IEA IETS ANNEX 15 INDUSTRIELLE ABWÄRMENUTZUNG –

Integration von thermischen Komponenten in zeitabhängige Prozesse mittels mathematischer Optimierung

Univ.Prof. Dr. René Hofmann
DI Anton Beck

12.-13.10.2017, IEA Vernetzungstreffen, Salzburg
Highlights und Ergebnisse laufender Projekte

IEA-IETS ANNEX 15-2 INDUSTRIELLE ABWÄRMENUTZUNG

Internationaler ANNEX15 – Phase 2

Annex Manager

Prof. Thore Berntsson (Energy and Environment, Chalmers University of Technology)

http://www.iea-industry.org/ongoing-annexes/annex-15.html

Teilnehmende Staaten

Dänemark, Deutschland, Norwegen, Österreich, Portugal, Schweden,…

Phase 2 gestartet 10/2016; Aktivitäten

Subtask 1: In-depth evaluation and inventory of excess heat levels

Subtask 2: Methodology on how to perform an inventory in practice

Subtask 3: Possible policy instruments and the influence on future use of excess heat

Subtask 4: Technology Development

IEA-IETS ANNEX 15-2 INDUSTRIELLE ABWÄRMENUTZUNG

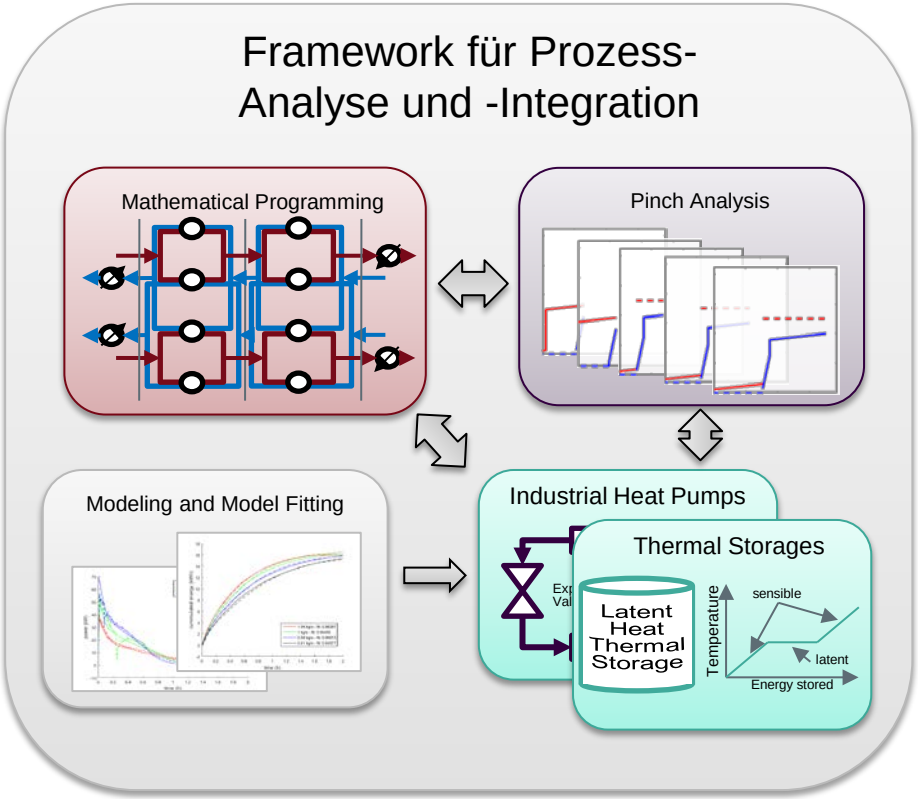
Internationaler ANNEX15 in 2 Phasen

Subtask 1: *In-depth evaluation and inventory of excess heat levels*
Subtask 2: *Methodology on how to perform an inventory in practice*
Subtask 3: *Possible policy instruments and the influence on future use of excess heat*
Subtask 4: *Technology development*

