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SEVENTH FRAMEWORK PROGRAMME

EFENIS

Framework for long term validity of energy integration management in the process industry

Joint dissemination event by LOCIMAP & EFENIS, „Future Industrial Parks − New Ideas“
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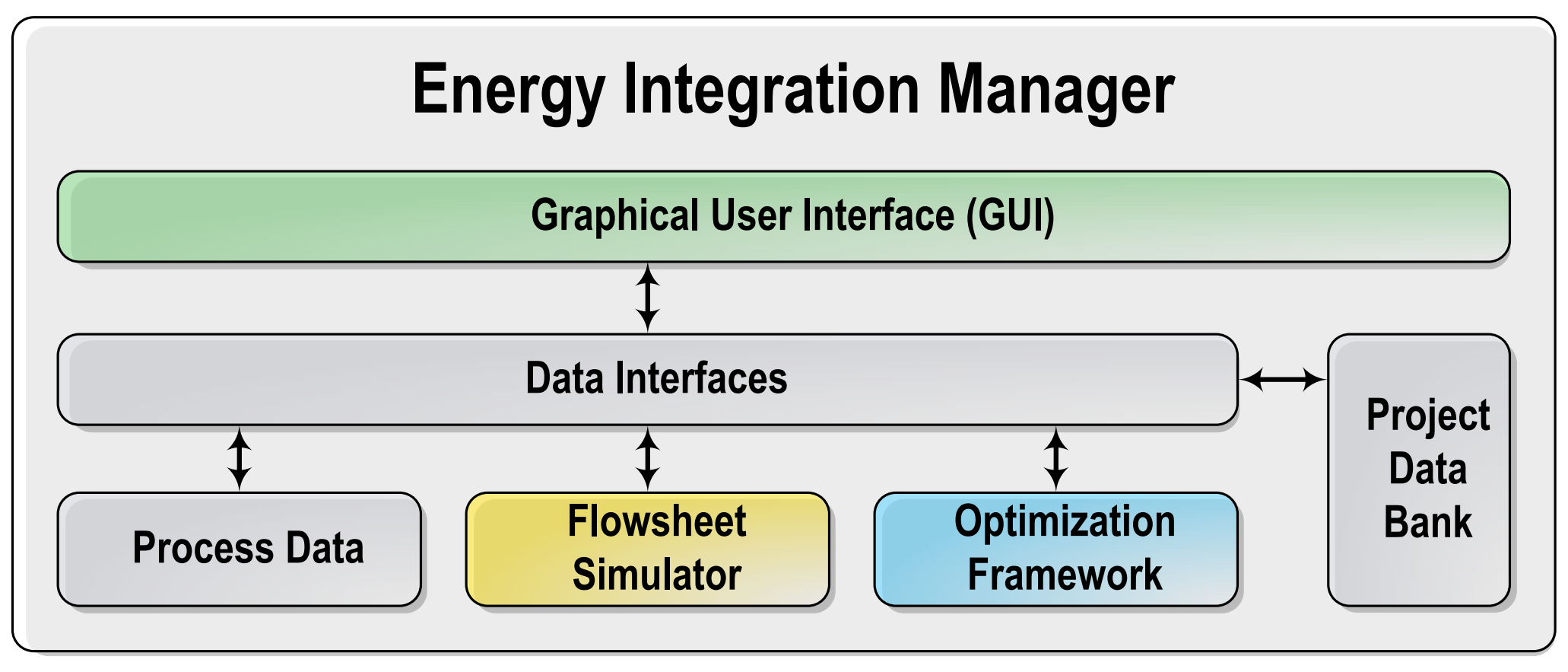
MOTIVATION

Comprehensive energy efficiency analysis is a major scope of recent process optimization developments. By now many chemical processes are already highly integrated. Process heat is recovered directly by applying a heat exchanger network and indirectly by using a super ordinated utility system. The simultaneous evaluation of these two heat integration strategies is the objective of a total site analysis. But the data basis for a total site analysis is only valid for a static snapshot of the whole industry site. Changes to single process units throughout the design phase of new industrial solutions as well as subsequent process modifications to existing plants necessitate an actualization of the total site analysis. Previously identified potentials to increase the energy efficiency may have become outdated or infeasible. An efficient framework for long term validity of energy integration is needed, utilizing computer aided process models as well as state-of-the-art engineering software for simulation and optimization. The demonstration of a solid workflow links scientific research to industrial experience.


