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Decarbonisation of Cooling and Heating in Switzerland

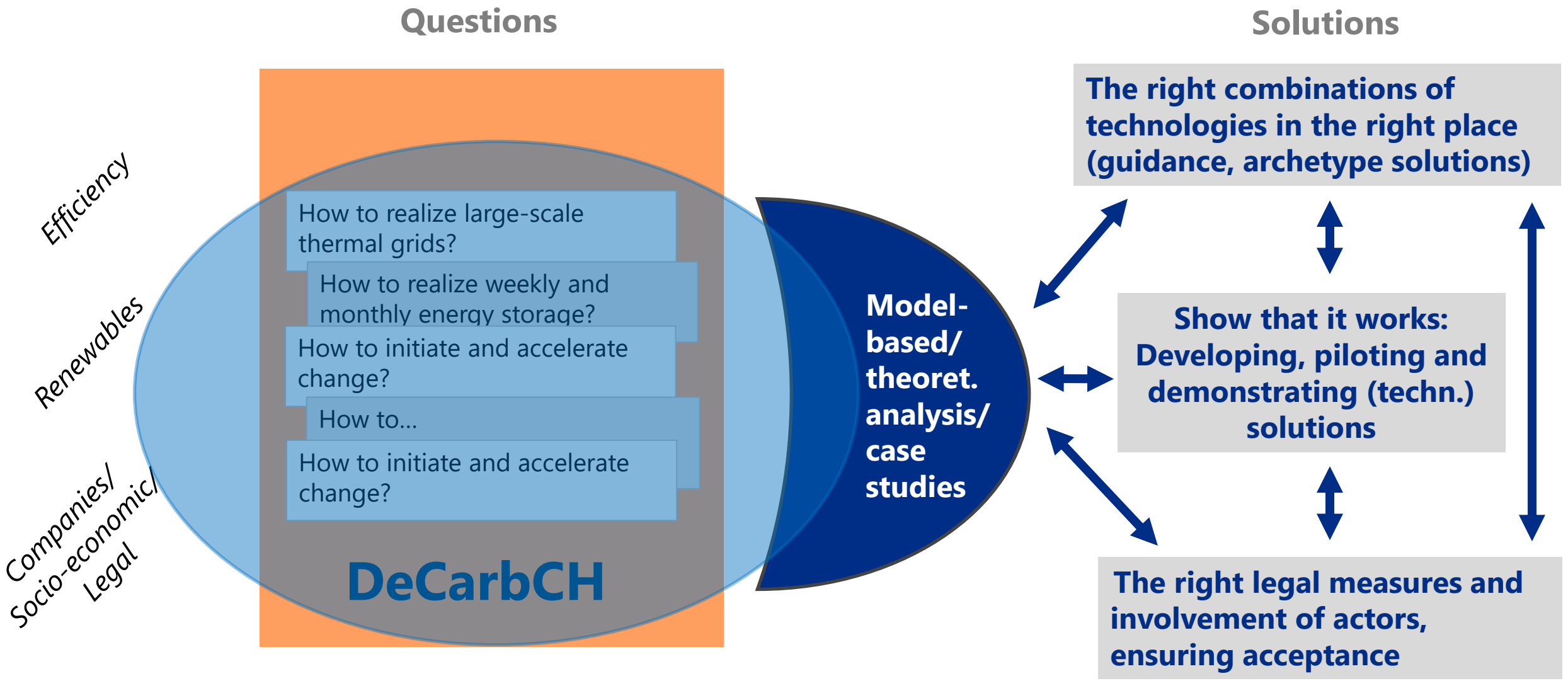
28. Tagung des BFE-Forschungsprogramms «Wärmepumpen und Kältetechnik»
22. Juni 2022, BFH Burgdorf

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

Content

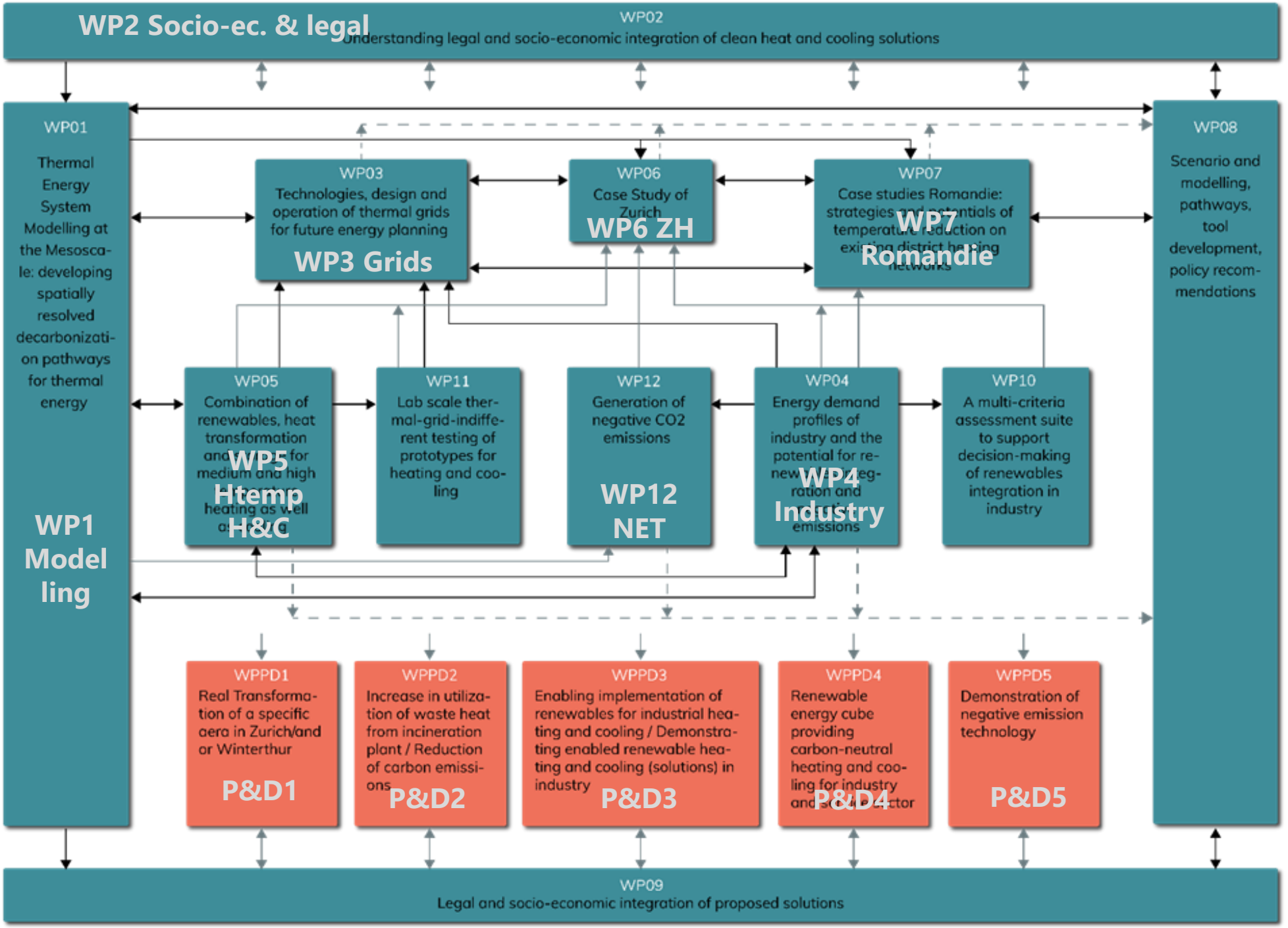
- Intro
- Thermal grids
- Industry
- Case studies
- Legal & Socio-economic
- Organisation

