Industry

Beat Wellig (HSLU)
Stefan Bertsch (OST)

Agenda

Part 1 – Beat Wellig

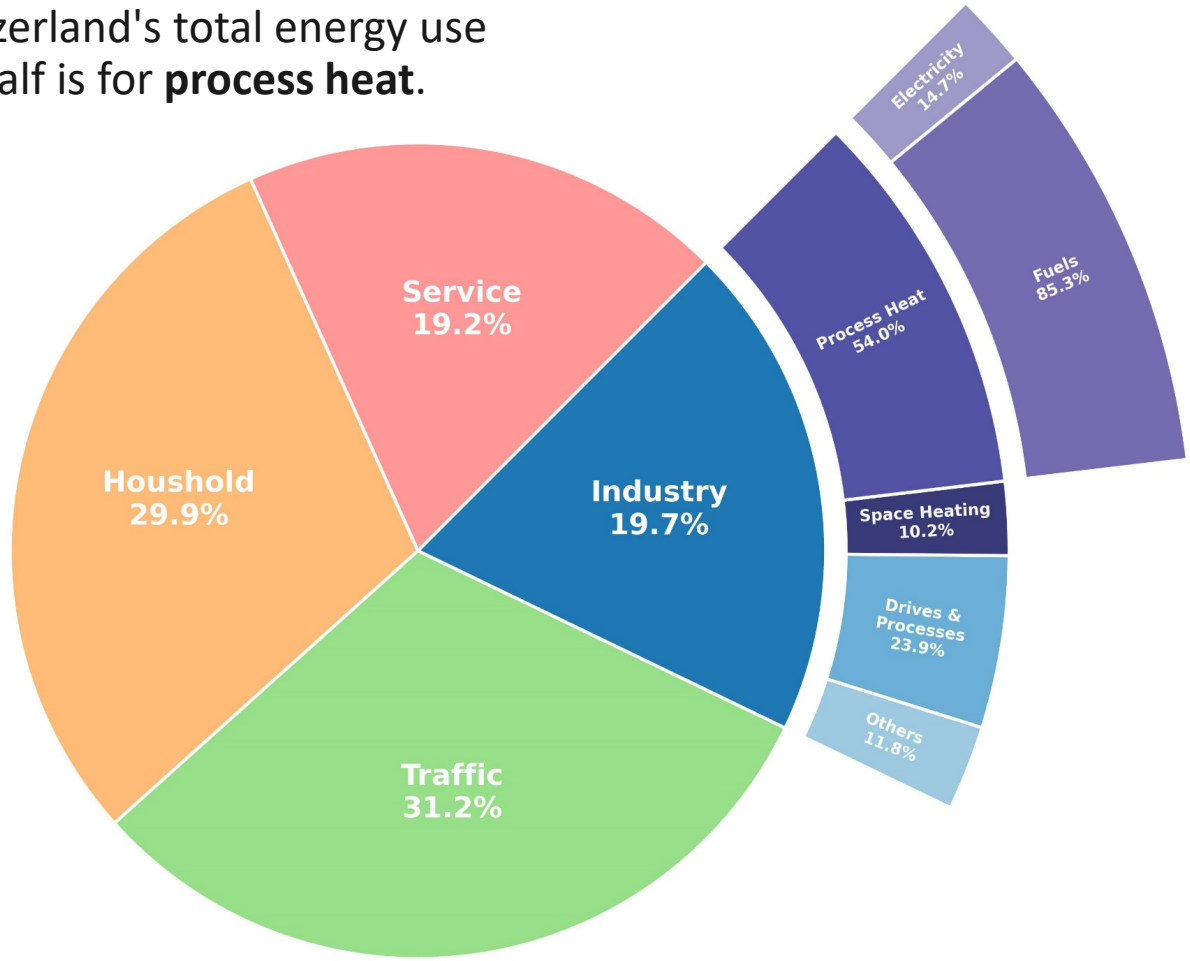
- Role of Process Integration
- Expected results until the end of 2022/24
- Examples of collaboration with industry

Part 2 – Stefan Bertsch

- Guidelines for integration of renewables
- Decarbonization as a multi-level process
- Funding opportunities / collaboration

Energy use in Swiss industry

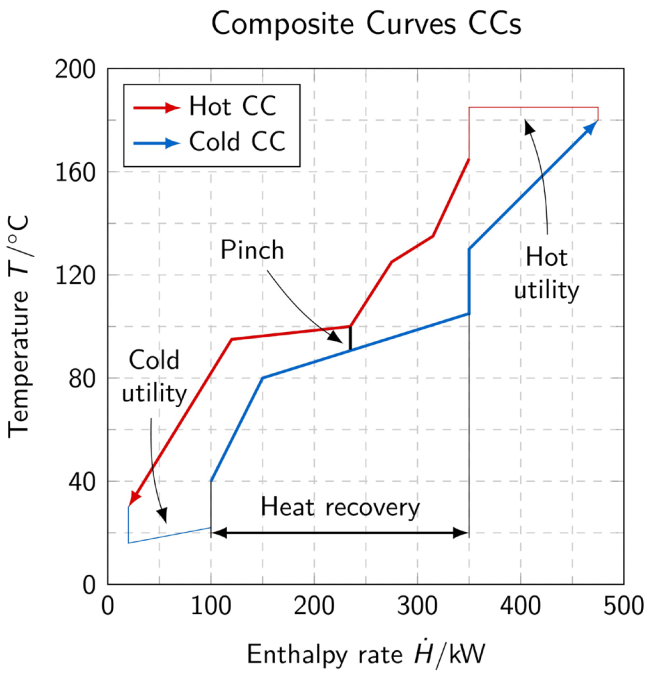
Approximately **20%** of Switzerland's total energy use is for industry. More than half is for **process heat**.

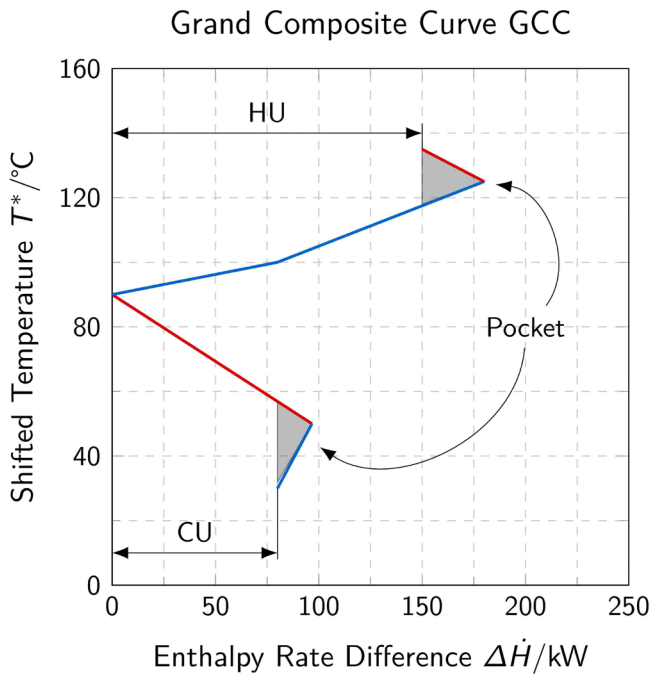


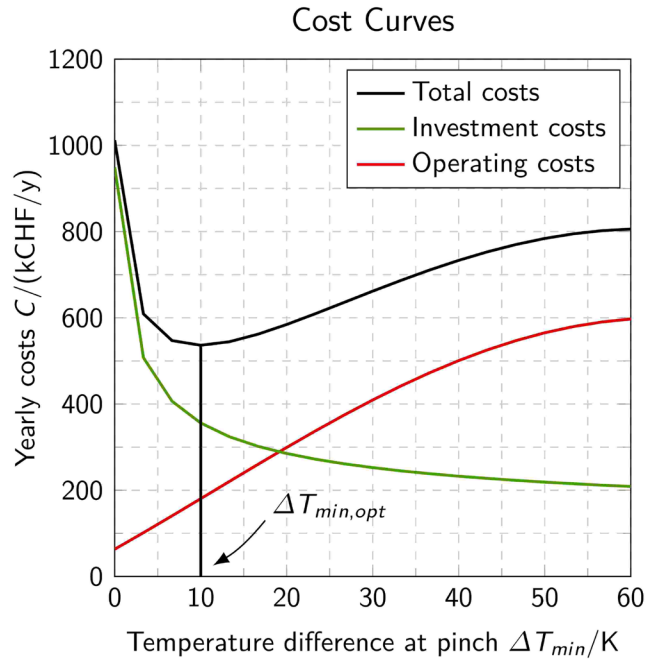
Source: Swiss Federal Office of Energy SFOE (2019)

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.