Energy Integration Manager

Graphical User Interface (GUI)

Data Interfaces

Project Data Bank

Process Data

Flowsheet Simulator

Optimization Framework

GENERAL CONCEPT

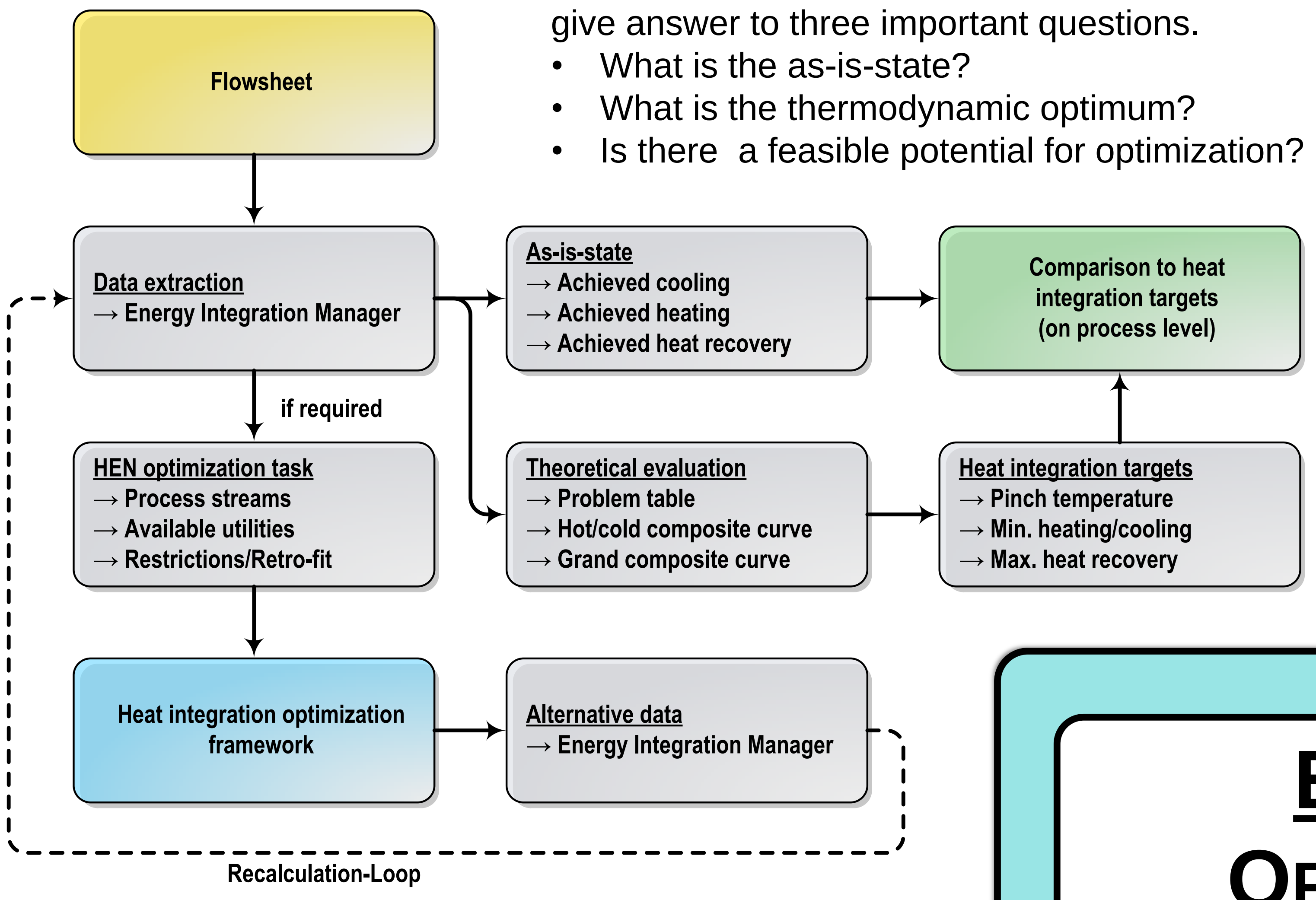
As mentioned above, it is very promising to process computer aided data models like Aspen Plus flowsheets directly as a data source for specialized optimization frameworks. The objective is to merge together different software methodologies by sharing a common manager system for transferring and presenting necessary information. This way an understandable and less time consuming method of energy efficiency analysis can be achieved. The importance of such an approach is underlined through the variety of different levels of consideration and analysis aspects. In general there two different levels of interest. The first level is the process level consisting of key elements like the heat exchanger network. The second level is the total site level consisting of key elements like the utility system or potentials for cogenerated energy.