DeCarbCH in a nutshell



➔ **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**

DeCarbCH by WPs



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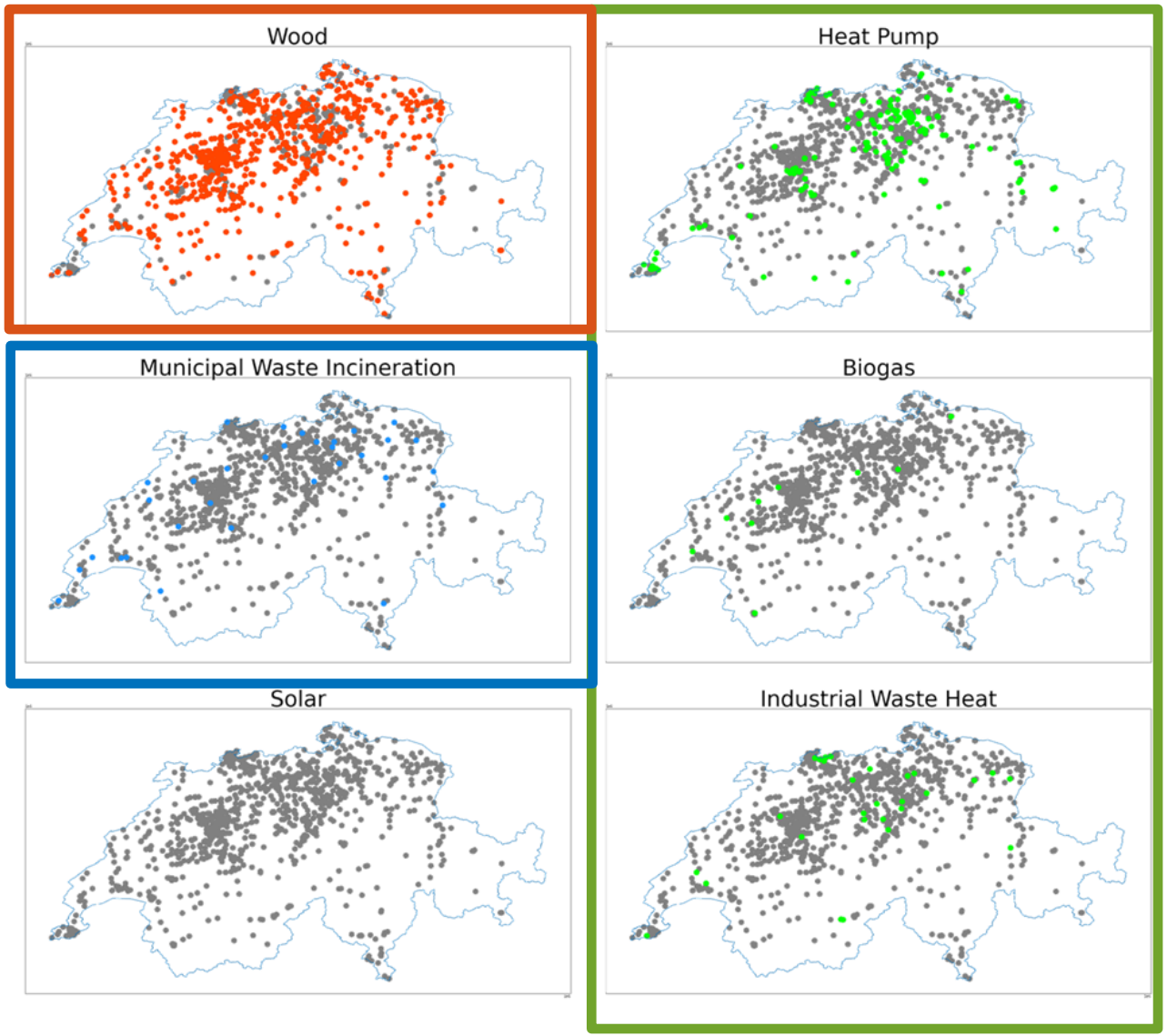
Thermal Grids

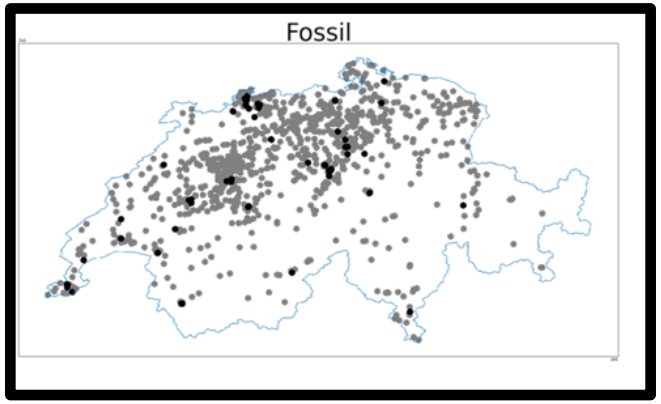
Willy Villasmil (HSLU)