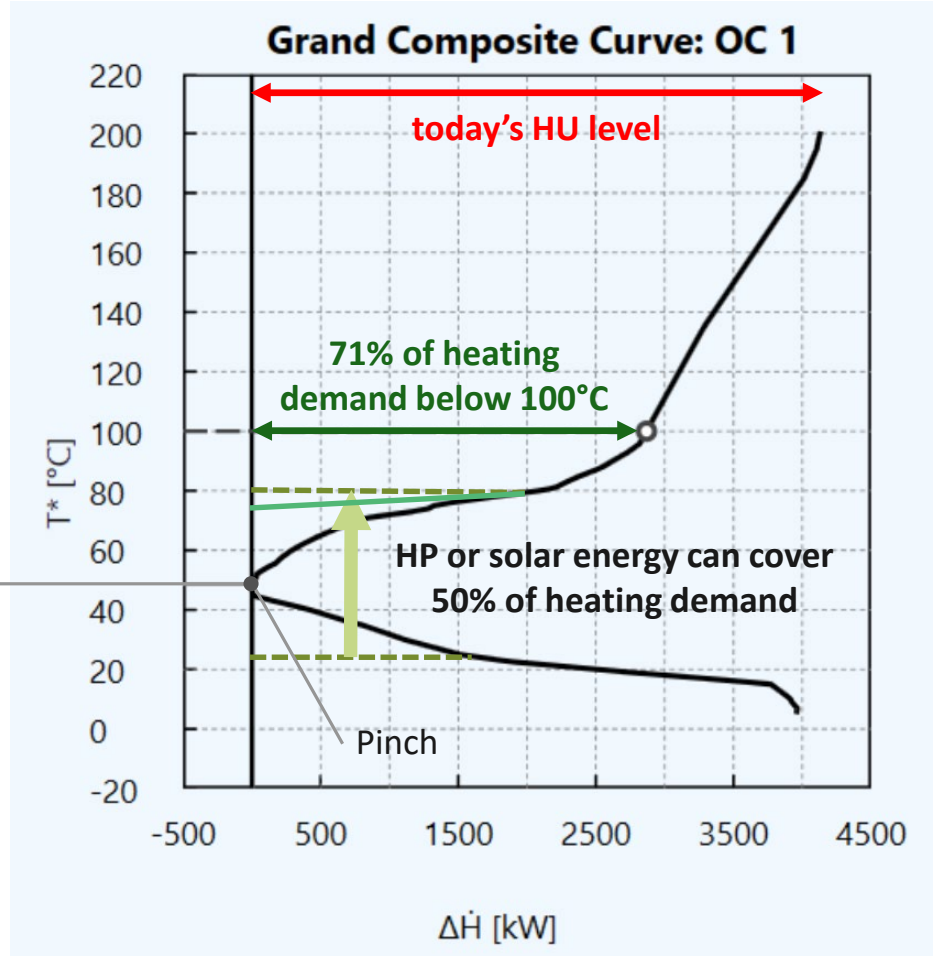
Process Integration is (by far) the most effective method to save energy and reduce CO_2 emissions in industry! (see SCCER EIP)
Typical saving pot. 10-40%, economic saving pot. min. 3 TWh/a, net savings per reduced tonne of CO_2 approx. 380 CHF/t CO_2

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!



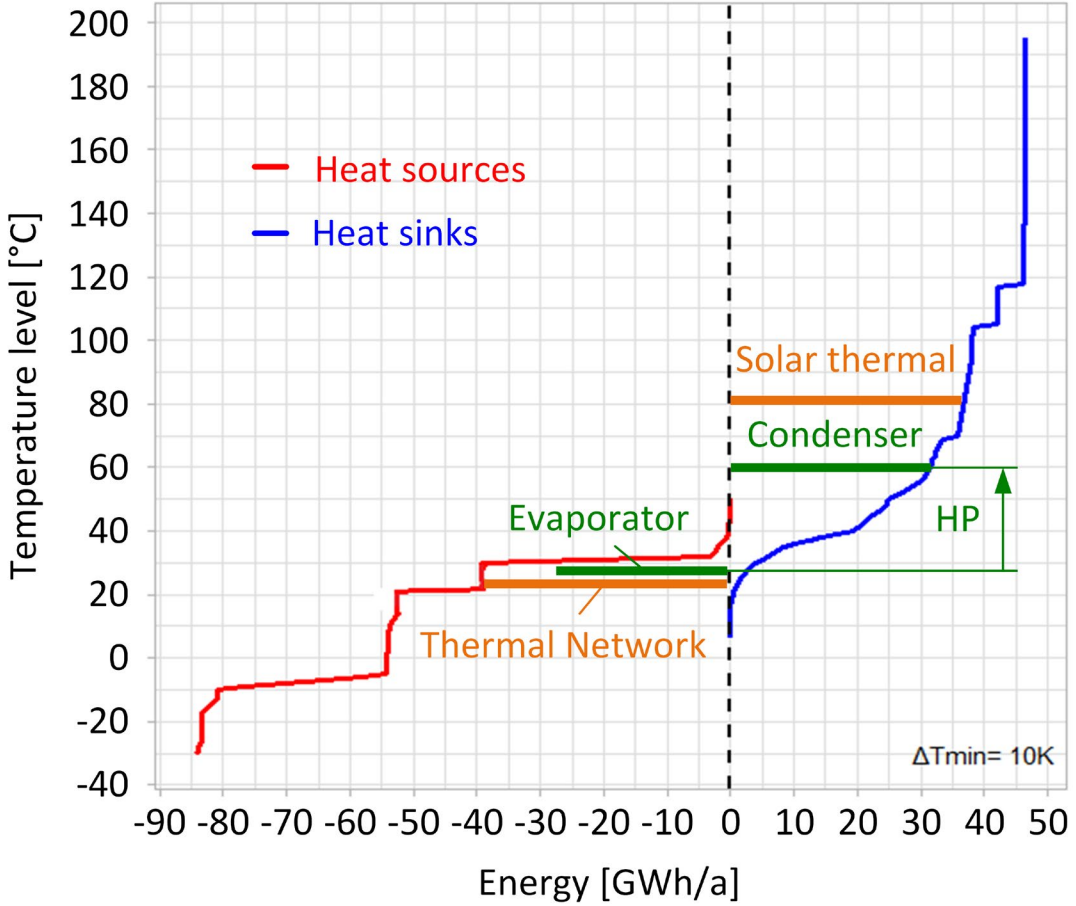
GCC of a dairy company

Expected results until the end of 2022

- Comprehensive **database** of evaluated Pinch Analysis projects*:
  - Process information, stream tables, scheduling information, economic data
  - Composite Curves, Grand Composite Curves
  - Implemented energy efficiency measures (EEMs)
- Tools to create **energy demand profiles** for companies in a specific sector
- **Sectorial profiles** (at least dairy industry)