DETAILED METHODOLOGY

The architecture of an energy integration manager system consists of several important sections. These sections are linked to each other to give answer to three important questions.

- What is the as-is-state?
- What is the thermodynamic optimum?
- Is there a feasible potential for optimization?

PROCESS LEVEL


Flowsheet

Data extraction
→ Energy Integration Manager

As-is-state
→ Achieved cooling
→ Achieved heating
→ Achieved heat recovery

Comparison to heat integration targets (on process level)

if required

HEN optimization task
→ Process streams
→ Available utilities
→ Restrictions/Retro-fit

Theoretical evaluation
→ Problem table
→ Hot/cold composite curve
→ Grand composite curve

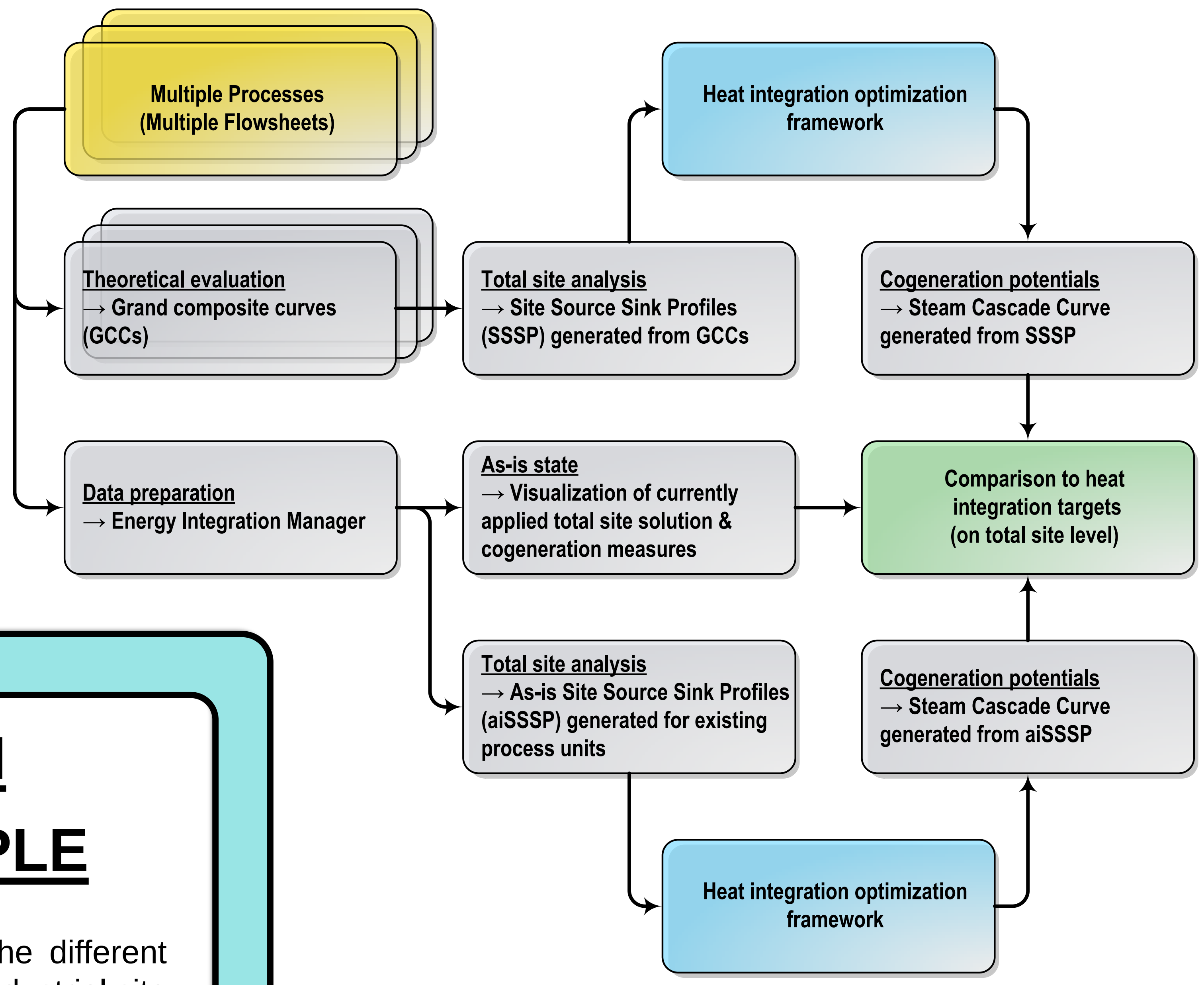
Heat integration targets
→ Pinch temperature
→ Min. heating/cooling
→ Max. heat recovery