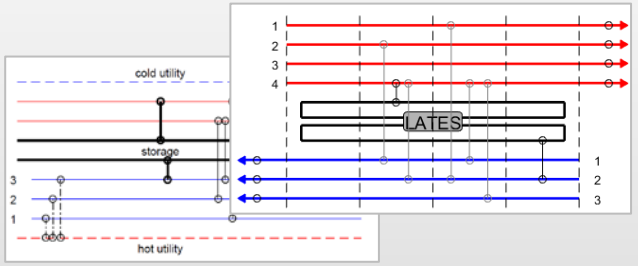
		1	2	3	4
Austria	– Methods for assessing excess heat amounts including use of pinch analysis	X	X		
	– Methodoloy based on EINSTEIN and GREENFOOD projects, branch concepts and best practice examples		X		
	– New financing instruments (TrustEE)			X	
	– Technology development • Advanced operation strategies (e.g. competition between excess heat and CHP), • technologies and systems for excess heat use (e.g. storage integration, heat pumps and electriciy generation), • thermal energy storage (sensible, latent, thermochemical, Ruths), • emerging usage of excess heat (internally or externally) process integration and process intensification				X
Denmark	– Results and experiences from operation of a steam turbo compressor in a test rig				X
Germany	– Waste heat atlas	X	X		
Norway	– Inventory of projects implemented for excess heat utilisation in Norwegian industry	X			
	– Proposal for a standardized survey method for excess heat inventory from industrial plants		X		
	– Matrix of available policy instruments in Norway with their positive, neutral and negative effects			X	
	– Recent results from research in the field novel heat pumps, power cycles for power production from excess heat for industrial processes, novel storage technologies for industrial processes,				X
Portugal	– Evaluation and inventory of excess heat levels in Portugal – some case studies	X			
	– Excess heat in the cement industry – case study	X			X
Sweden	– Development and application of new methods for identifying efficient ways to use industrial excess heat	X	X	X	
	– New absorption media for carbon capture utilizing low temperature heat	X			X

METHODENENTWICKLUNG ZUR KOSTENEFFIZIENTEN WÄRMEINTEGRATION

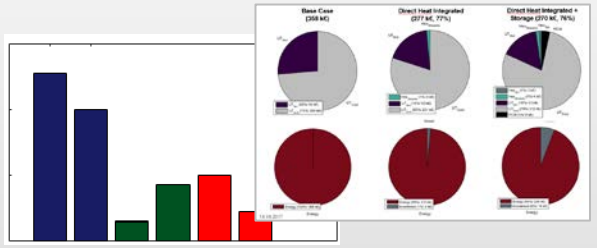
Framework für Prozess-Analyse und -Integration



Netzwerk Szenarien



Kostenanalyse



Ausgewählte Resultate werden u.a. in laufende Aktivitäten der IEA eingebracht
(IEA IETS ANNEX 15-2 – Industrial Excess Heat Recovery)

METHODENENTWICKLUNG ZUR KOSTENEFFIZIENTEN WÄRMEINTEGRATION

Ziele:

Identifikation von Abwärmepotentialen industrieller Prozesse

- ✓ **Kontinuierliche Prozesse, Batch Prozesse**

Prozessintegration

- ✓ **Wärmetauscher Netzwerke**
- ✓ **Thermische Speicher (TES)**
- ✓ **Wärmepumpen im dynamischen Betrieb**

Ökonomisch optimale Szenarien für Wärmeintegration

Methoden:

Erweiterung existierender Methoden für Prozessanalyse und –integration

- ✓ **Linearisierung → Komplexitätsreduktion → Modellintegration**
- ✓ **Kombination von Pinch-Analyse und Mathematical Programming**

Kosteneffiziente Dimensionierung von Anlagenkomponenten (TES, WP, HEX)