* Core group “temperature levels”:
HSLU-TEVT, HEIG-VD, UNIGE, OST-IES, OST-SPF

Energy demand profile for sub-sector «Meat» after implementation of EEMs (residual source/sink profile)



Expected results until the end of 2024

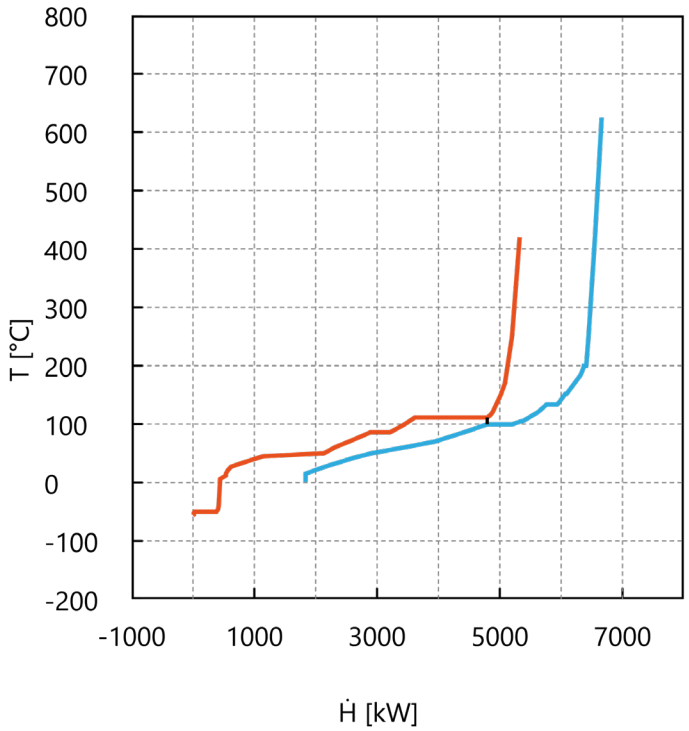
Quantify and assess the **integration opportunities** for renewables and excess heat usage based on the energy demand profiles and Process Integration techniques:

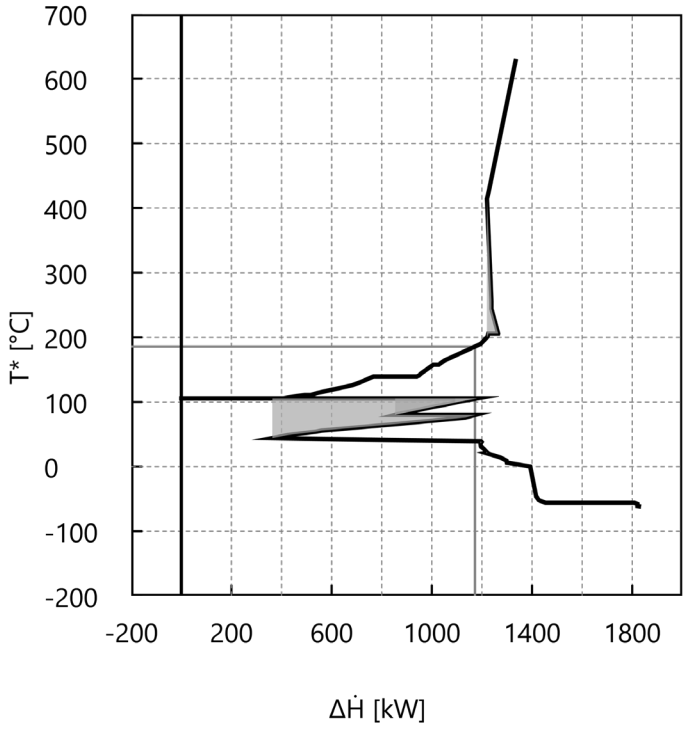
Industrial Company				
First priority: Energy Efficiency Measures (EEMs), always reduce heating and cooling demand, as well as excess heat				
Renewable Heating		Renewable Cooling		Excess heat (that cannot be used internally)
< 150 °C [1]	> 150 °C	< T "ambient"	> T "ambient"	
• Heat pumping [2]: process-integrated 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

Collaboration with industry partners

- Ongoing **Pinch Analysis projects**: Emmi, HACO, Narida, Vaparoid, CABB, Nestlé (**co-funded by the SFOE**)
- Recent **company courses** and **individual coaching** of professionals from engineering firms and industrial companies: Calorifer Engineering, Lemon Consult, Bayer (GER), Croda Europe (UK), Altana (GER, US)

Composite Curves and Grand Composite Curves of a food and beverage company:

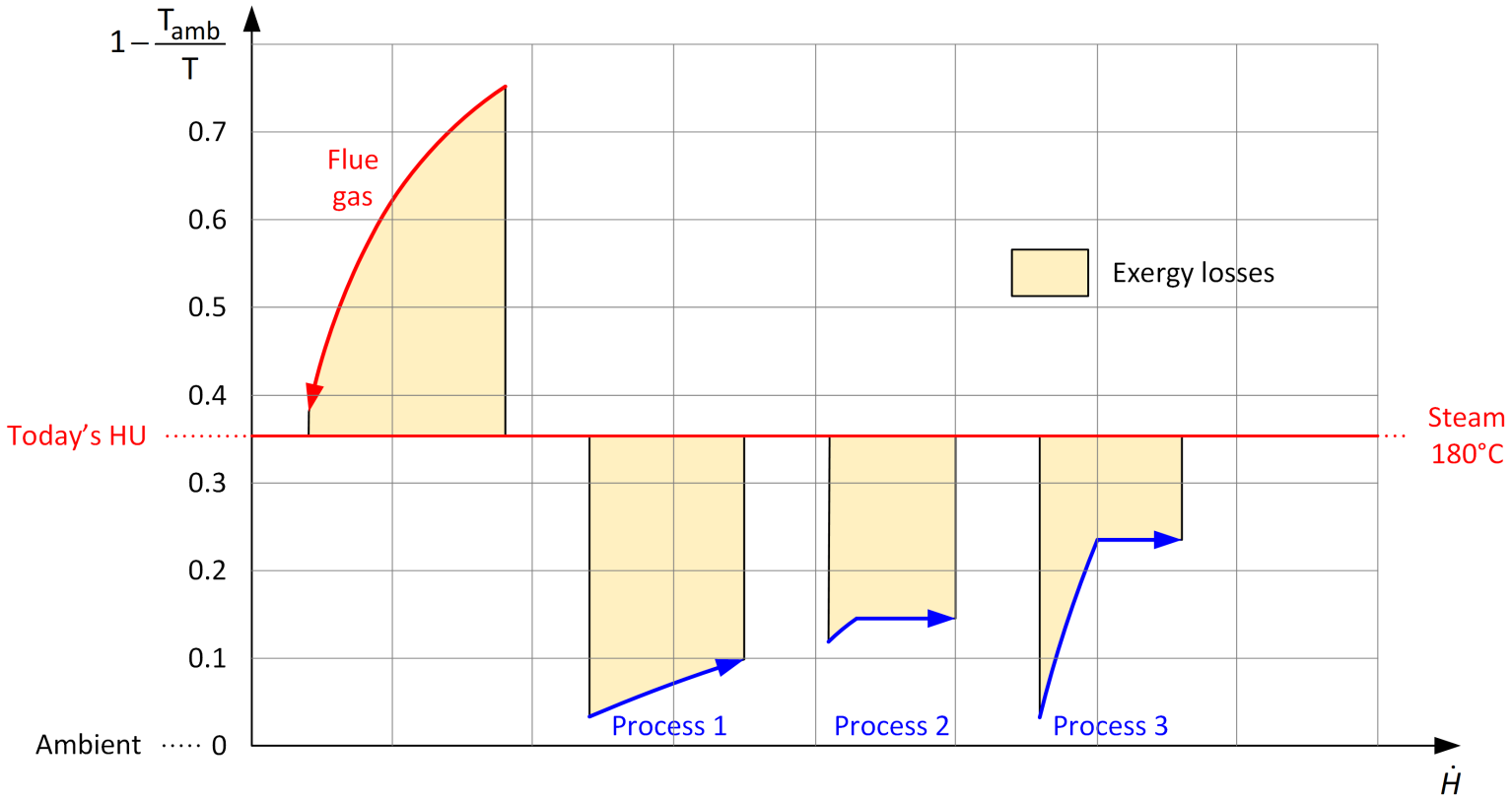




SFOE Project DeCarb-PUI

[Decarbonisation of industrial processes through redesign of the process-utility interface]

- Typical situation with combustion of fuels: medium-pressure steam as hot utility → **large exergy losses**
- DeCarb-PUI in simple words: ***"Retrofit for cooler hot utilities and hotter cold utilities."***



Industry partners:
- Emmi
- Fenaco

Manufacturing partners:
- Bühler
- Bucher Unipektin
- Tetrapak

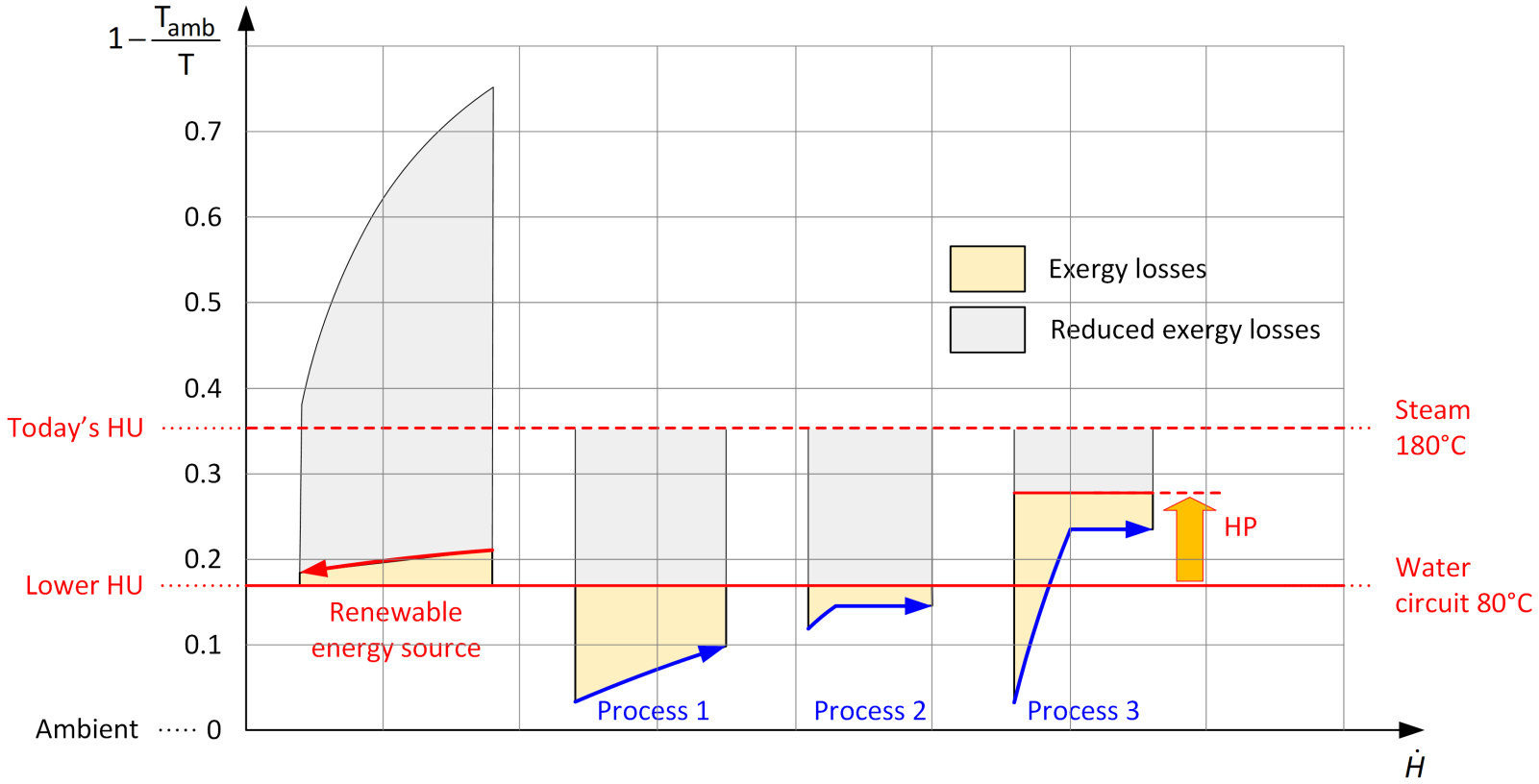
"Process i" means the heating demand from a cluster of (many) individual streams

Symmetrically, the same applies to process cooling

SFOE Project DeCarb-PUI

[Decarbonisation of industrial processes through redesign of the process-utility interface]

- Reduction of exergy losses and **increasing the potential for heat recovery, heat pumps, and renewables integration**
- Development of practical tools to design and optimize processes, utilities, and energy resources as a whole



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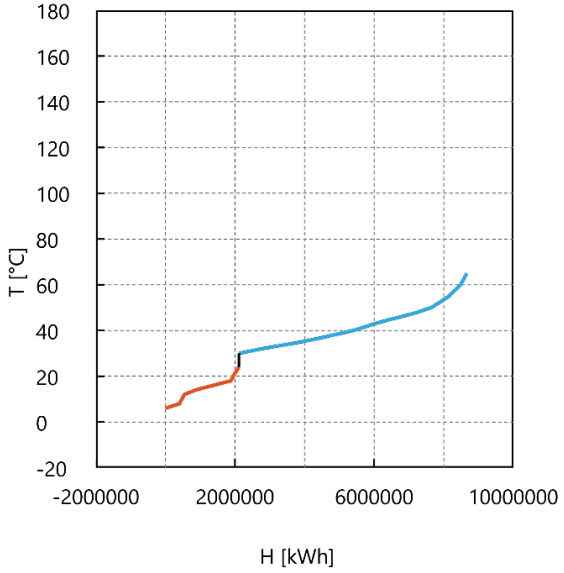
Design, optimization and simulation of thermal grids

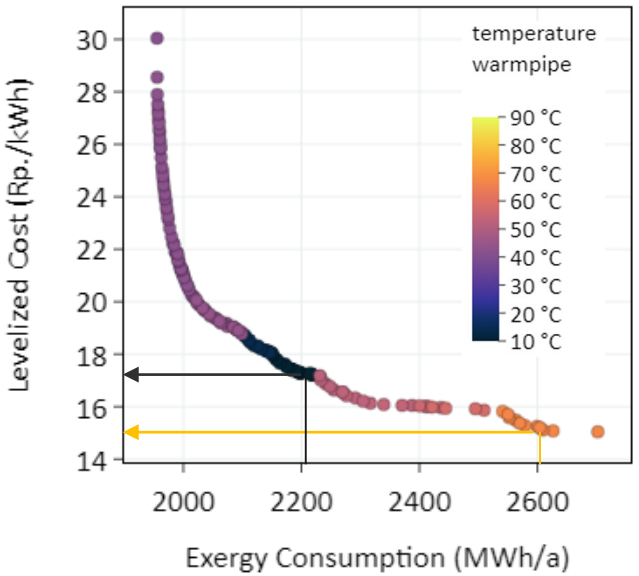
- Use of Process Integration methods to characterize and optimize (fully electrified) thermal grids* and use of digital twins to simulate and optimize the grid operation
- Exemplary results from case study in Zurich:

Case study Zurich Bellevue/Limmat
City Energy Analyst

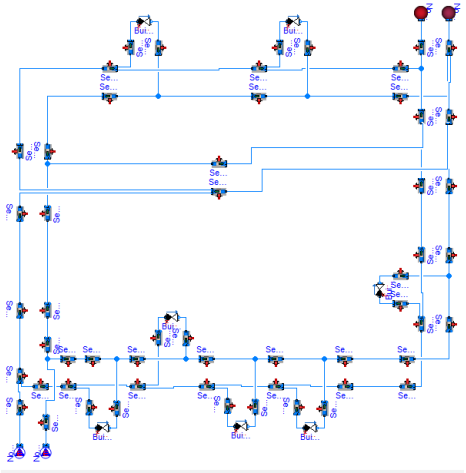
Characterization of heating and cooling demand with CCs
PinCH Software



Multi-criteria (Pareto) optimization of thermal grid*
Python



Dynamic simulation (digital twin) of thermal grid*
Modelica



(extract from the simulated grid)

* complete thermal grid incl. energy center, storages, centralized and decentralized heat pumps and chillers, hydraulics, sub-stations, control etc.

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WP05 – Combination of renewables, heat transformation and storage for medium & high temperature heating & cooling

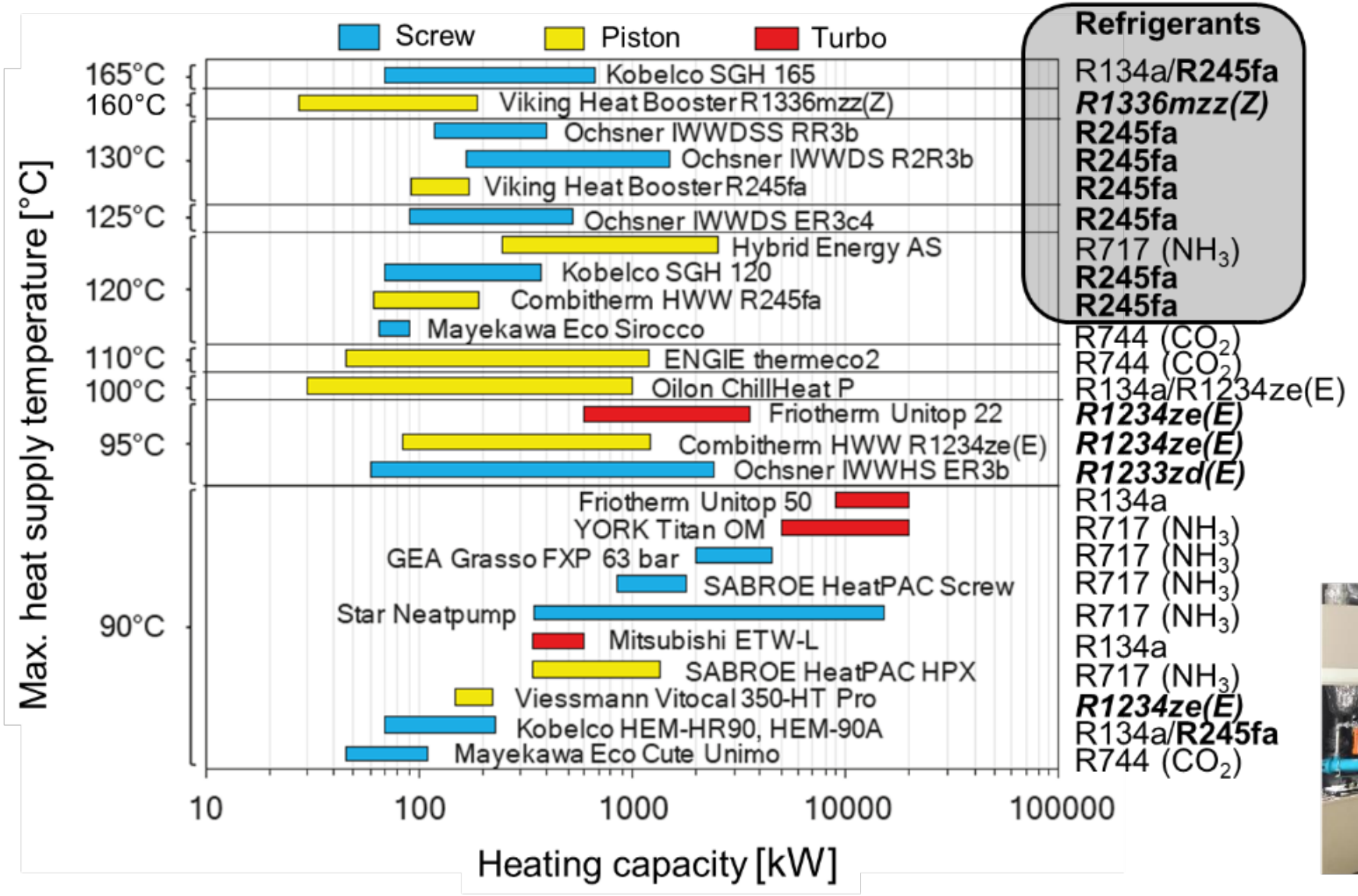
Objectives

- Develop solutions for heat supply at medium 80-200°C and high temp. + cooling
- Showcase systems including solutions for policy, legal aspects, business models,…
- Optimal matching with respect to spatial and temporal demand
- Develop tool to identify optimal combination of renewables, storage & heat transformation

Approach

- Develop solutions based on WP01 and patterns from WP04
- Combining digital twins and time series for analysis of various systems
- Publication of case studies to push faster market uptake
- Investigation of systems with long-term storage

Status of high temperature heat pumps



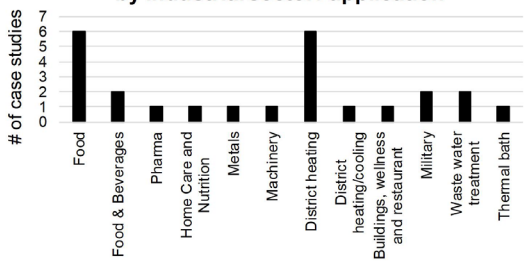
OCHSNER ENERGIE TECHNIK

HeatBooster S4 (Viking Heat Engines AS)

Kobelco SGH 120/165 (Steam Grow Heat Pump)

Annex 48: 25 Case Studies of Industrial Heat Pumps

A



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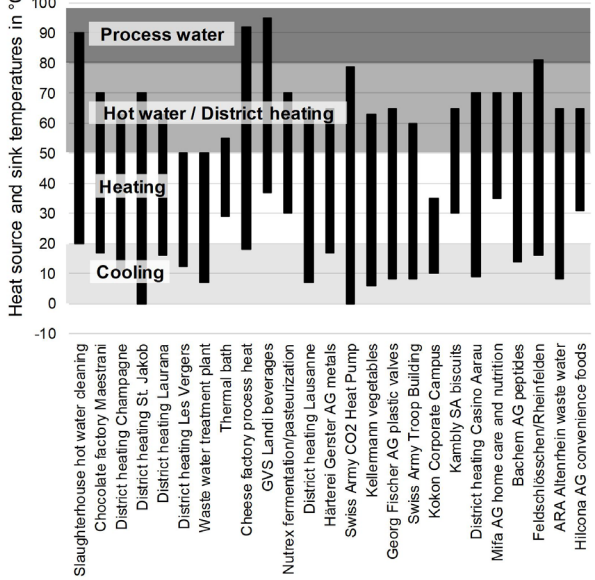

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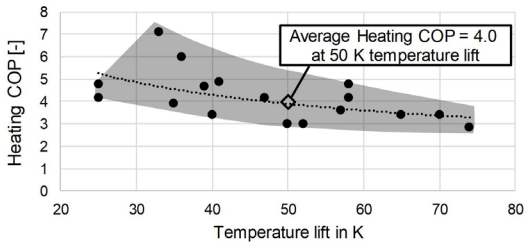


D

Savings	t CO_2/a	Energy savings
Slaughterhouse	510	2'590 MWh fossil fuels
Maestrani AG	179	n.a.
District Champagne	620	n.a.
District Laurana	1'746	1'435 MWh fossil fuels
Cheese factory Gais	n.a.	1.5 million kWh gas
GVS Landi	n.a.	26'000 L oil/a
Nutrex	310	up to 65'000 L oil/a
Härterei Gerster AG	160	800 MWh gas
Kellermann AG	960	n.a.
Kambly SA	100	25% energy
Casino Aarau	n.a.	40% energy by 2035
Mifa AG	960	20% energy
Bachem AG	300	n.a.
Feldschlösschen	n.a.	75% energy
ARA Altenrhein	3'000	n.a.

E

Refrigerants	
R134a	9
R717	7
R1234ze	5
R744	2
R245fa	1
R410A	1

F

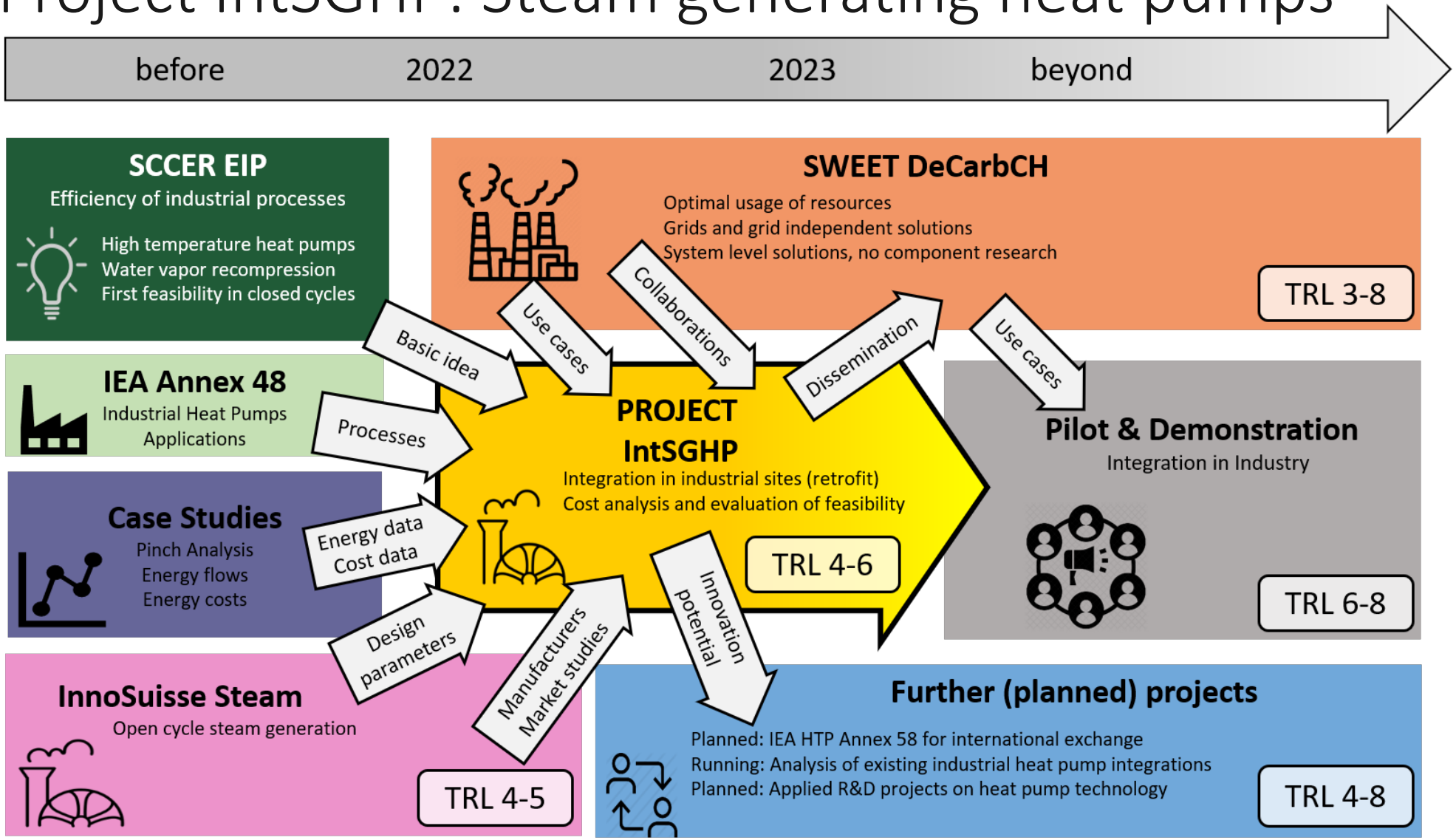
Compressors	
Piston	15
Screw	7
Turbo	2
Scroll	1

G

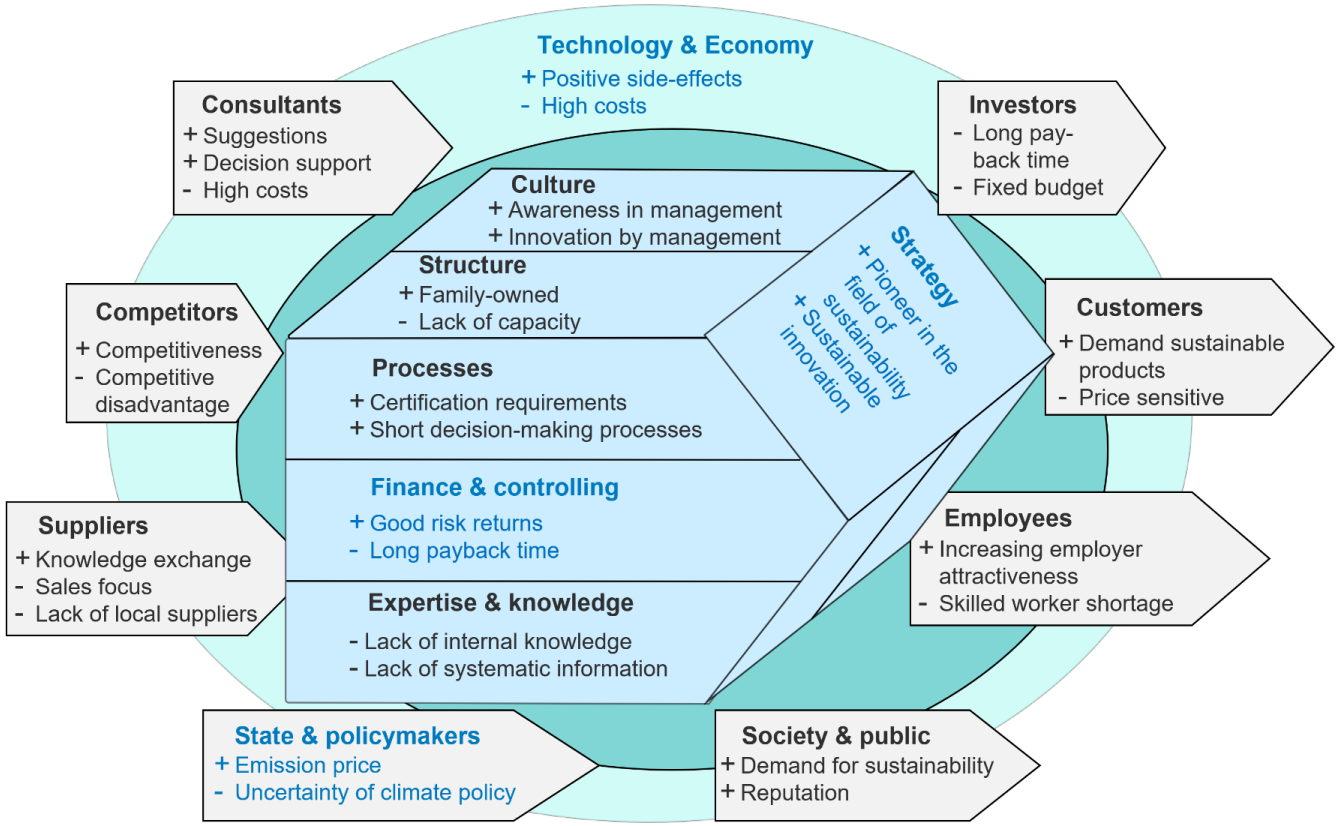
Heat Pump manufacturers			
Carrier	1	Mayekawa	1
CTA	4	MTA	1
Enex	1	Ochsner	2
Friotherm	2	Scheco	2
GEA	2	SCM Frigo	
JohnsonControls	4	Sulzer	1
Kibernetik	1	Thermea	1
		Viessmann	1

Company, Location	Industry / Sector	Application	Integration level	Capacity (kW)	Temperature range (°C)		No.
Slaughterhouse, Zurich	Food	Hot water, cleaning water	Process	800	20	90	CH01
Chocolate factory Maestrani, Flawil	Food	Hot water, heating, cooling	Process	276	17	70	CH02
Cheese factory, Gais Appenzell	Food	Hot water, heating	Process	520	18	92	CH13
Kambly SA, Trubschachen	Food	Hot water for biscuit production	Process	471	20	65	CH23
Kellermann AG, Ellikon an der Thur	Food	Hot water for greenhouse heating	Plant	1'000	6	65	CH19
Hilcona AG, Schaan	Food	Hot water for fresh convenience foods	Plant	507	31	67	CH29
Nutrex, Busswil bei Büren	Food & Beverages	Vinegar fermentation and pasteurization	Process	194	30	70	CH15
GVS Schaffhausen Landi	Food & Beverages	Process/hot water, heating, cooling	Plant	63	37	95	CH14
Bachem AG, Bubendorf	Pharma	Heating and cooling of peptides	Process	480	14	70	CH26
R134a heat pump, Geistlich Wolhusen	Pharma	Hot water, heating	Plant	606	2	67	CH08
Mifa AG Mibelle Group, Frenkendorf	Home Care and Nutrition	Hot/cold water, heating, cooling	Plant	885	35	70	CH25
Härterei Gerster AG, Egerkingen	Metals	Process heat for hardening process	Plant	260	17	65	CH17
Georg Fischer AG, Grüsch	Machinery	Heating for production of plastic valves	Plant	382	8	65	CH20
Feldschlösschen, City of Rheinfelden	District heating, brewery	Hot water, district heating	Plant/Network	1'350	16	81	CH27
Champagne, Biel	District heating	Hot water, heating	Network	650	11	63	CH03
St. Jakob, Basel	District heating	Hot water, heating	Network	181	0	65	CH04
Laurana, Thônex	District heating	Hot water, heating	Network	338	14	63	CH09
Les Vergers, Meyrin	District heating	Heating of residential buildings	Network	5'000	12	50	CH10
City of Lausanne	District heating	Hot water for residential buildings	Network	4500	6	68	CH16
Casino Aarau	District heating/cooling	District heating and cooling network	Network	1'975	9	70	CH24
Kokon Corporate Campus, Ruggell	Wellness and restaurant	Hot water, heating	Building	341	10	35	CH22
Swiss Army, CO_2 HP Payerne	Military	Tap water and facility heating	Building	60	9	45	CH18
Swiss Army Troop building, Matt	Military	Hot water, heating	Building	270	8	60	CH21
ARA Altenrhein	Waste water treatment	Hot water for sewage sludge drying	Plant	2'840	8	65	CH28
Waste water treatment plant, Zürich	Waste water treatment	Hot water	Plant	410	7	50	CH11
Bad Zurzach	Thermal bath	Hot water	Plant	550	29	55	CH12

Project IntSGHP: Steam generating heat pumps



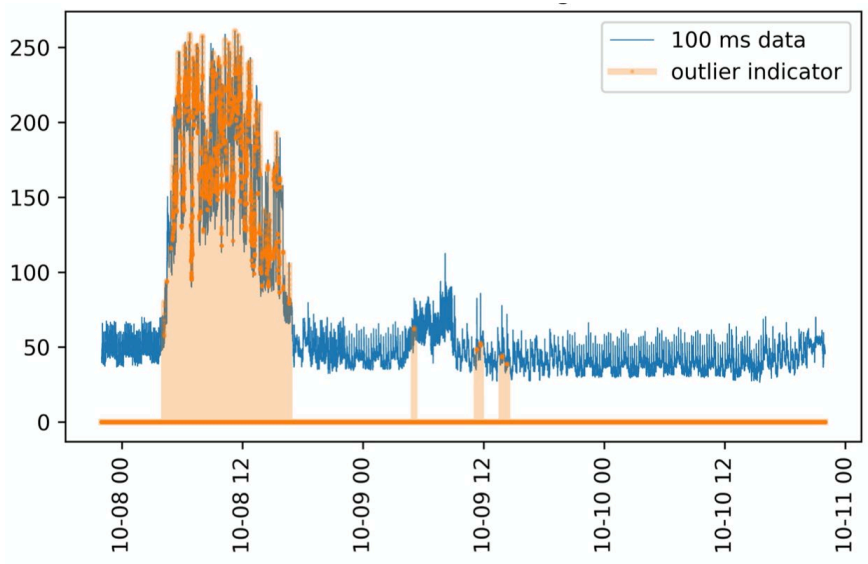
SERENDIP study

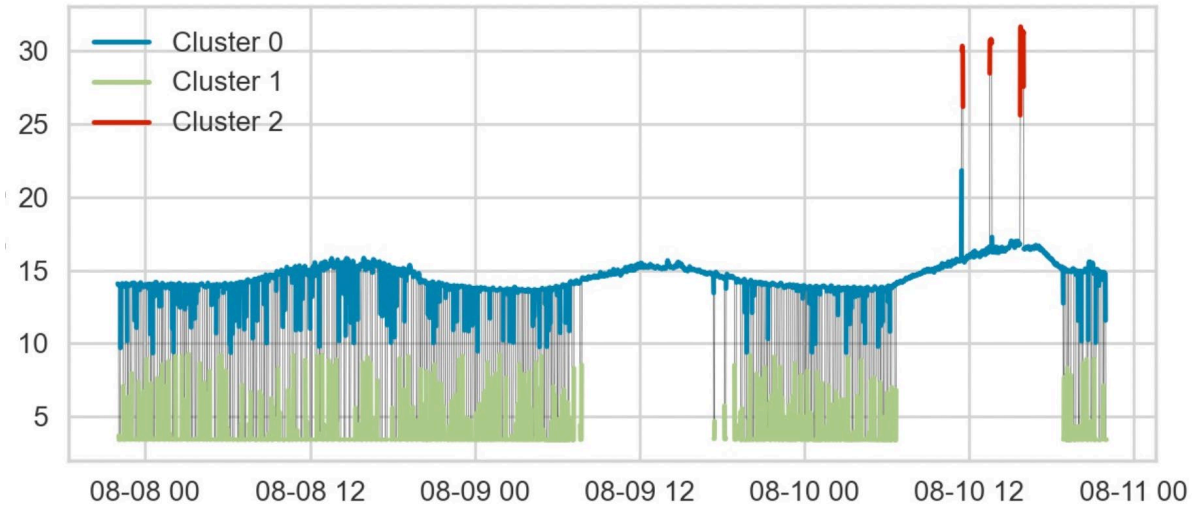


- Industrial decarbonization as a **dynamic, systemic and multi-level** process
- Policy is crucial to drive decarbonization, but different **actor groups** have their own **leverage points** on the process
- **Orchestration** of actions and incentives as a potential high-leverage point for future policy development

Further studies

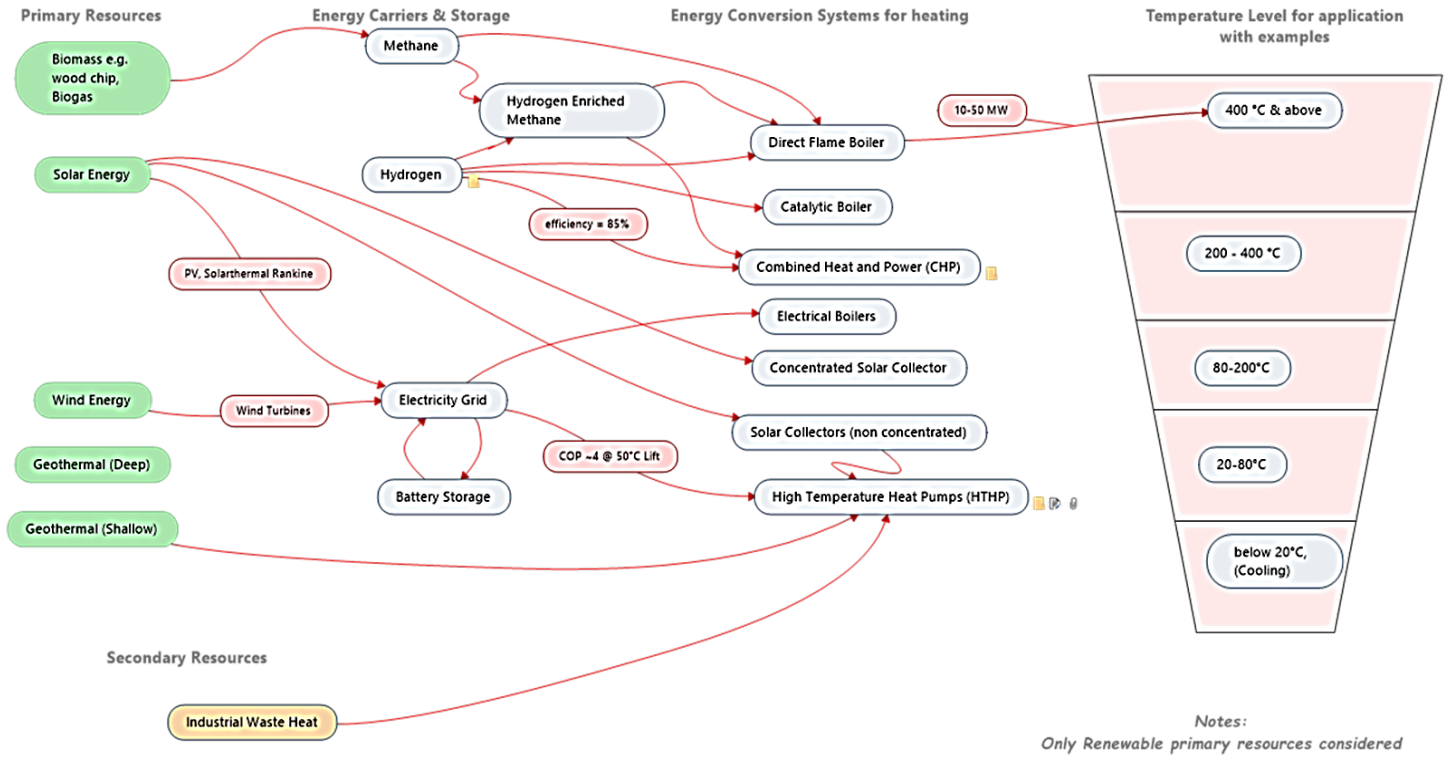
- Solar thermal systems for industrial heat
- Digital twins to optimise processes
- New finance models for decarbonization
- Combination with storage of medium and high temperature heat





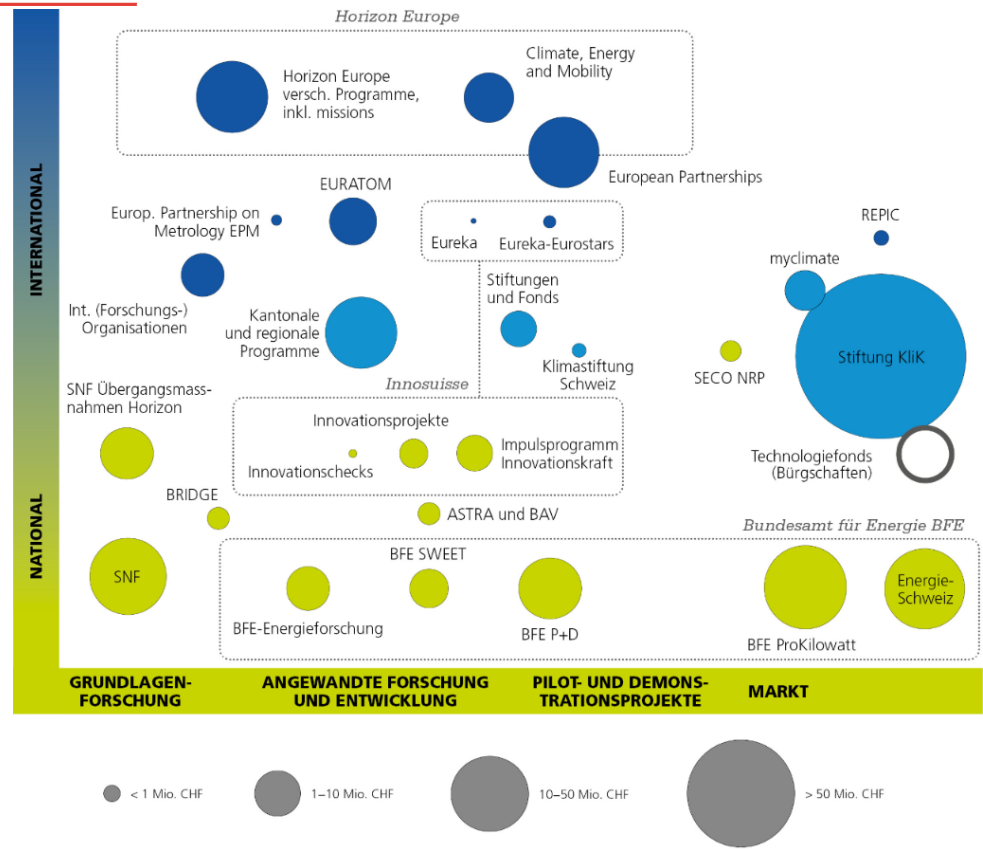
Next steps

- Develop graphical overview of different technologies
  - Selector tool using different metrics
- Guidelines for integration of renewable energy in industrial processes
  - How to design the system
  - How to operate and optimize
- Demonstration of the integration
  - Start P&D projects with industry
  - Monitor existing integrations



Industry – Funding options

- Pinch analyis: up to 40% of the cost
  - https://www.energieschweiz.ch/beratung/pinch/
- Heat pumps for process heat: up to 40% of the aditional cost
  - https://www.energieschweiz.ch/prozesse-anlagentechnik/industrielle-waermepumpe/
- Pilot & Demonstration: up to 40% of the aditional cost
  - https://www.bfe.admin.ch/bfe/de/home/forschung-und-cleantech/pilot-und-demonstrationsprogramm.html
- Overview of funding programs
  - https://www.bfe.admin.ch/bfe/de/home/forschung-und-cleantech/ueberblick-innovationsfoerderung.html



Summary

- There is significant potential in energetically improving processes
- Planning of the implementation is crucial
- In order to help implementation, case studies and information on technologies is systematically collected
- There are several funding opportunities for projects and demonstration