Heat integration optimization framework

Alternative data
→ Energy Integration Manager

Recalculation-Loop

TOTAL SITE LEVEL


Multiple Processes (Multiple Flowsheets)

Heat integration optimization framework

Theoretical evaluation
→ Grand composite curves (GCCs)

Total site analysis
→ Site Source Sink Profiles (SSSP) generated from GCCs

Cogeneration potentials
→ Steam Cascade Curve generated from SSSP

Data preparation
→ Energy Integration Manager

As-is state
→ Visualization of currently applied total site solution & cogeneration measures

Comparison to heat integration targets (on total site level)

Total site analysis
→ As-is Site Source Sink Profiles (aiSSSP) generated for existing process units

Cogeneration potentials
→ Steam Cascade Curve generated from aiSSSP

Heat integration optimization framework

EVALUATION OF AN EXAMPLE

In order to give a short inside on the different evaluation methods, as exemplarily industrial site is presented as follows. The required data is listed on the left.

Process A: **Dehydration of methanol to dimethyl-ether**

Name [ ]	T_in [K]	T_out [K]	Duty [kW]	Type [ ]	Apparatus [ ]
Eq01_p1	323	400	1511	cold	Heat exchanger
Eq02_p1	423	570	1557	cold	Heat exchanger
Eq03_p1	400	423	5289	cold	Vaporizer
Eq04_p1	433	433.1	2059	cold	Reboiler
Eq05_p1	380	380.1	1763	cold	Reboiler
Eq06_p1	686	590	1194	hot	Heat exchanger
Eq07_p1	590	451	1557	hot	Heat exchanger
Eq08_p1	451	418	1511	hot	Heat exchanger
Eq09_p1	418	355	4370	hot	Heat exchanger
Eq10_p1	318	317.9	1643	hot	Condenser
Eq11_p1	338	337.9	2453	hot	Condenser