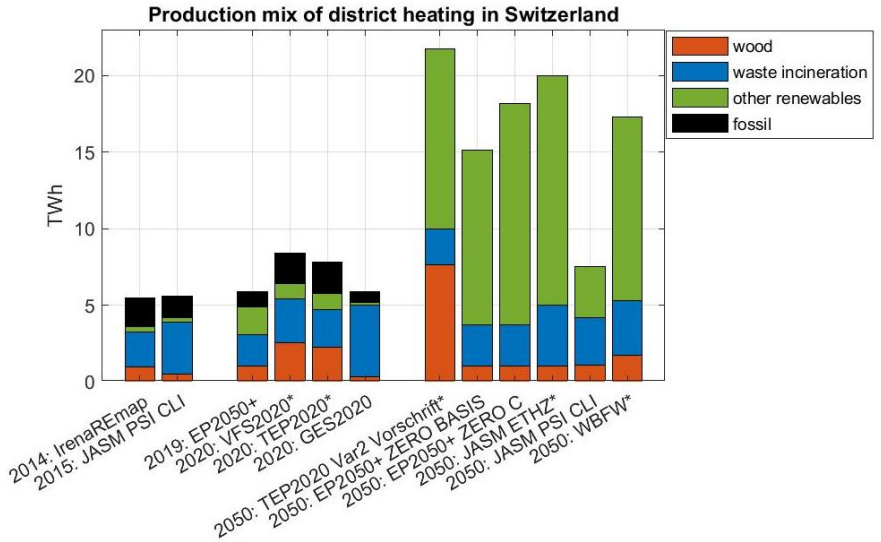
Tobias Sommer (HSLU)

Jonathan Chambers (UNIGE)

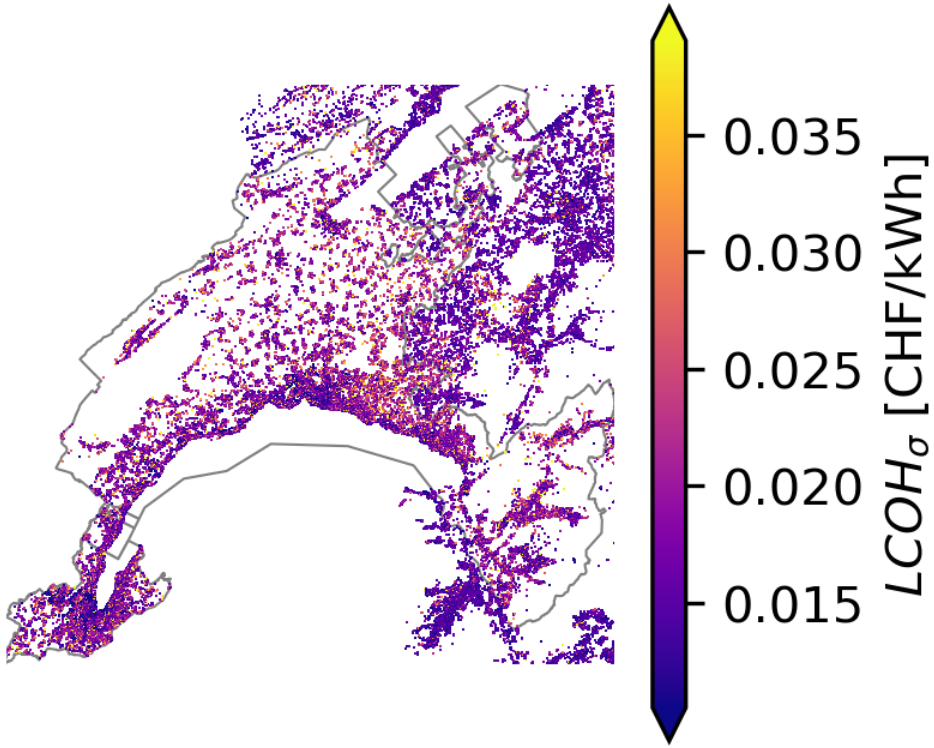
Thermal networks – current status in Switzerland



