SCCER EFFICIENCY OF INDUSTRIAL PROCESSES

Increase Energy Efficiency, Economy of Industrial Processes and Thermal Energy Systems

SCCER School – Shaping the Energy Transition

Donald Olsen, Lucerne University of Applied Sciences and Arts

In cooperation with the CTI
Energy funding programme
Swiss Competence Centers for Energy Research
Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Swiss Confederation
Commission for Technology and Innovation CTI

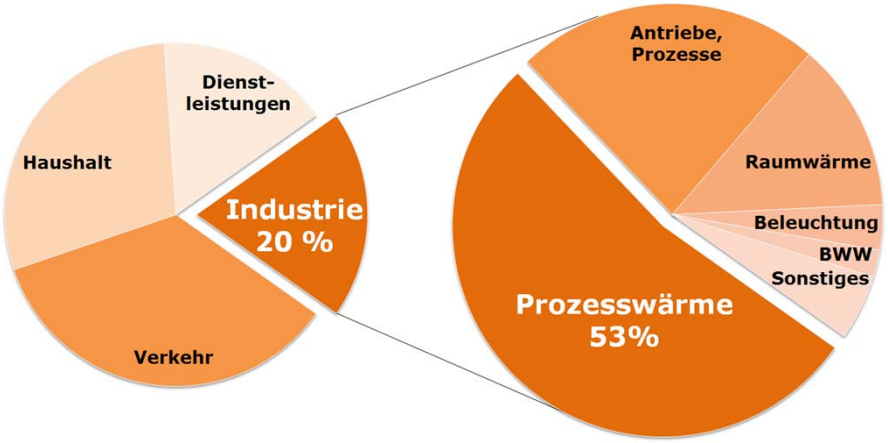
Outline

- **Industrial Process Energy Use**
- **SCCER-EIP**
- **Process Integration/Pinch Analysis**
- **Research Activities**

2

Energy use in Swiss industry

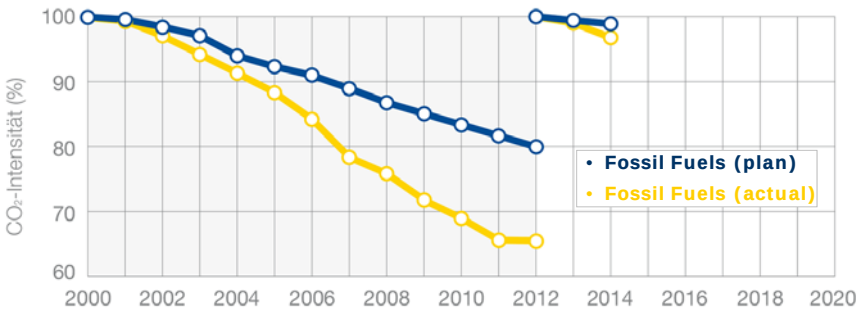
Around **20%** of Switzerland's total energy use.
More than half of it is **process heat**.



Source: Swiss Federal Office of Energy SFOE

3

Energy Efficiency Measures: What is the situation today?

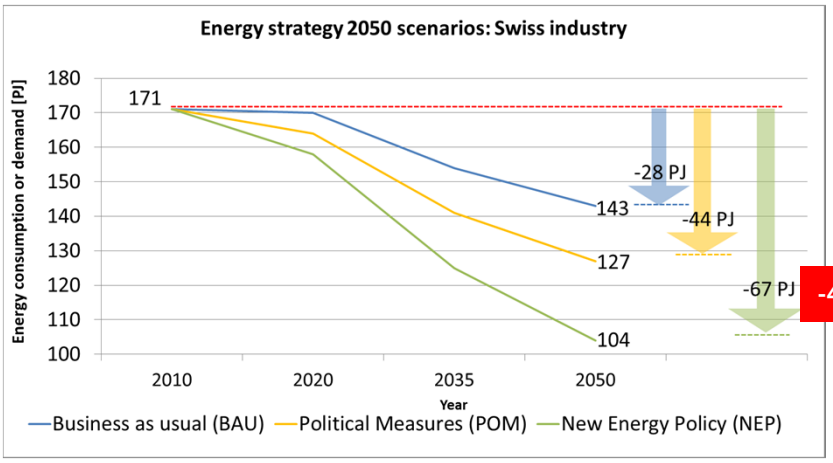


- EnAW: 3'400 Companies active, 1'850 Target Agreements
- E.g. 2014: Savings of 1.5 Mio. Tons CO_2 und 1.5 TWh Energy