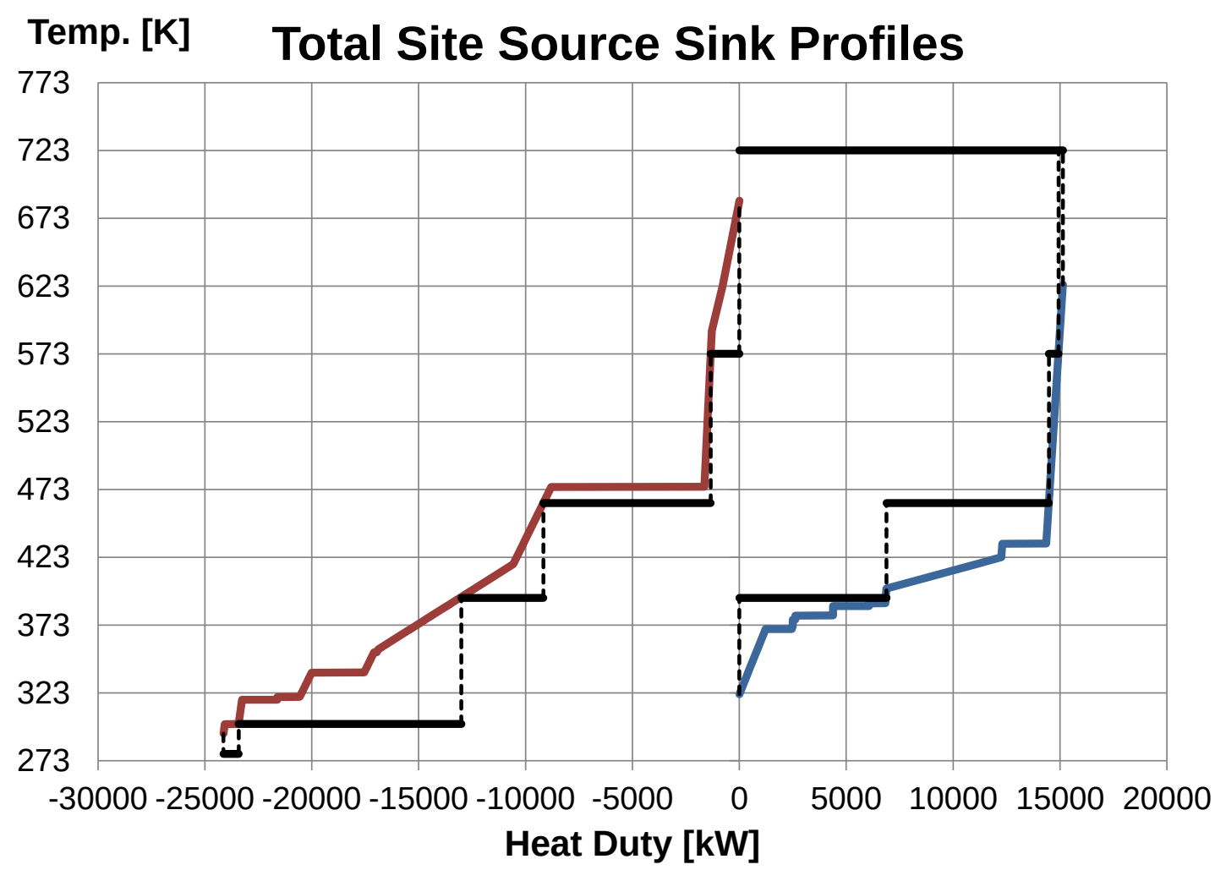
Process B: **Carbonylation of dimethyl-ether to methyl-acetate**