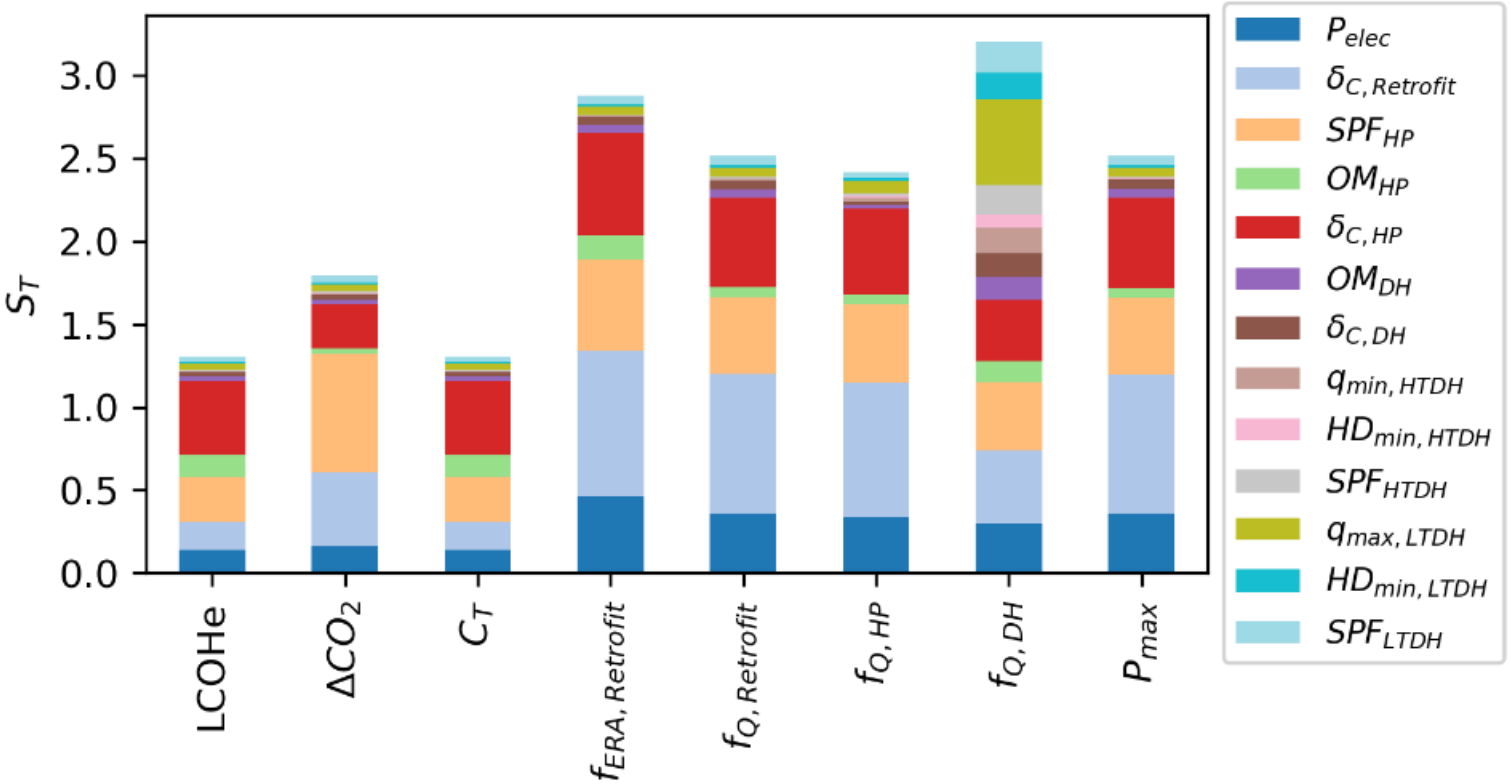




High sensitivity
- Limited usefulness of cost-optimal approach



Spatial variance of LCOH in GSA



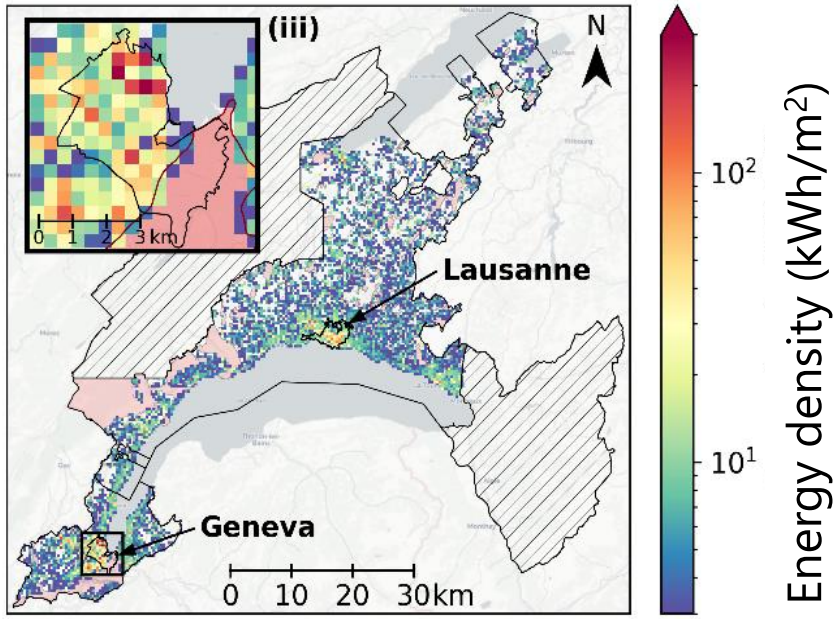
Sobol Sensitivity Index for model KPIs showing high impact of efficiency related parameters