(Source: Energie-Agentur der Wirtschaft, Partner in SCCER-EIP)

4

Energy Strategy 2050
Swiss industry: scenarios

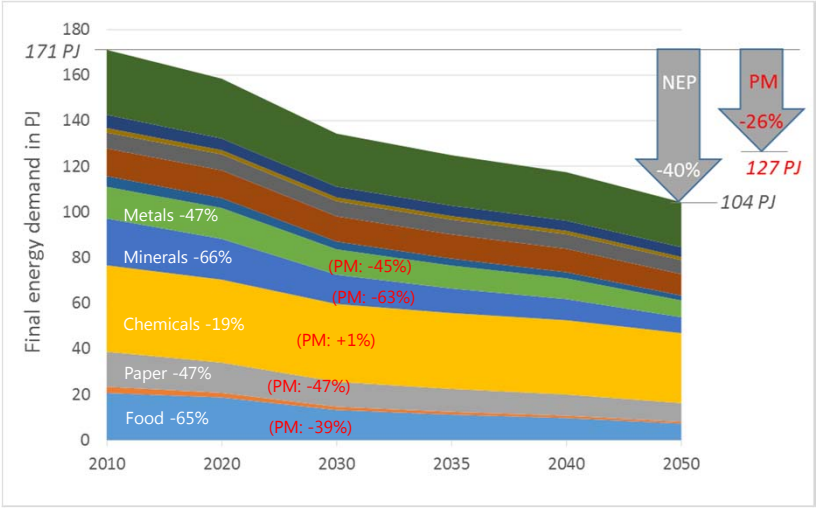


ⓘ 2050 vs. 2010: energy savings approx. 40% (NEP)

Source: Die Energieperspektiven für die Schweiz bis 2050 – SFOE /Prognos AG

5

Swiss Industry - Energy demand 2010-2050



Prognos 2015 (Energieperspektiven)

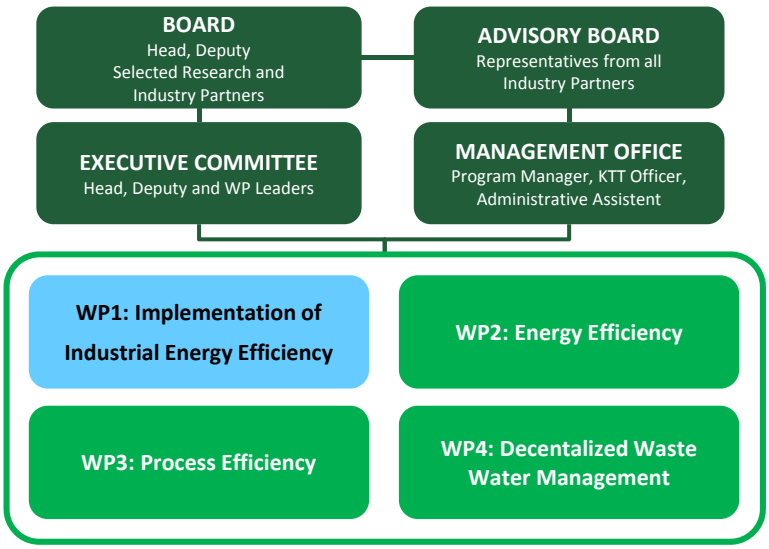
6

Outline

- Industrial Process Energy Use
- **SCCER-EIP**
- Process Integration/Pinch Analysis in the Praxis
- Research Activities

7

SCCER – EIP Phase 2 Structure



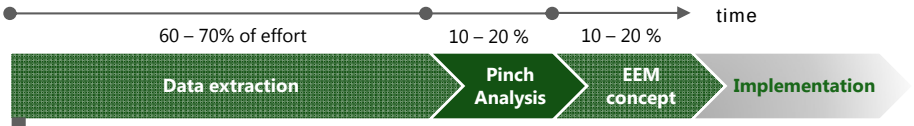
8

Phase 2: WP1.2: Integration Module

- *Task 1.2.1 Energy modelling for Pinch Analysis (**HSLU**)*

What are the typical challenges that industry faces in order to increase energy efficiency?

- Fast and reliable estimation of saving potential is required
- But the effort required for data extraction is large
- **Because understanding the process from an energy perspective is difficult**



Methods and tools for data extraction and energy modelling:

- E-Modules
- Mapping material flow analysis to energy flows
- Linking process simulation and pinch analysis bidirectionally

9

Outline

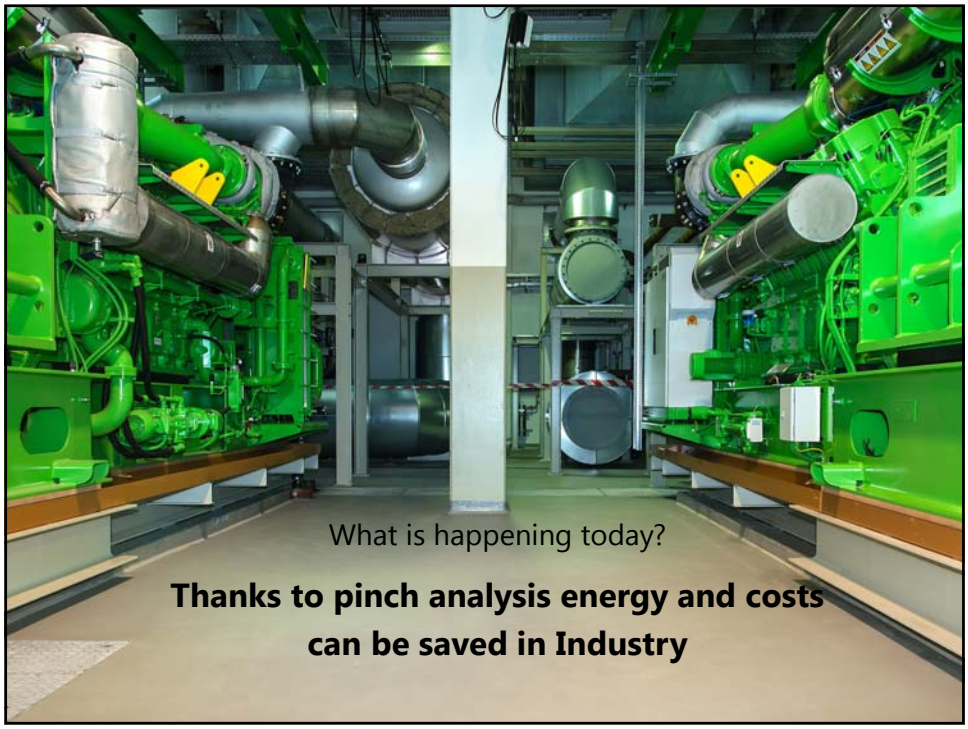
- **Industrial Process Energy Use**
- **SCCER-EIP**
- **Process Integration/Pinch Analysis**
- **Research Activities**

10

What is energetic process integration?

- **Another perspective** on industrial production and infrastructure processes
- **System Orientated Methods** to determine the optimal energy input and plant design under the condition of minimal cost (investment and operation)
- «Energy-Optimization based on a System instead of Trial-and-Error»

Pinch Analysis = Most important **tool** for energetic process integration

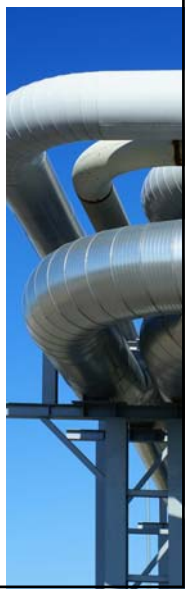


What is happening today?

Thanks to pinch analysis energy and costs can be saved in Industry

The Pinch Analysis Method Answers the Following Questions:

1. How energy efficient is the industrial process.
2. What is the heat recovery potential if a completely optimized process was to be built?
3. How can a heat pump, CHP, etc. be properly integrated?
4. Where lies the economic optimum when considering the investment and operating cost tradeoff?
5. How can this optimum state be achieved?



Benefits of Pinch Analysis

- Holistic Optimization of
  - Unit Operation Design, Utility Systems
  - Energy Efficiency
  - Investment and Operating Costs
- Determination of the absolute Energy Savings Potenzial
- Strategic Planning of Measures
  (Energy Recovery and Utility Systems)
- Reduction of the energy demand typically 10-40%

Pinch-Offensive SFOE

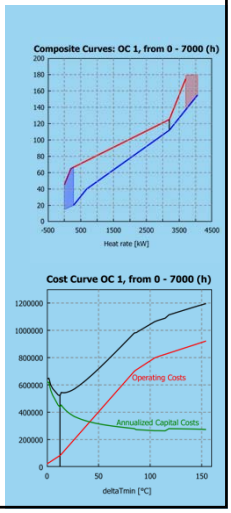
Goals:

- Pinch Analysis becomes the standard
- Buildup/Quality Assurance of high-quality pinch analysis services (EnAW, HSLU)
- Exploit the energy saving potential (10-40%) of several thousand companies in Switzerland

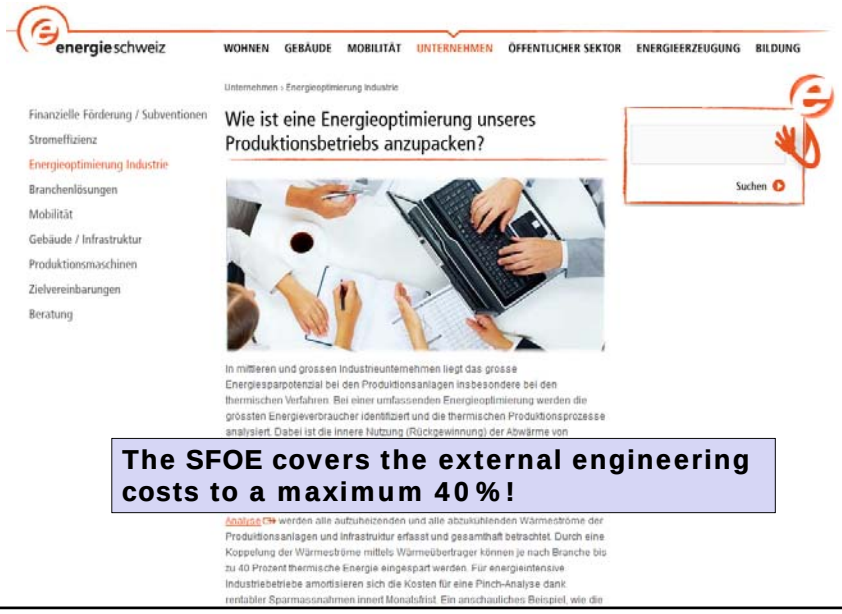
SFOE Process Integration/PinCH-Center
Lucerne University of Applied Sciences and Arts

Tasks:

- Sales of software and application support
- Consulting for industrial companies and engineering firms in the area of process integration and pinch analysis
- Educational course and customised company training courses
- Program maintenance and development



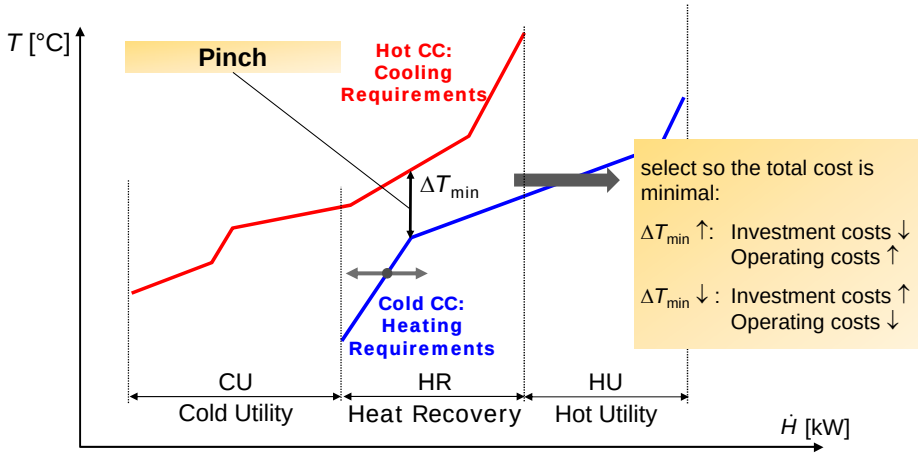
Implementation Program Through the SFOE



The SFOE covers the external engineering costs to a maximum 40 %!

17

Principle of Pinch Analysis: The Composite Curves



select so the total cost is minimal:

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

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

18

Project Example: Ziegler Papier AG

- Saving in Heat Energy: 19 GWh/a (16%)
- Cost Savings: 1.1 Mio. CHF/a
- Payback: 1.7 Years (prior. Measures)

(Pinch -Analysis completed by Helbling Beratung + Bauplanung AG, Zürich)

Project Example: Nestlé SA

- Saving in Heat Energy: 12.5 GWh/a (40%)
- Cost Saving: 1.15 Mio. CHF/a
- Payback: 2.6 Years

(Pinch Analysis completed by Weisskopf Partner GmbH, Zürich)

Pinch Analysis in der Swiss Industry

Status in Switzerland:

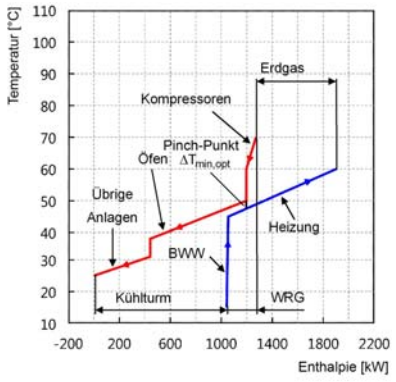
- > 100 Pinch Analysis completed
- Realized Energy Savings ca. 10-40%

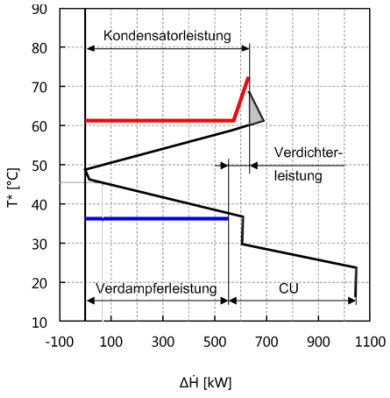
Remaining Potential:

- 600-800 Companies > 2.5 GWh/a
- Possible Energy Savings (conservative estimate) ca. 2'200 GWh/a

Source: Swiss Federal Office of Energy SFOE

Pinch Analysis: e.g. von Roll Casting AG



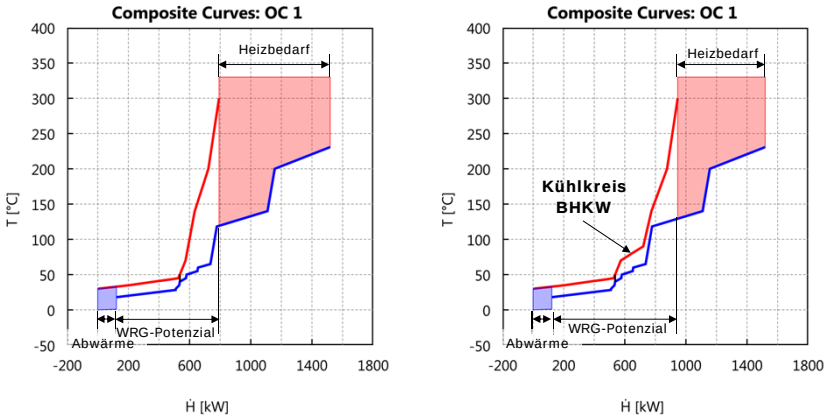


- Significant increase of the HR potential through the proper integration of a heat pump
- HP: Heating Capacity 384 kW, COP 4.3 for W28/W60, Amortisation Time ca. 4-5 Jahre

Pinch Analysis: Grüniger PLUS GmbH/HSLU, 2013
hk gebäudetechnik, 9/2015

23

Pinch Analysis:
e.g. Powder Coating Systems



- Integration CHP (90 kW_{el}, Reduction Natural Gas Requirment ca. 150 kW)
- Increase of the total energy efficiency ca. 35%

Pinch Analysis: e.luterbach AG, 2014
hk gebäudetechnik, 11/2015

24

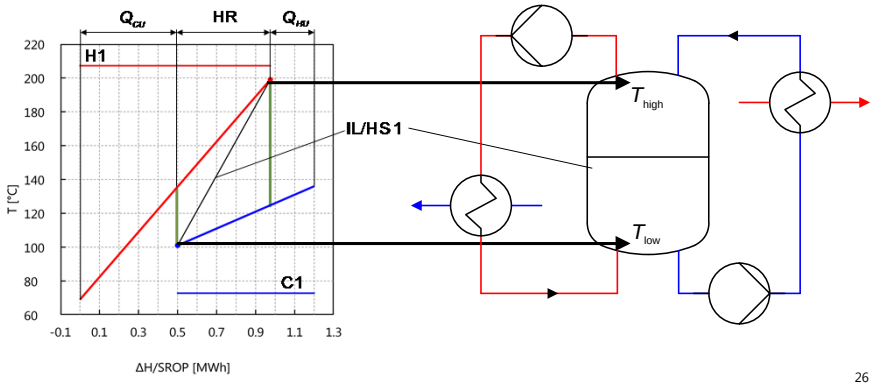
Outline

- **Industrial Process Energy Use**
- **SCCER-EIP**
- **Process Integration/Pinch Analysis**
- **Research Activities**

25

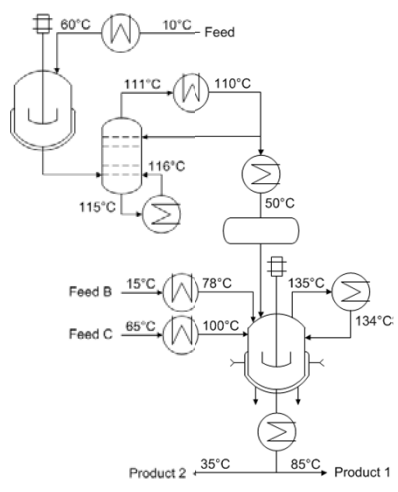
Indirect Source Sink Profile (Time Dependent Hot and Cold Streams)

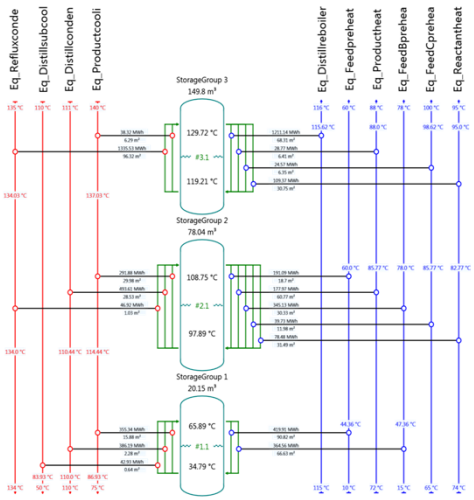
- Based on Time Average Model (kWh)
- Streams rearranged in priority based on duration and overall heat transfer coefficient using temperature shifting



Process Integration in SCCER-EIP: Method Development

e.g. **Optimization of Batch Processes** (Group B. Wellig, HSLU)





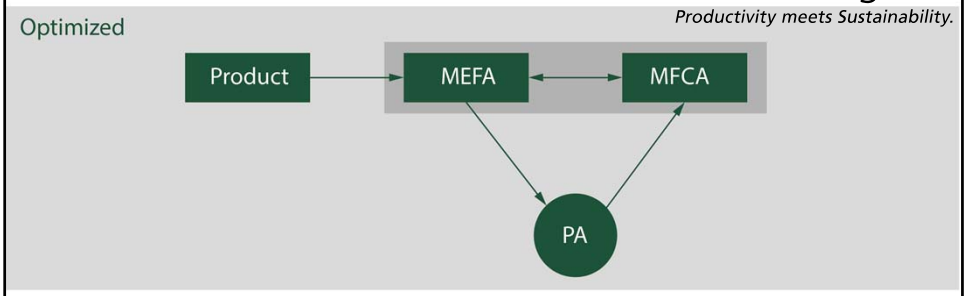
Source: HSLU

Task 1.2.1: Energy modelling for Pinch Analysis

MEFA/MFCA and Pinch Analysis (PA)

Proposed workflow between pinch analysis and detailed **material flow and energy analysis (MEFA)** and extended to **material and flow cost accounting (MFCA)**

ifu hamburg
Productivity meets Sustainability.

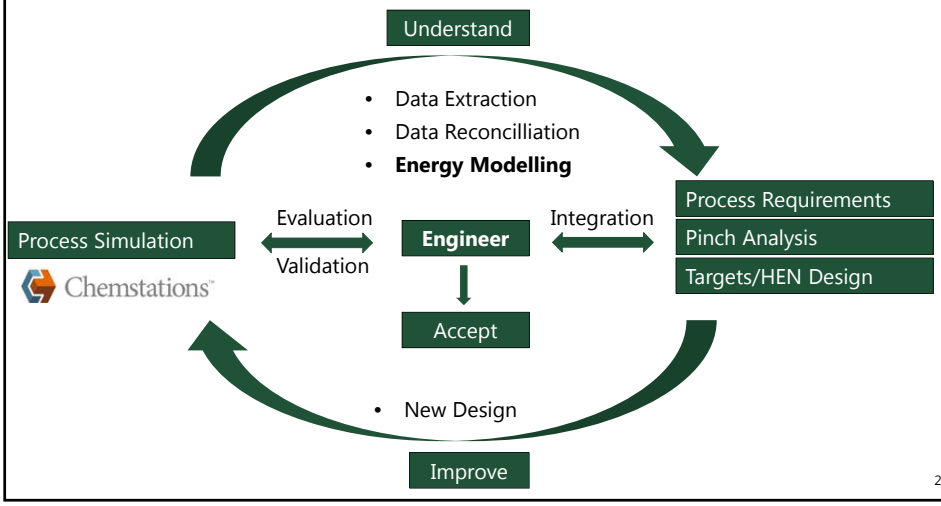


28

Task 1.2.1: Energy modelling for Pinch Analysis (HSLU)

Process Simulation and Pinch Analysis (PA)

Proposed workflow to support the evolutionary process of conceptual design (**pinch analysis**) and detailed design (**process simulation**)



29

Estimated Energy Savings: Outcome WP1

- **Today,** the Swiss industry uses approx. **24 TWh_{th}/a**
- The SFOE estimates the following saving potential through **implementation of process integration**:

Scenario	Potential energy savings
A: 300 companies with E_{tot} > 5 GWh/a (considering 6 most demanding sectors)	1'600 GWh/a
B: 600 companies with E_{tot} > 5 GWh/a (considering all sectors)	1'900 GWh/a
C: 800 companies with E_{tot} > 2.5 GWh/a (considering all sectors)	**2'200 GWh/a**

- The research activities of EIP-WP1 will generate at least 25% additional savings, i.e. **2750 GWh_{th}/a saved**
- This corresponds to **11% of today's yearly thermal energy demand**

Source: SFOE (E_{tot} *: total energy demand)*

30

Conclusions

- Industrial process energy use in Switzerland requires a significant amount of heat
- Pinch analysis provides a practical method to optimize industrial energy use
- Further research is needed in advancing methods to accelerate the implementation of energy efficiency measures and provide new process integration techniques

Thank you for your attention!

31