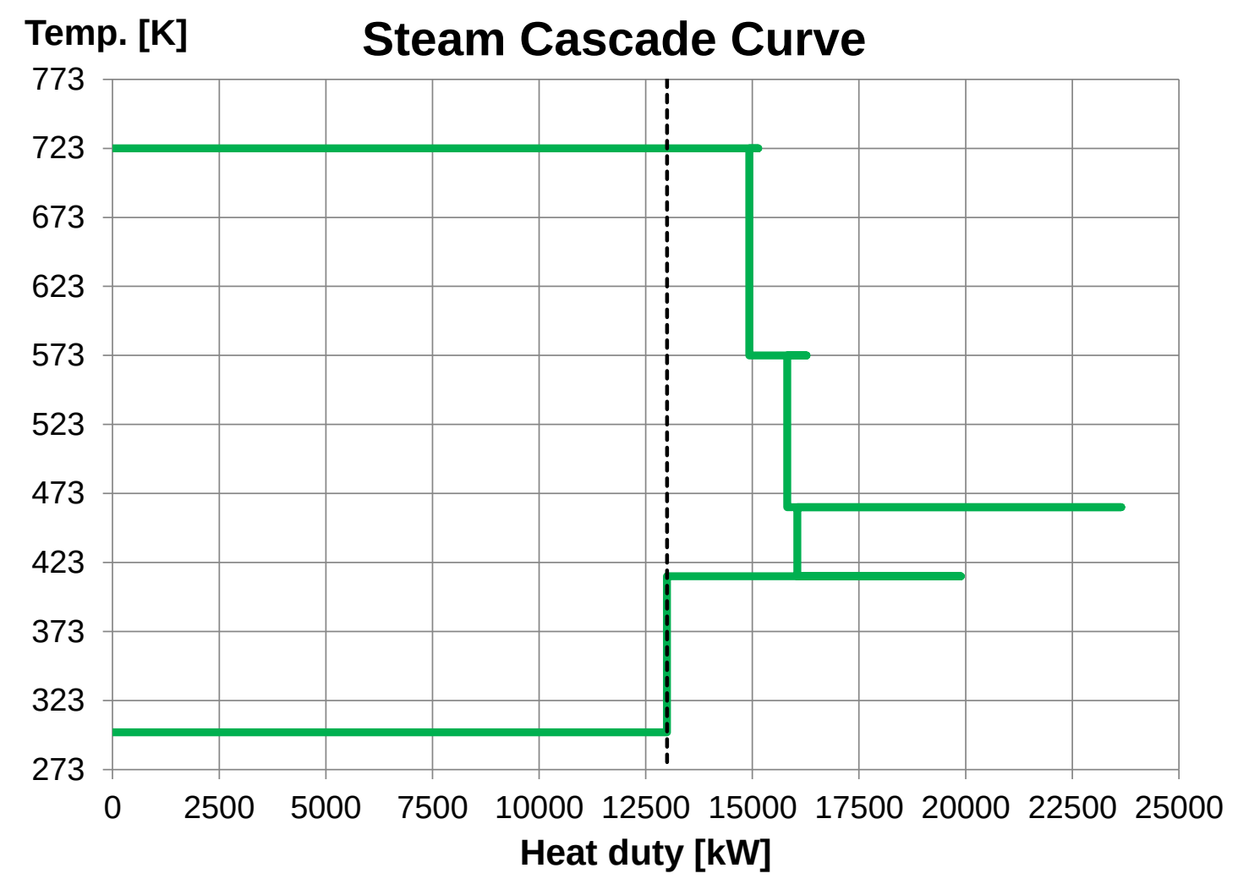
Name [ ]	T_in [K]	T_out [K]	Duty [kW]	Type [ ]	Apparatus [ ]
Eq01_p2	322	372	1280	cold	Vaporizer
Eq02_p2	387	387.1	1690	cold	Reboiler
Eq03_p2	475	474.9	7165	hot	Reactor jacket
Eq04_p2	475	320	4369	hot	Heat exchanger
Eq05_p2	300	299.9	653	hot	Condenser