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

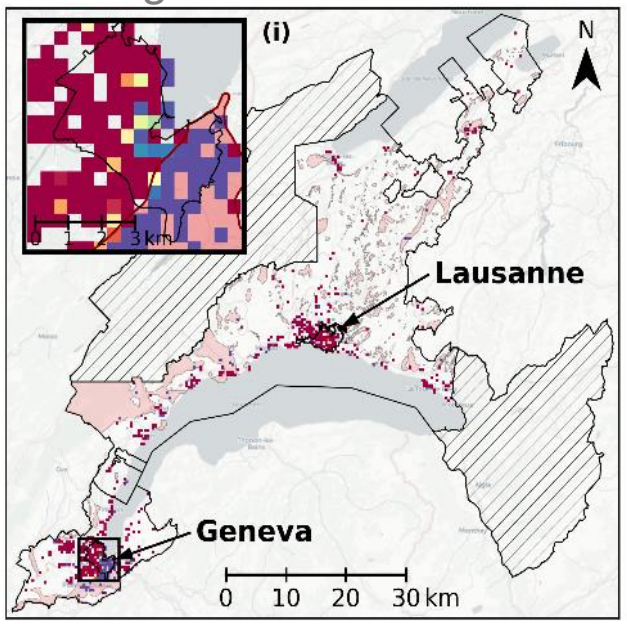
GSHP

Technical potential for heating

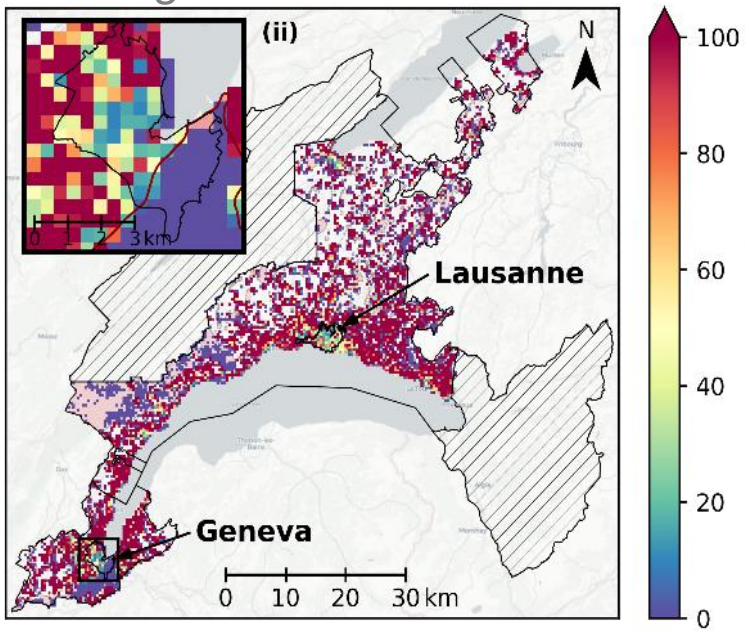


Useful potential to supply heating and cooling demands

Cooling



Heating



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

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

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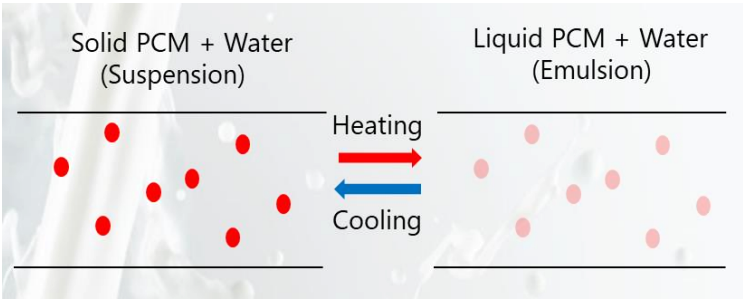
ewb

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

https://www.sweet-decarb.ch/news/article/online-mini-workshop-on-district-heating-and-energy-storage-on-6-april-2022-1400-1600

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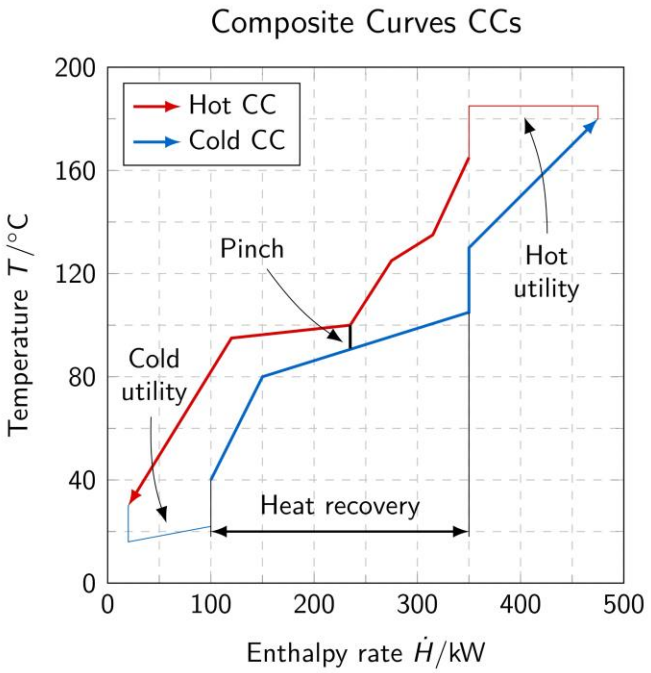
Industry

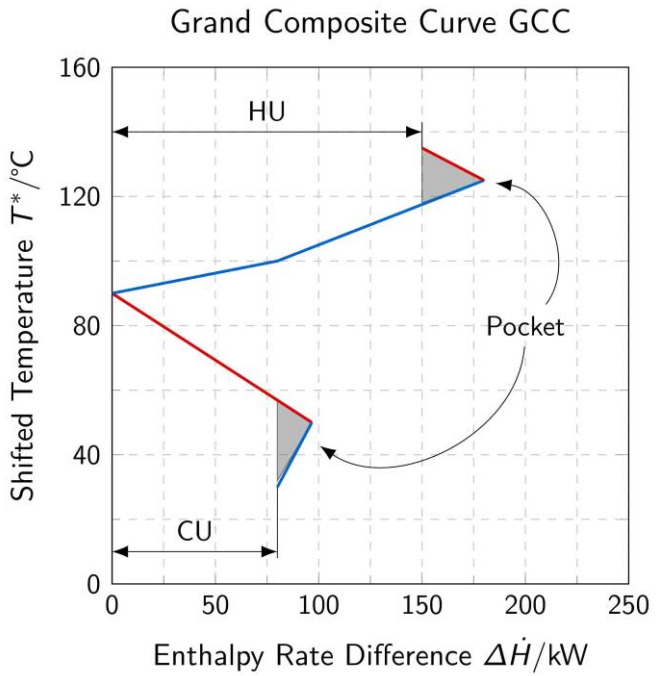
Beat Wellig (HSLU)

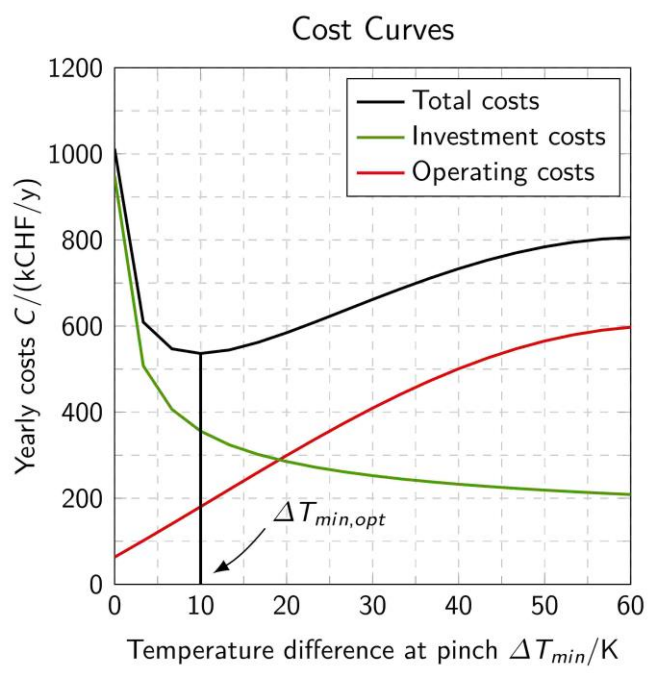
Stefan Bertsch (OST)

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 CO_2 emissions in industry

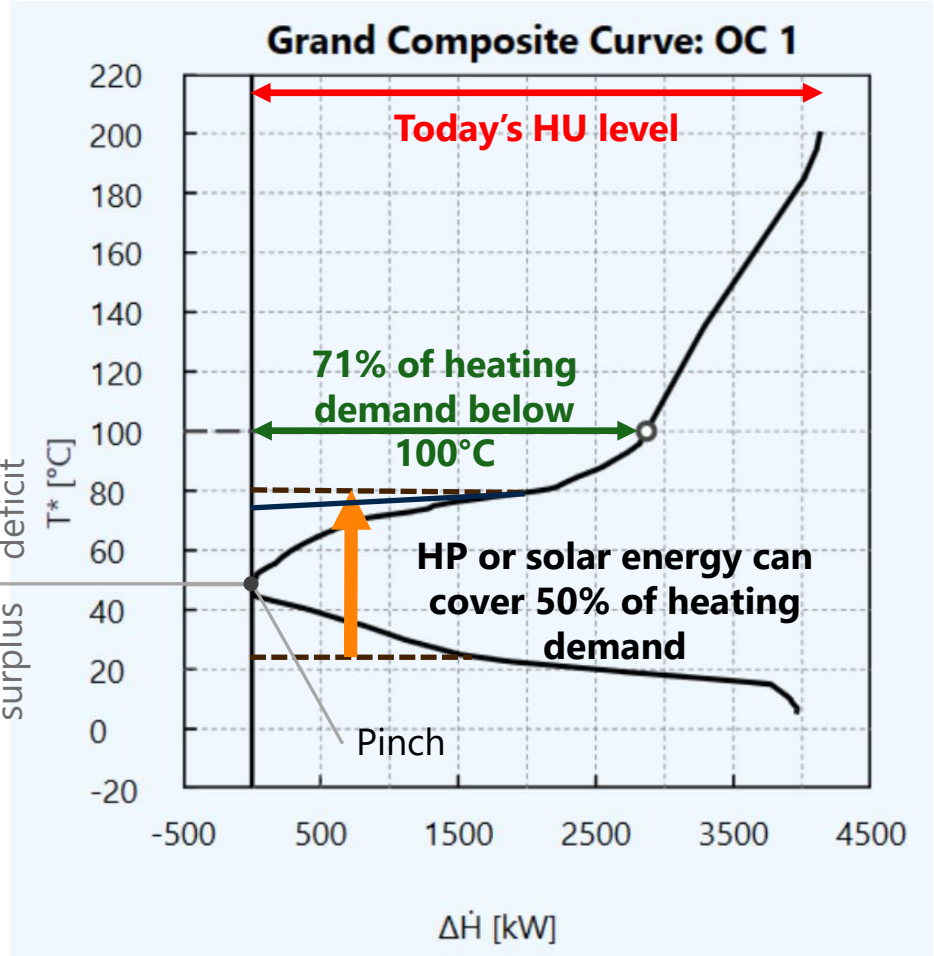
Typical saving pot. 10-40%, economic saving pot. min. 3 TWh/a, net savings per reduced tonne of CO_2 approx. 380 CHF/t CO_2

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!



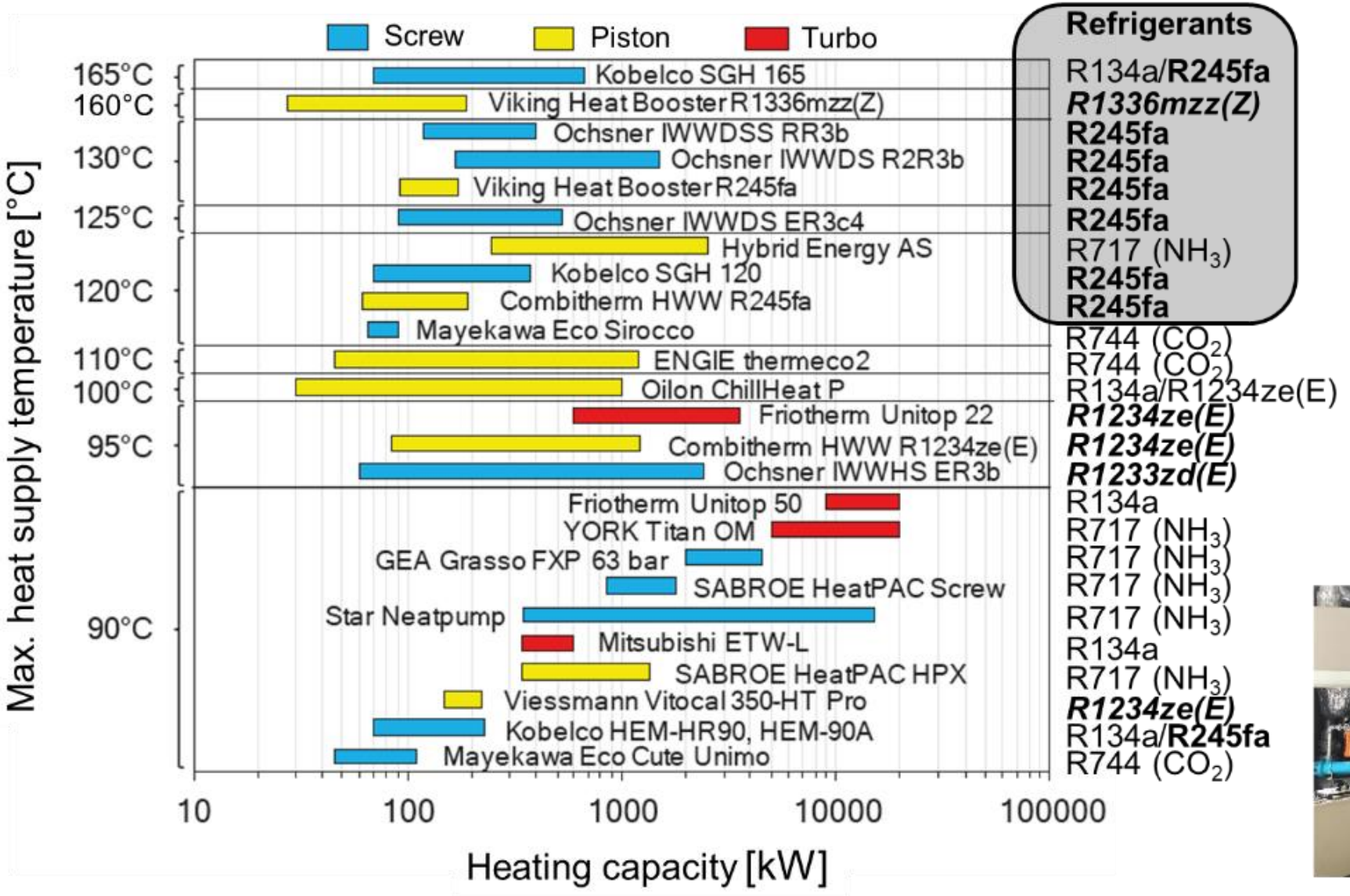
GCC of a dairy company

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), always 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

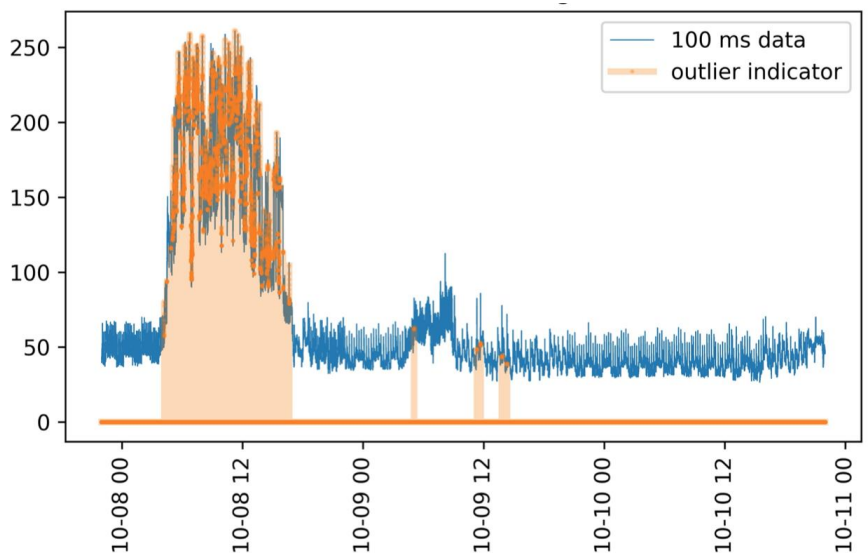


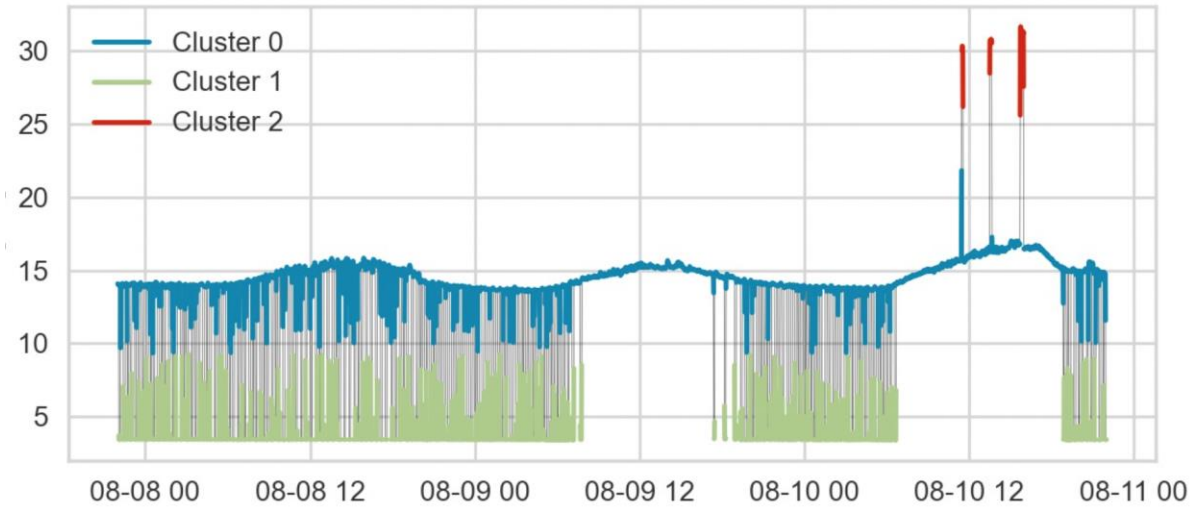
HeatBooster S4 (Viking Heat Engines AS)

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

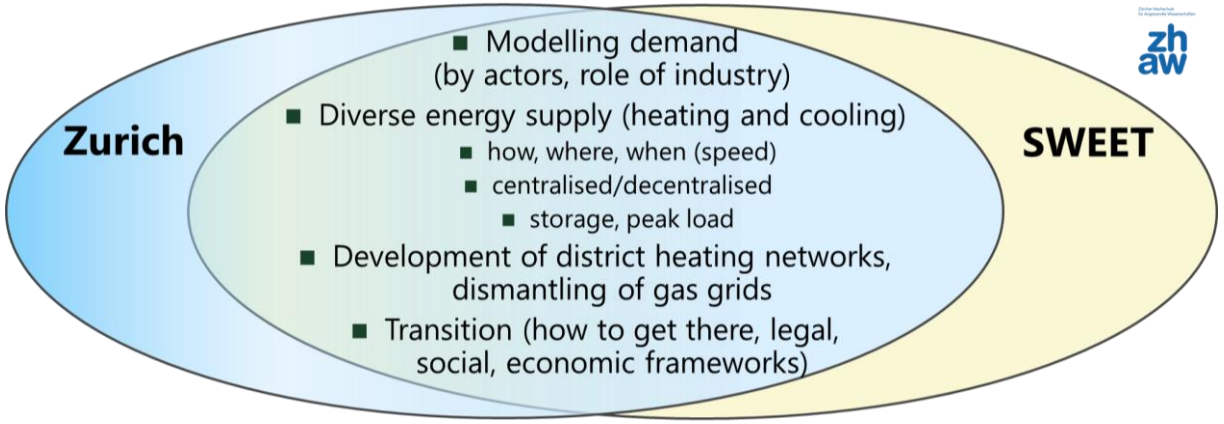




Case studies

Pierre Hollmuller (UNIGE)

Armin Eberle (ZHAW)



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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
zh aw School of Engineering
INE Institut für Nachhaltige Entwicklung

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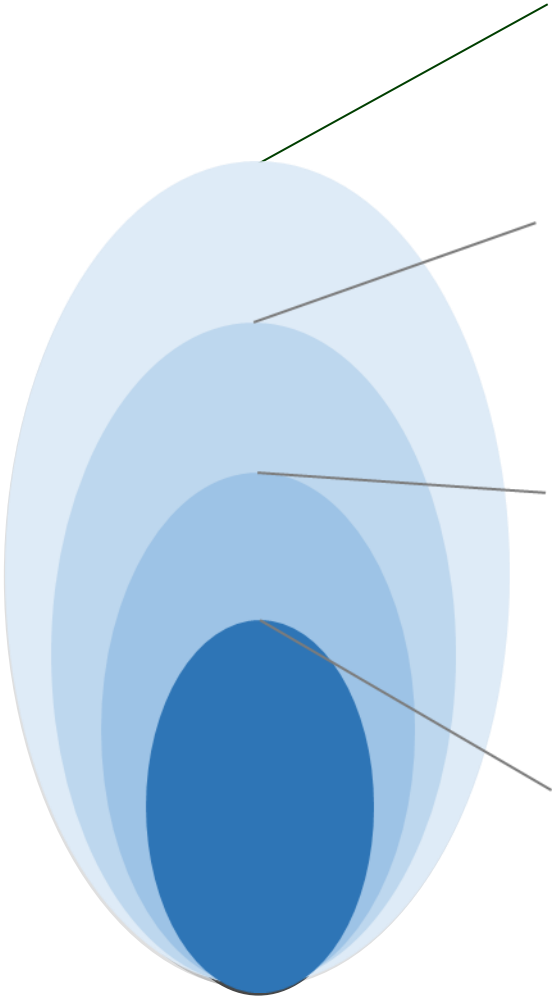


Public / societal value

Ecosystem value

Business value

Customer value

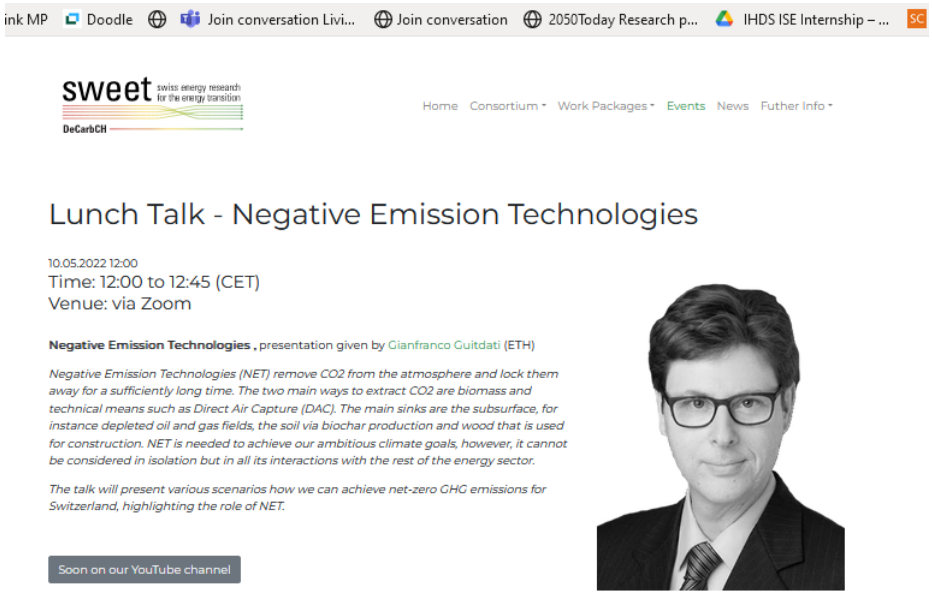
Fair tariff models for district heating

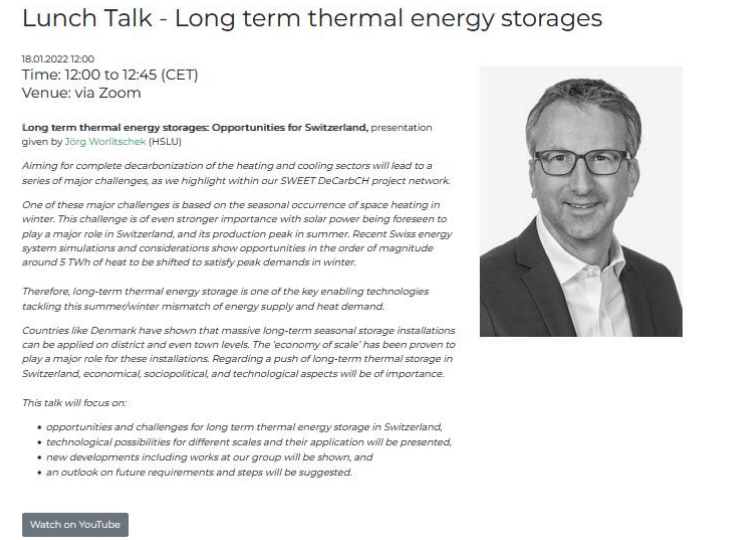
Intermediary resources to support decarbonization

Options to valorize circular energy use in multi-actor systems

KTT (Knowledge and Technology Transfer)

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





Core, associate and cooperation partners

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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 Demokratiepolitik	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)

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Cities

- City of Zürich
- City of Wintherthur

Associations

- Swissolar (Swiss Solar Energy professionals Association)
- VFS/ASCAD (Verband Fernwärme Schweiz, L'Association Suisse du chauffage à distance)
- 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)
- 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
- Technische Betriebe Wil

Public sector – Transport

- SBB AG

Cooperation Partners (2/2)

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Privat sector – Engineering firm

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

Privat sector – Consulting

- INFRAS AG
- Helbling Beratung + Bauplanung AG

Privat sector – Industrial

- BASF Schweiz AG
- Juracime SA
- Emmi Schweiz AG
- Coop Genossenschaft
- Migros-Genossenschafts-Bund
- Feldschlösschen Supply Company AG
- Belimo Automation AG
- Sika Manufacturing AG
- Sefar AG
- Cowa Thermal Solutions AG
- Schenk AG
- Casale SA
- Nestlé
- Danfos

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Networking Conference 25/26 April 2022 Seminarzentrum Campus Sursee

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Confédération suisse
Confederazione Svizzera
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