ANNEX 15/2 WORKSHOP ON PINCH-METHODOLOGY

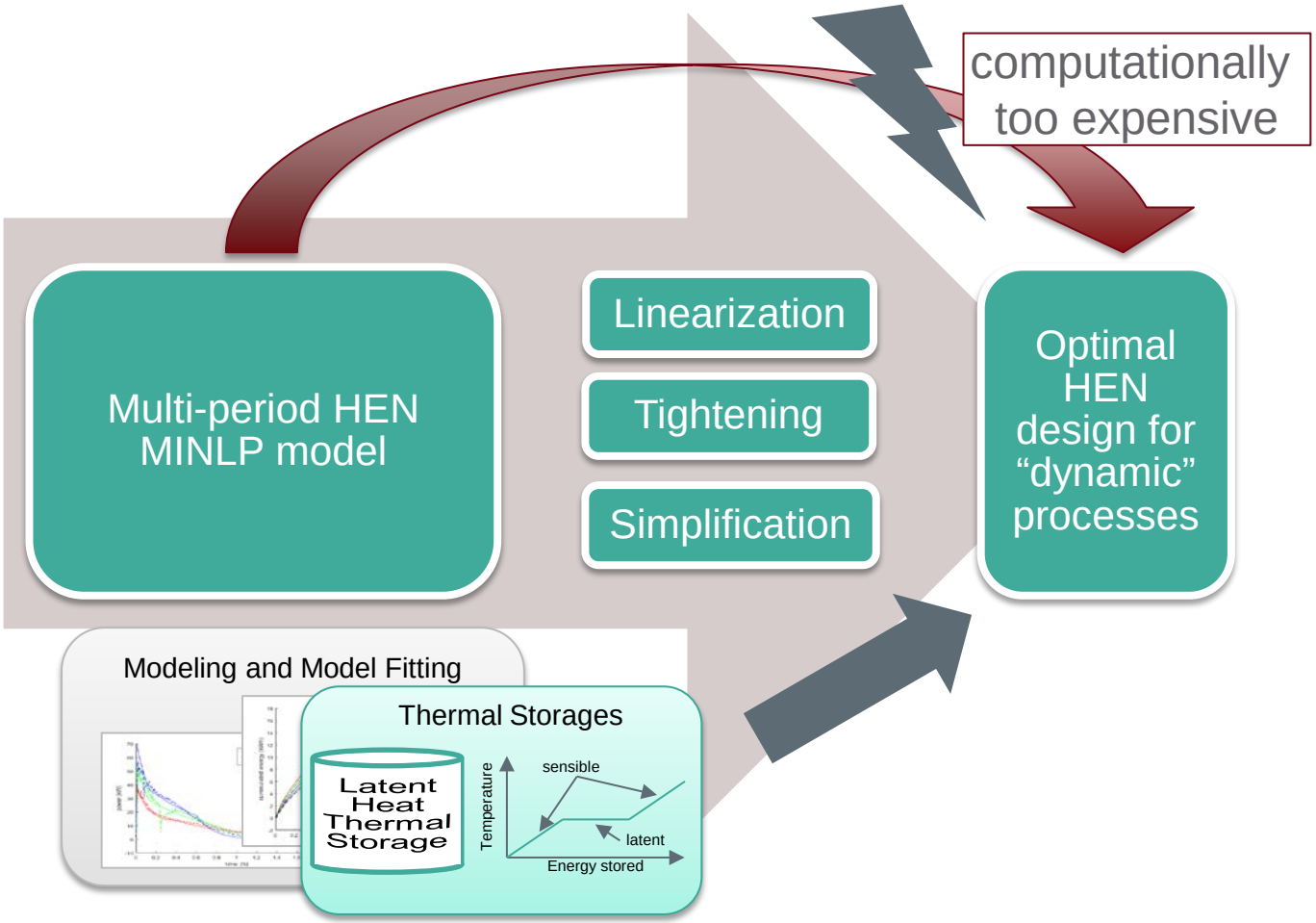
27. SEPTEMBER 2017, AIT

Program:

- Advanced pinch methods for analysis of industrial process energy systems.
- Applications for identifying opportunities for
  - internal heat recovery;
  - excess heat usage;
  - heat pumping;
  - thermal energy storage

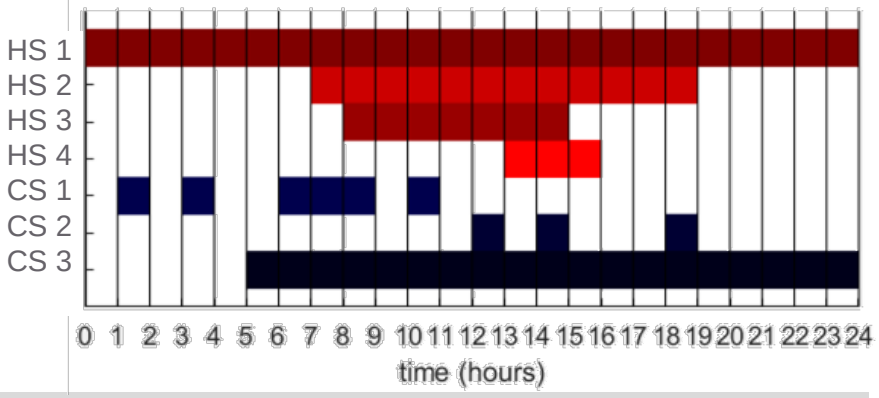
MÖGLICHKEITEN ZU PROZESSINTEGRATION TRANSIENTER PROZESSE

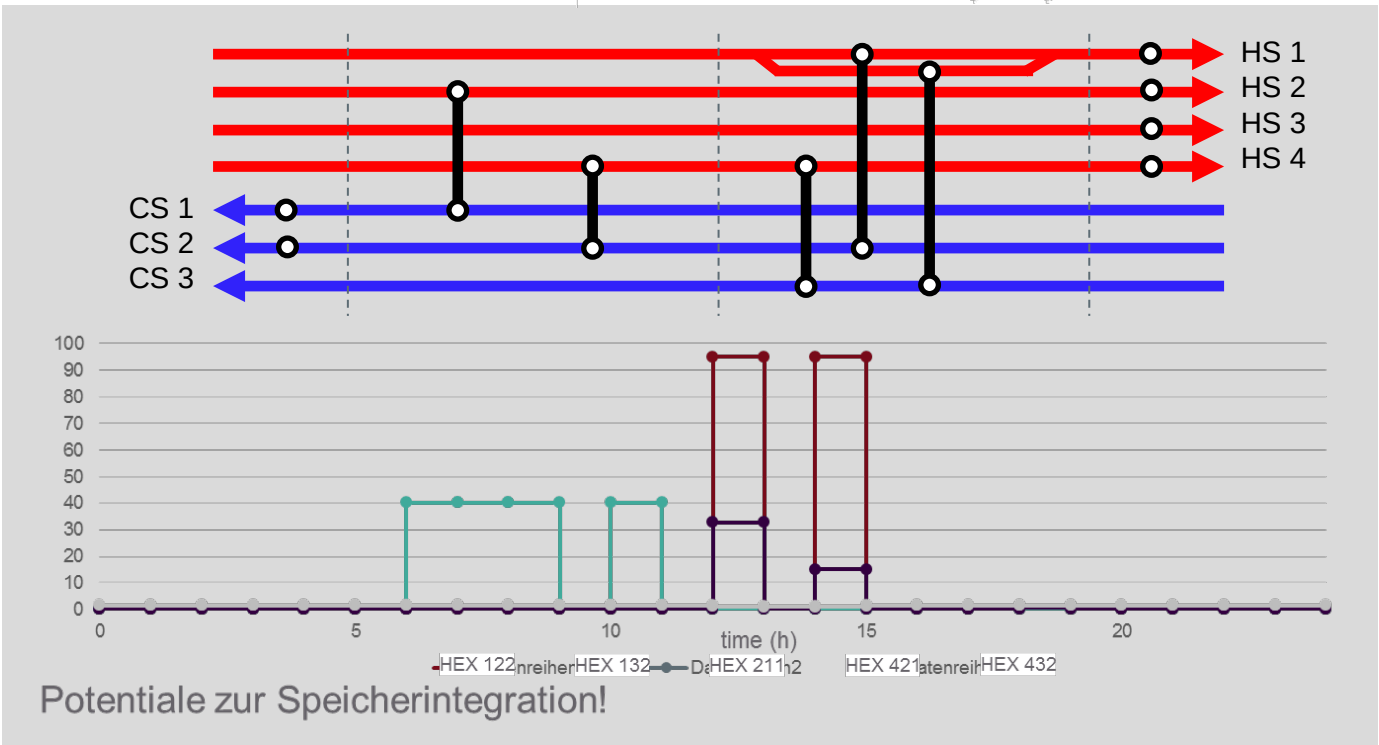
Modifikationen der Superstructure Formulierung



