitschek)
6	Hochschule Luzern	HSLU (HSLU-TEVT, Wellig)
7	OST Hochschule für Technik Buchs	OST (OST-IES, Bertsch)
8	OST Hochschule für Technik Rapperswil	OST (OST-SPF, Häberle)
9	Zürcher Hochschule für Angewandte Wissenschaften	ZHAW (ZHAW-INE, Eberle)
10	Zürcher Hochschule für Angewandte Wissenschaften	ZHAW (ZHAW-ZOW, Abegg)

6 Associate

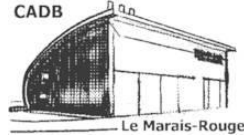
11	Centre de Recherches Energétiques et Municipales	CREM (Ragers)
12	Haute Ecole d'Ingénierie et de Gestion du Canton de Vaud	HEIG-VD-IGT (Duret, Krummenacher)
13	Institut für Nachhaltigkeits- und Demokratiepoltik	INDP (Bolliger)
14	Scuola universitaria professionale della Svizzera italiana	SUPSI (Curti)
15	Université de Genève	UNIGE (UNIGE-GE, Moscariello)
16	Université de Genève	UNIGE (UNIGE-SE, Hollmuller)

Cooperation Partners (1/2)

Cities

- City of Zürich  Stadt Zürich
- City of Winterthur  Stadt Winterthur

Associations

- Swissolar (Swiss Solar Energy professionals Association) 
- VFS/ASCAD (Verband Fernwärme Schweiz, L'Association Suisse du chauffage à distance) 
Die Komfort-Energie
- VBSA (Verband der Betreiber Schweizerischer Abfallverwertungsanlagen) 
- VSG (Verband der Schweizerischen Gasindustrie) 
- CADB (Société cooperative de chauffage à distance à bois de Marais-Rouge) 
- EnAW (Energie-Agentur der Wirtschaft) 
DER WIRTSCHAFT EnAW
- energie-cluster.ch  energie-cluster.ch

Public sector – Industrial

- Verein für Abfallentsorgung Buchs (VfA Buchs)



Public sector – Urban

- GSG (energienetz GSG AG, St. Galler Stadtwerke) 
- energie360° AG (e360) 
- Energie Wasser Bern (ewb) 
- Services Industriels de Genève (SIG) 
- Viteos 
toutes vos énergies
- Technische Betriebe Wil 

Public sector – Transport

- SBB AG  **SBB CFF FFS**

Cooperation Partners (2/2)

Privat sector – Engineering firm

- Abicht Zug AG  **Abicht Gruppe**
- Amstein + Walthert AG  **AMSTEIN+WALTHERT**
- Anex Ingenieure AG 
- eicher+pauli Olten AG **eicher+pauli**
- Weisskopf Partner GmbH 
- Lauber IWISA AG 

Privat sector – Consulting

- INFRAS AG 
- Helbling Beratung + Bauplanung AG 

Privat sector – Industrial

- BASF Schweiz AG 
- Juracime SA **JURA** 
- Emmi Schweiz AG 
- Coop Genossenschaft **coop**
- Migros-Genossenschafts-Bund **MIGROS**
- Feldschlösschen Supply Company AG 
- Belimo Automation AG **BELIMO** 
- Sika Manufacturing AG 
- Sefar AG **S E F A R** 
- Cowa Thermal Solutions AG 
- Schenk AG 
- Casale SA 
- Nestlé 
- Danfos 



Networking Conference 25/26 April 2022 Seminarzentrum Campus Sursee

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Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra