Mapping Thermal Storage Potential with Pinch Analysis

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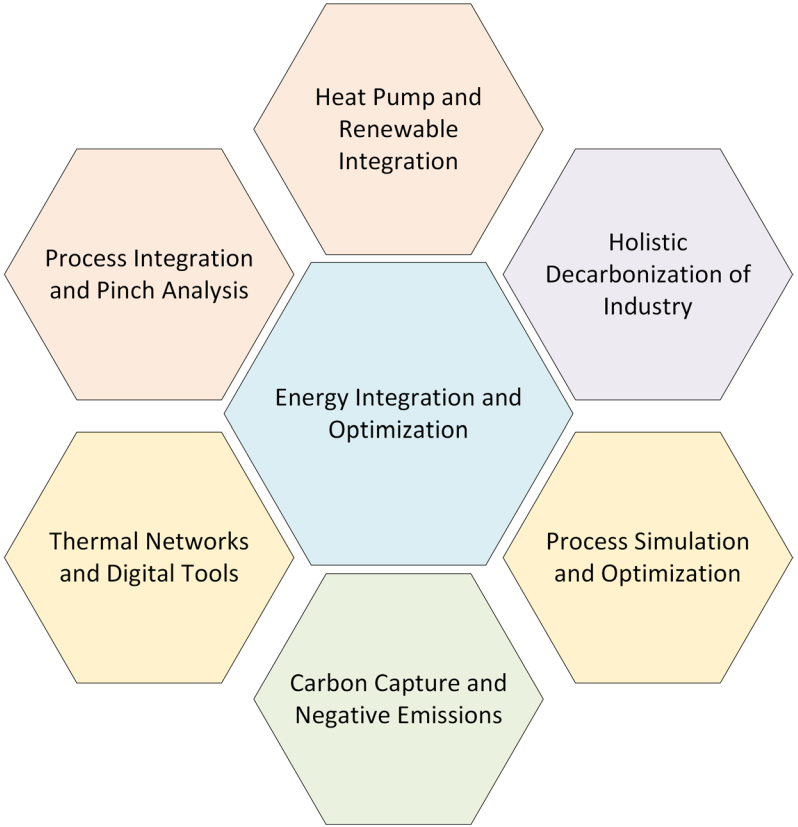
Energy Integration and Optimization

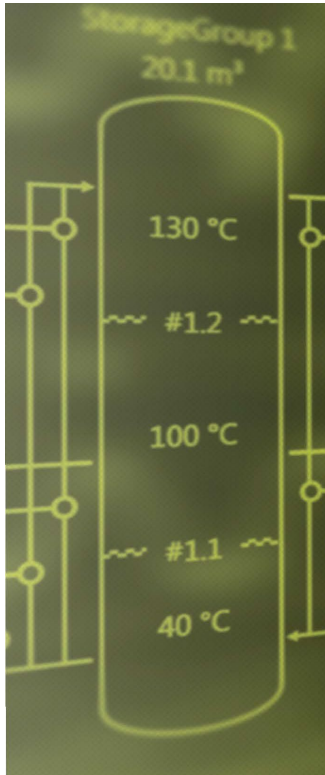
Research activities

- EIO conducts applied research related to **energy systems**, **process engineering**, and **decarbonization strategies**.
- Our focus is to **accelerate energy transitions** in the Swiss industrial sector through systems integration approach.
- Three pillars of competency:
  - Industrial Process Integration
  - New Industry Greenprint Development
  - Sectorial Energy Transition Modelling



SFOE Process Integration/PinCH Center at HSLU

- **PinCH software** development, maintenance and user support
- **Consulting for industrial companies and engineering firms** in the area of process integration and pinch analysis
  - Ongoing PA projects: Emmi, HACO, Vaparoid, CABB, Syngenta, etc. (co-funded by the SFOE)
- **Continuing education courses**, customized company **training courses** and **individual coaching**
- **Certification body** for Pinch Analysis consultants

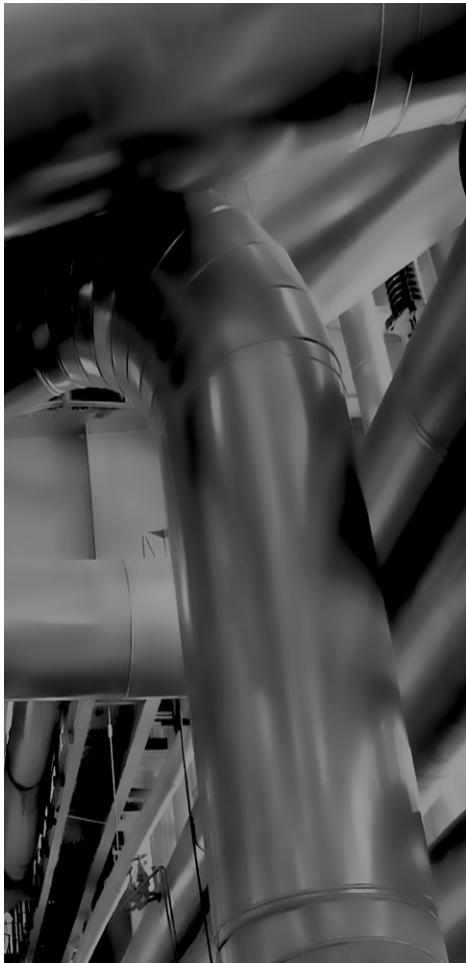


SFOE: Swiss Federal Office of Energy

www.pinch.ch

Outline

1. **The Challenges**
   - Variability in non-continuous processes
   - Effect on electrification
2. The Role of Pinch Analysis
3. Mapping of Potentials

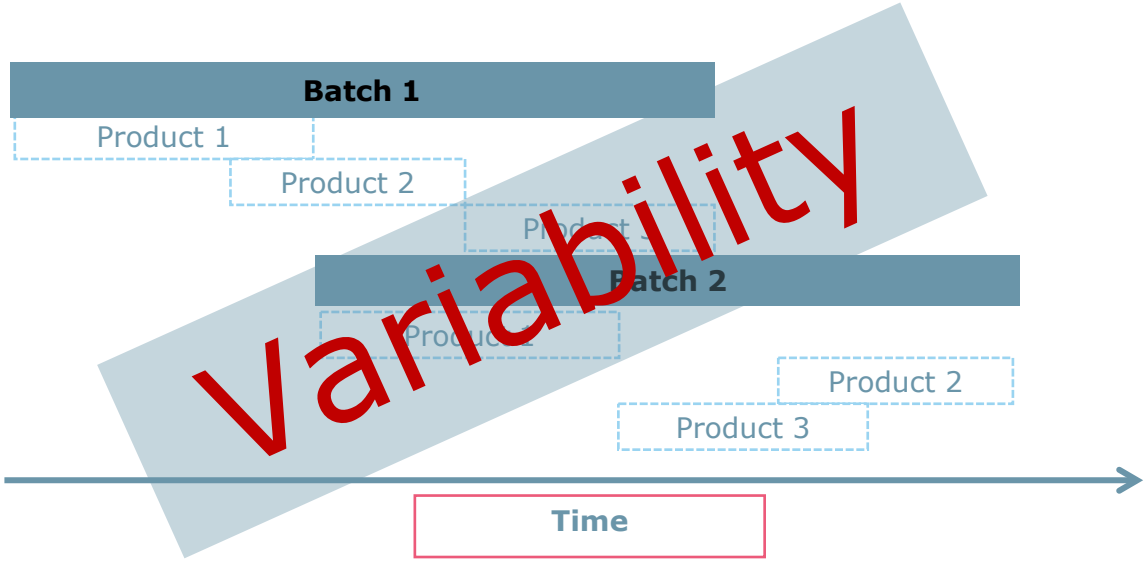


Non-Continuous Processes

Challenge 1

Non-continuous processes are very common in industry:

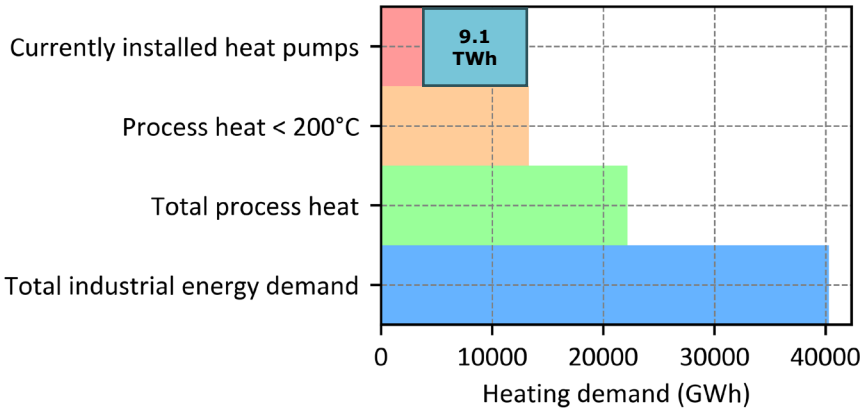
- Non-continuous processes can be batch processes or multi-period processes
- The product is created by sequential operations or demand-driven



Decarbonizing process heat through electrification

Heat pump integration potential

- Industrial process heat is responsible for **12% of annual CO_2 emissions** in Switzerland[1]
- Approximately **half of the process heat demand** from the Swiss industry is < 200 °C[2]
- Currently installed HPs only cover approx. **10 to 20% of that heating demand**[3]
- Standard and high-temperature heat pumps can **electrify 9.1 TWh of process heat** from the Swiss industry



Estimation of HP potential in the Swiss industry

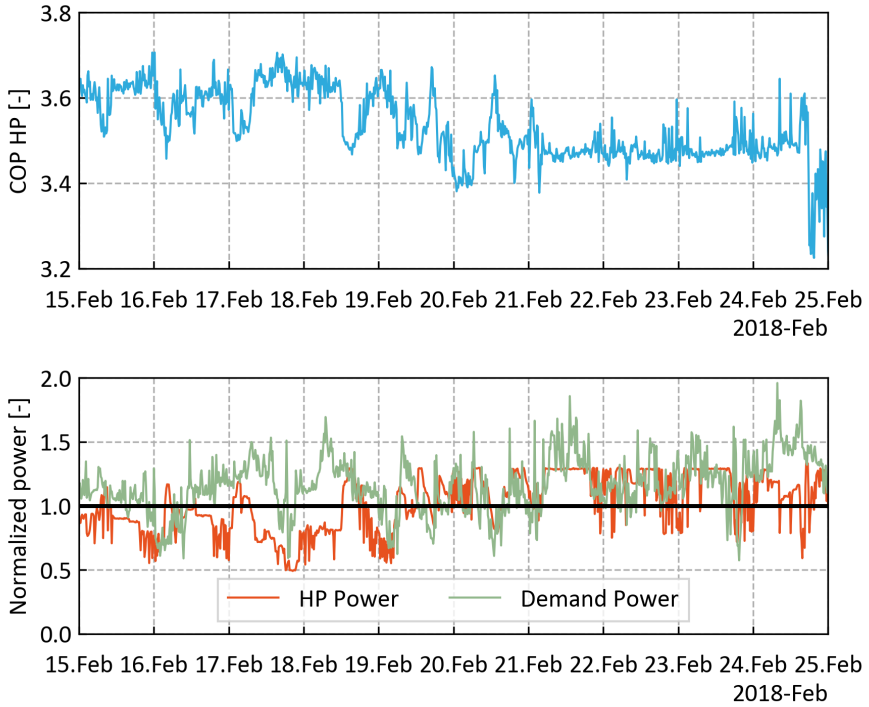
[1] EEA, 2025| [2]Estimates based on bottom-up analysis| [3]https://www.fws.ch/statistiken/

Temperature range: Low < 200°C| 200°C< Medium< 500°C | 500°C < High

Decarbonizing process heat through electrification

Challenge 2: Heat Pump Performance Stabilisation Strategy

- Despite a substantial potential, the process heat demand in the Swiss industry is variable
- Variability affects HP performance, leading to lower COPs.
- Thermal energy storage: a mitigation strategy to stabilize the HP performance.



Example of variable HP demand (Berchtold, 2023)

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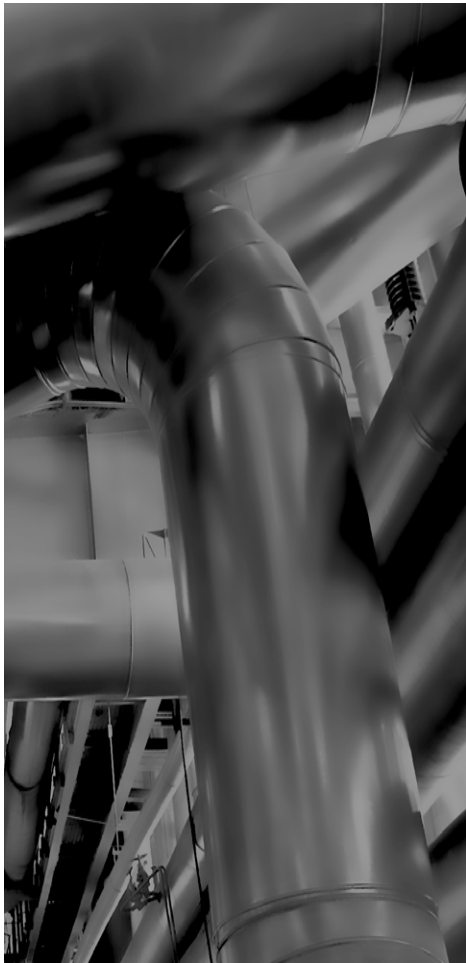
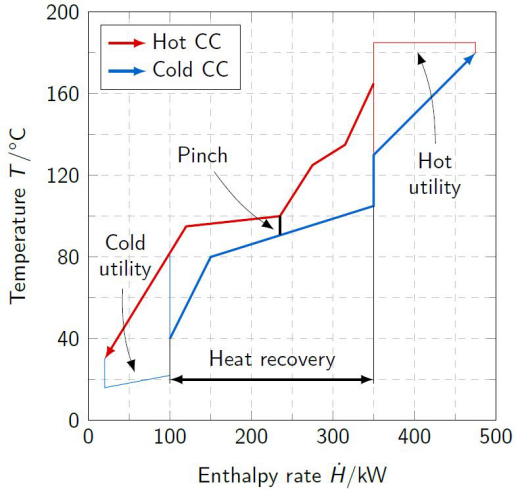
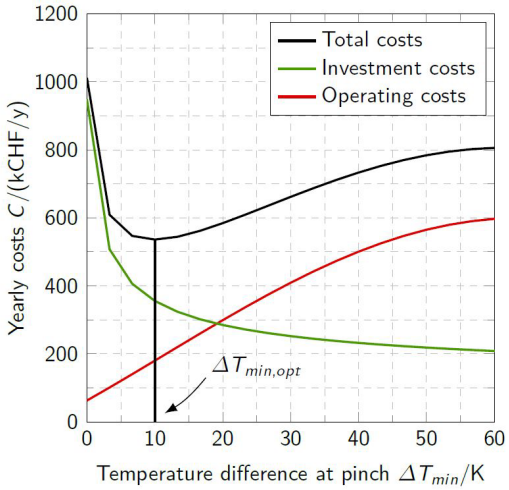


Energy and Cost Savings with Pinch Analysis

- Holistic and systematic analysis and optimisation of energy efficiency and costs
- Strategic planning measures for energy recovery & utility systems
- Goal: Best heat exchanger network design and use of energy to maximize profitability

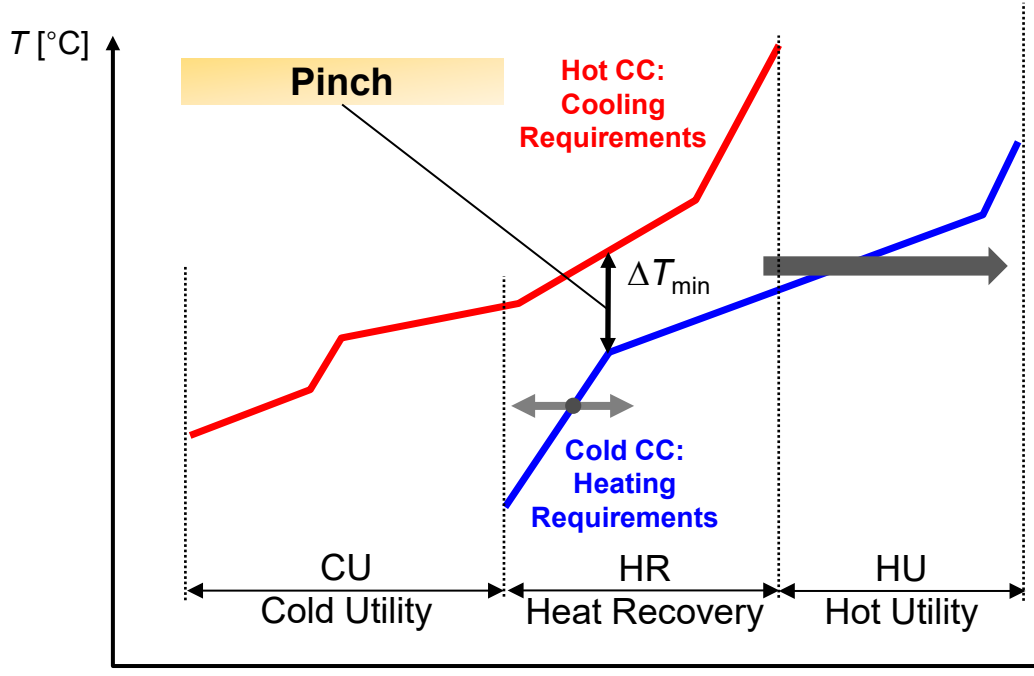
„Strengthen Competitiveness and Protect the Environment"





Principle of Pinch Analysis: the Composite Curves

A process is abstracted into "streams" that have heating requirements (cold streams) or cooling requirements (hot streams) → the **Composite Curves** are the basis of PA.



select so the total cost is minimal:

ΔT_{min} ↑: Investment costs ↓
Operating costs ↑

ΔT_{min} ↓ : Investment costs ↑
Operating costs ↓

Storage Integration

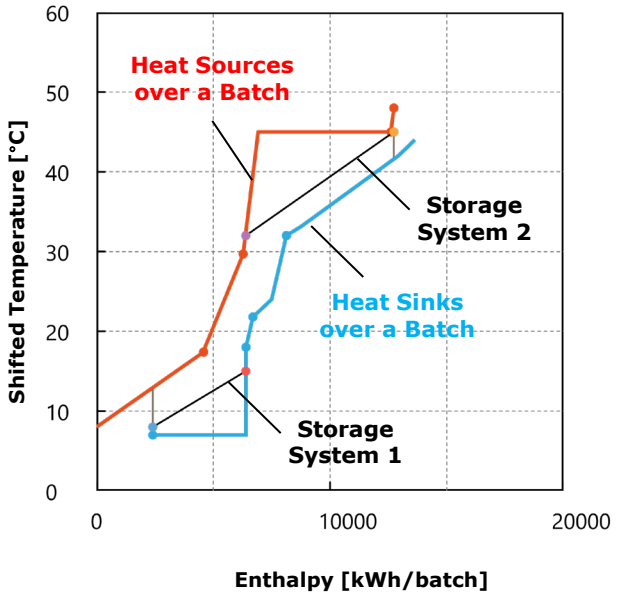
Indirect source-sink profile

Composite curves :

- Energy (kWh)
- Streams not co-existent

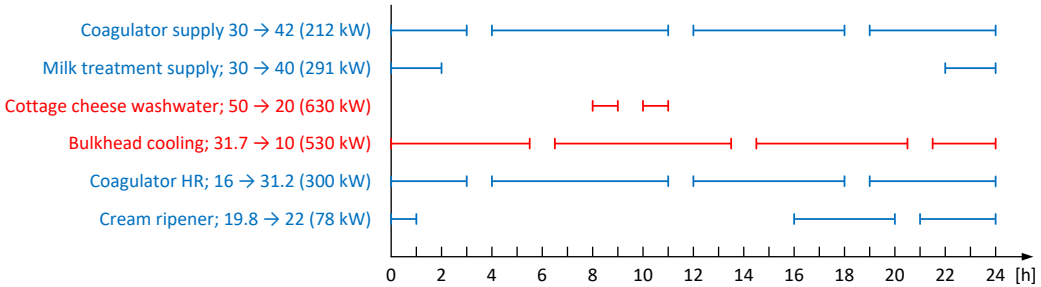
Supports systematic conceptual design of the storage integration:

- Number and capacity of storages
- Streams to be integrated
- Temperature levels for the storage
- Heat recovery level and cost estimation



Example

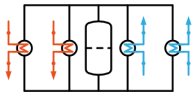
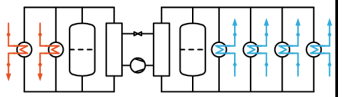
- 5th largest Swiss dairy, 26 t/y production and 150-160 MCHF/y in turnover
- BCD: 24 hours, approx. 340 batches/y
- State of the Art (SoA):
  - Some existing direct HR in process included, residuals used for this analysis
  - Utility cost for the considered subsystems: 216 kCHF/y

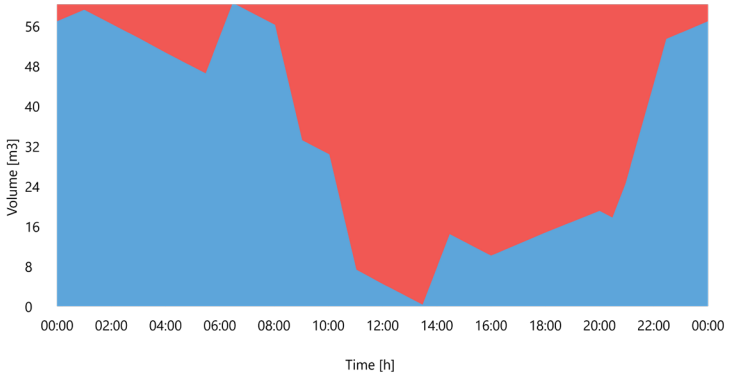


Gantt chart of considered subsystems

Example
Application of PinCH

Summary of results:

	SoA	IHR only	HP only
			
Investment	-	280 kCHF	659 kCHF
Energy Cost Savings	-	44 kCHF/y	131 kCHF/y
Total Annual Cost	216 kCHF/y	210 kCHF/y	174 kCHF/y
Static Payback	-	6.4 y	5 y
15y IRR	-	13.2%	18.3%



Loading and Unloading profile of the stratified storage tank for the IHR

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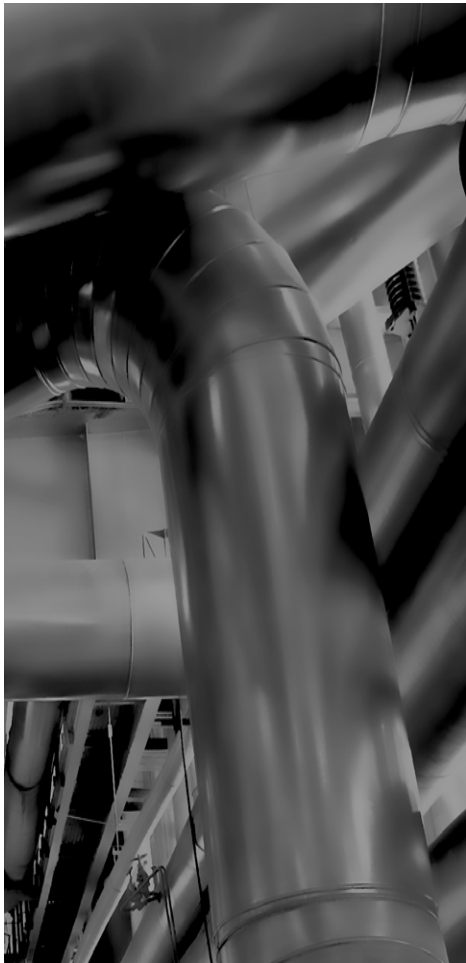
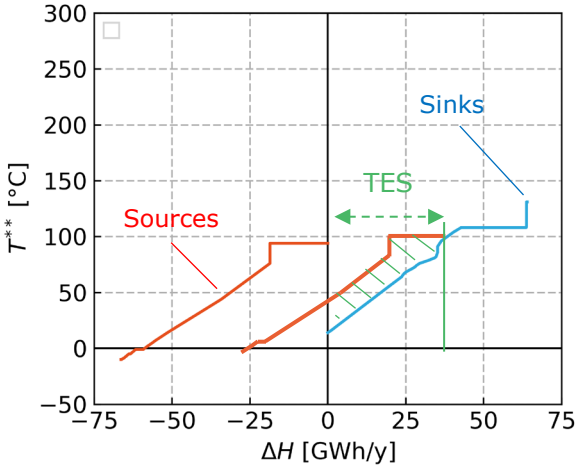


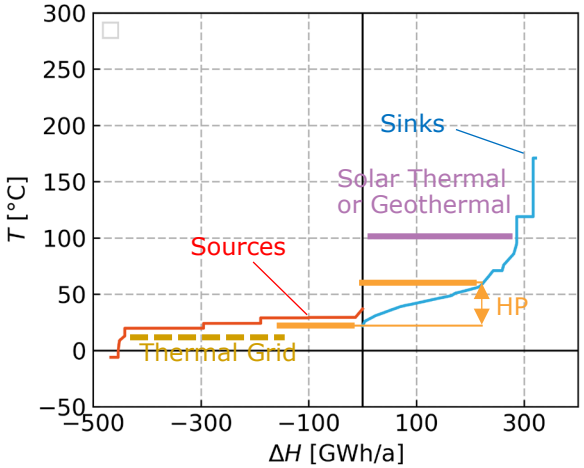
Mapping of Technology Potentials in Sectors

Sectorial Analysis

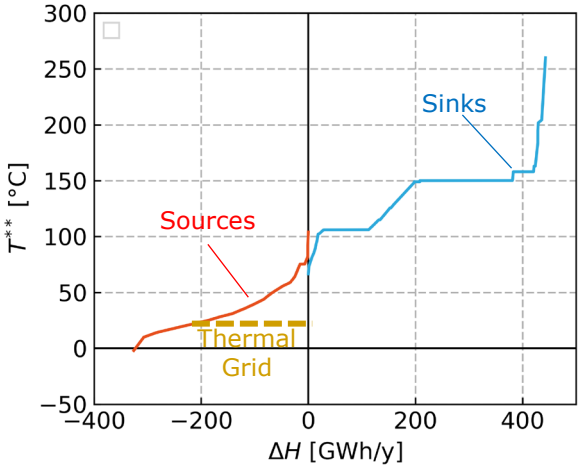
- Residual energy demand profiles for products/sectors after implementation of direct heat recovery
- Allows the quantification of indirect heat recovery (TES), heat pump integration, renewable integration, and excess heat available



Product group **beverages,** product **beer**



Product group **food,** product **meat**



Sub-sector **pulp and paper**

Takeaway

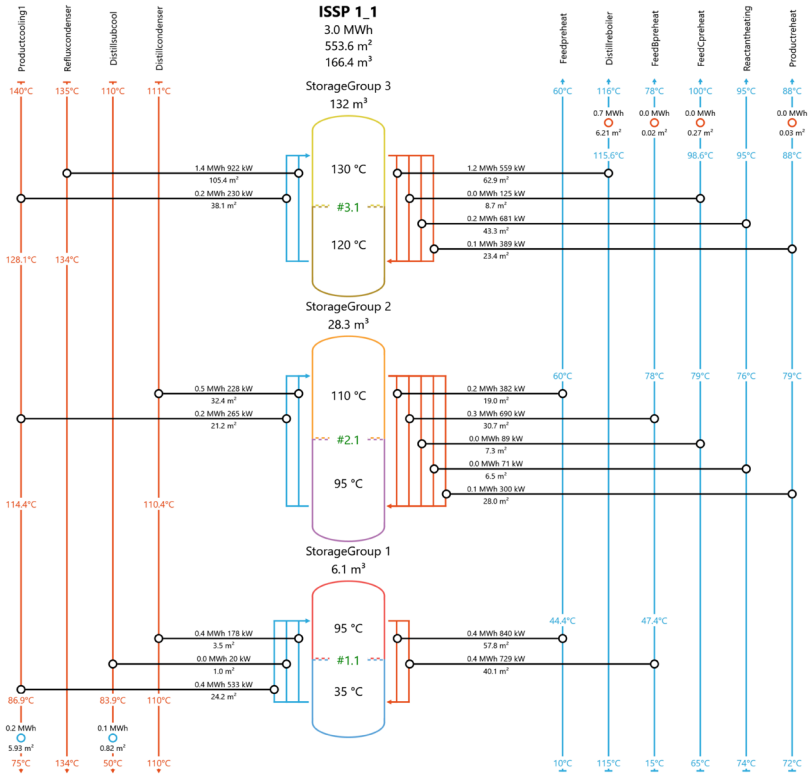
- Heat pumps electrify heat — thermal storage makes them work in real operations
- Pinch analysis reveals temperature and timing constraints from the demand side

Next course: **Energy Optimization with Pinch Analysis**

German : Hybrid Format from 13. May to 24. June 2026

English : Online Format from 12. May to 23. June 2026

More information, visit website pinch.ch



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Thank you!

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