BEISPIEL: GENERSICHER ZEITABHÄNGIGER PROZESS

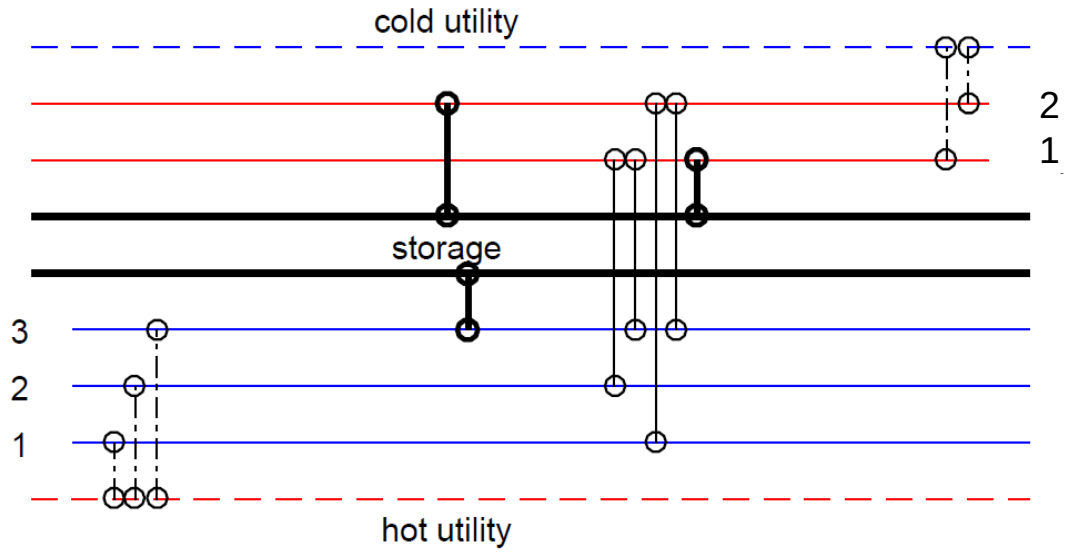
- 4 hot streams
- 3 cold streams
- 24 Operation periods





Potentiale zur Speicherintegration!

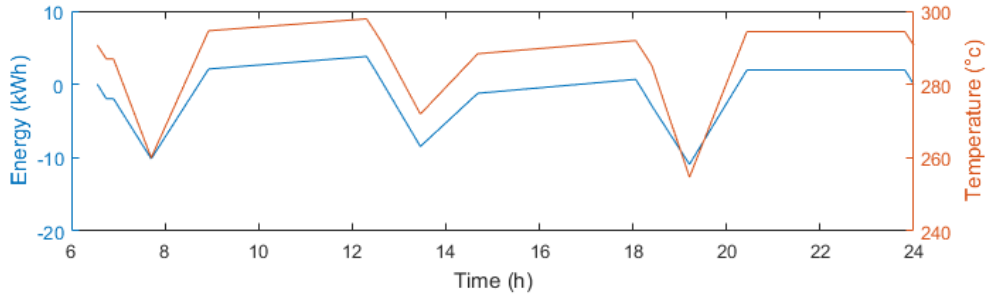
BEISPIEL: LATENTWÄRMESPEICHER INTEGRATION



Process – Process HEX
Utility – Process HEX
Storage – Process HEX

- 4 P-P HEX
- 5 Utility HEX
- 3 Storage HEX

Storage

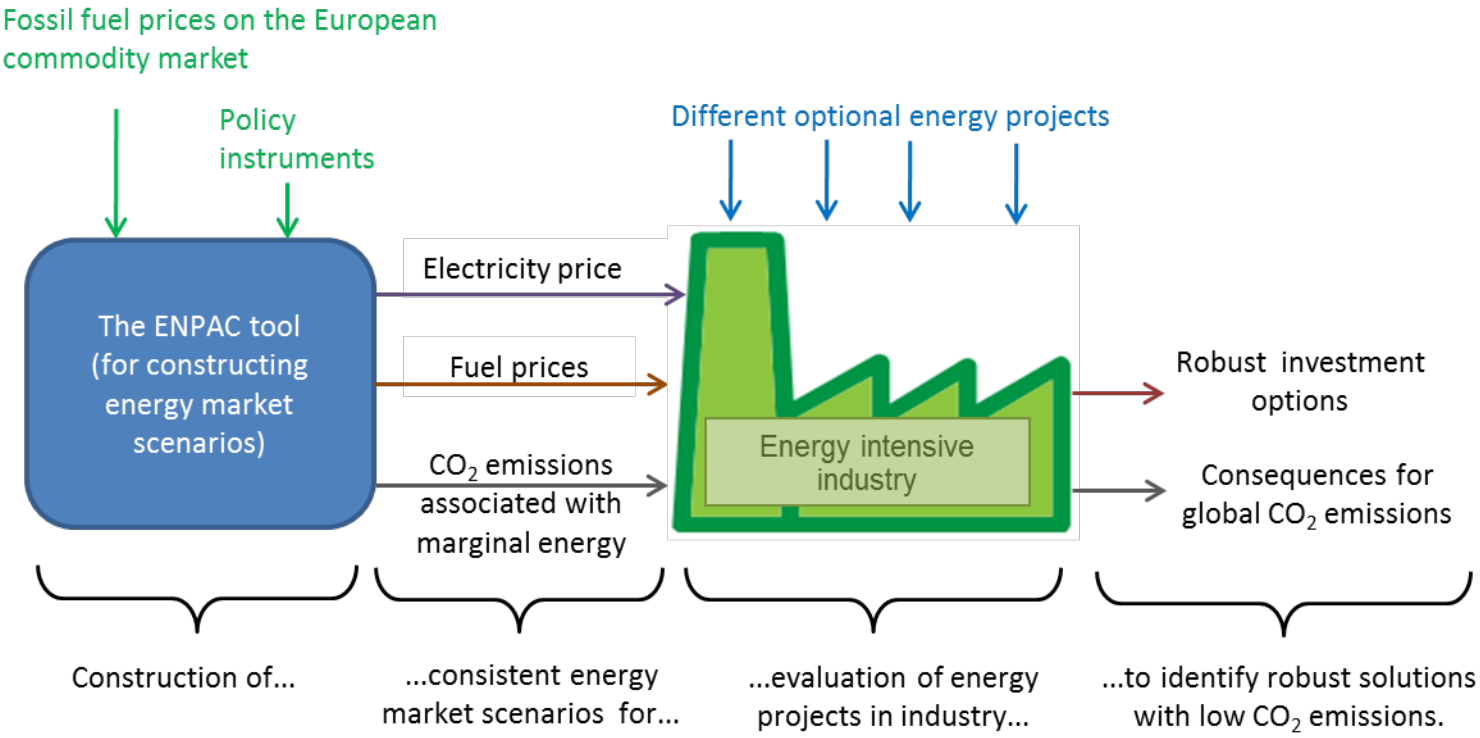


- Ideal storage mass: 183,26 kg PCM
- Ideal melting Point: 288,13 ºC
- ~20 kWh amplitude

SCENARIOS FOR ASSESSING PROFITABILITY AND CARBON BALANCES OF ENERGY INVESTMENTS IN INDUSTRY

Erik Axelsson, Profu
Simon Harvey, Chalmers, Energiteknik

The Energy Price and Carbon Balance Scenario tool (ENPAC)



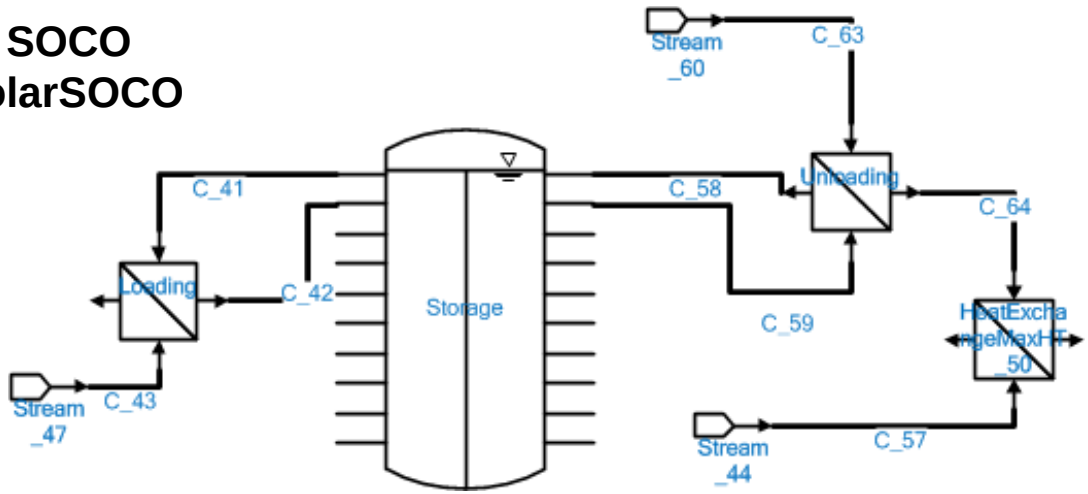
SOCO - Storage Optimisation Concept

DI Wolfgang Glatzl, DI Christoph Brunner

Motivation SOCO:
Design of heat exchangers and heat storage for optimal energy system in industries
Questions:

- ✓ Process design, Operating hours / Variable time profiles
- ✓ Integration and design of heat exchangers and heat storages
- ✓ Integration of renewable energies

Algorithms developed and used in SOCO
SOCO tool
Case studies performed with SOCO
Currently in development: SolarSOCO



CHALMERS
UNIVERSITY OF TECHNOLOGY

Advanced pinch curves for targeting of industrial excess heat potentials

Thore Berntsson

IEA Annex 15 – Industrial Excess Heat Recovery
Workshop 27 September 2017

Advanced pinch curves–Graphical tool for retrofit of heat exchanger networks

- Retrofit requires knowledge about the existing system
- The advanced curves offers new insights:
  - Actual and potential temperature levels for heating and cooling–before and after retrofit
  - Information about the design of the existing network
  - Visualization of trade-off between internal or external use of excess heat
  - Visualization of potential heat recovery at different complexity levels

VIELEN DANK!

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