Process C: **Dehydrogenation of isopropanol to acetone**

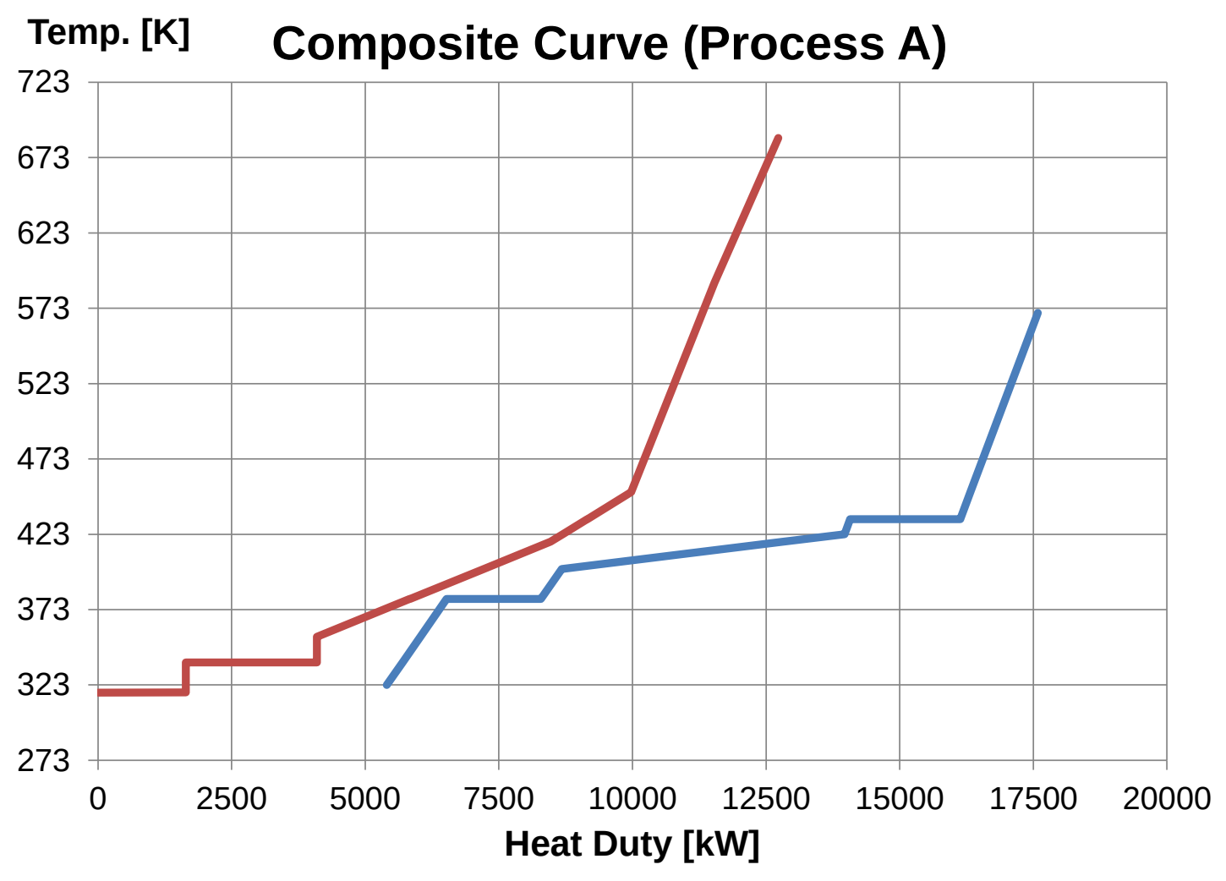
Stream [ ]	T_in [K]	T_out [K]	Duty [kW]	Type [ ]	Apparatus [ ]
Eq01_p3	389	389.1	757.7	cold	Vaporizer
Eq02_p3	370	370.1	1217	cold	Reboiler
Eq03_p3	377	377.1	120.4	cold	Reboiler
Eq04_p3	389	624	960	cold	Reactor jacket
Eq05_p3	623	318	899.3	hot	Heat exchanger
Eq06_p3	318	293	220.3	hot	Heat exchanger
Eq07_p3	320	319.9	1045	hot	Condenser
Eq08_p3	353	352.9	119.3	hot	Condenser

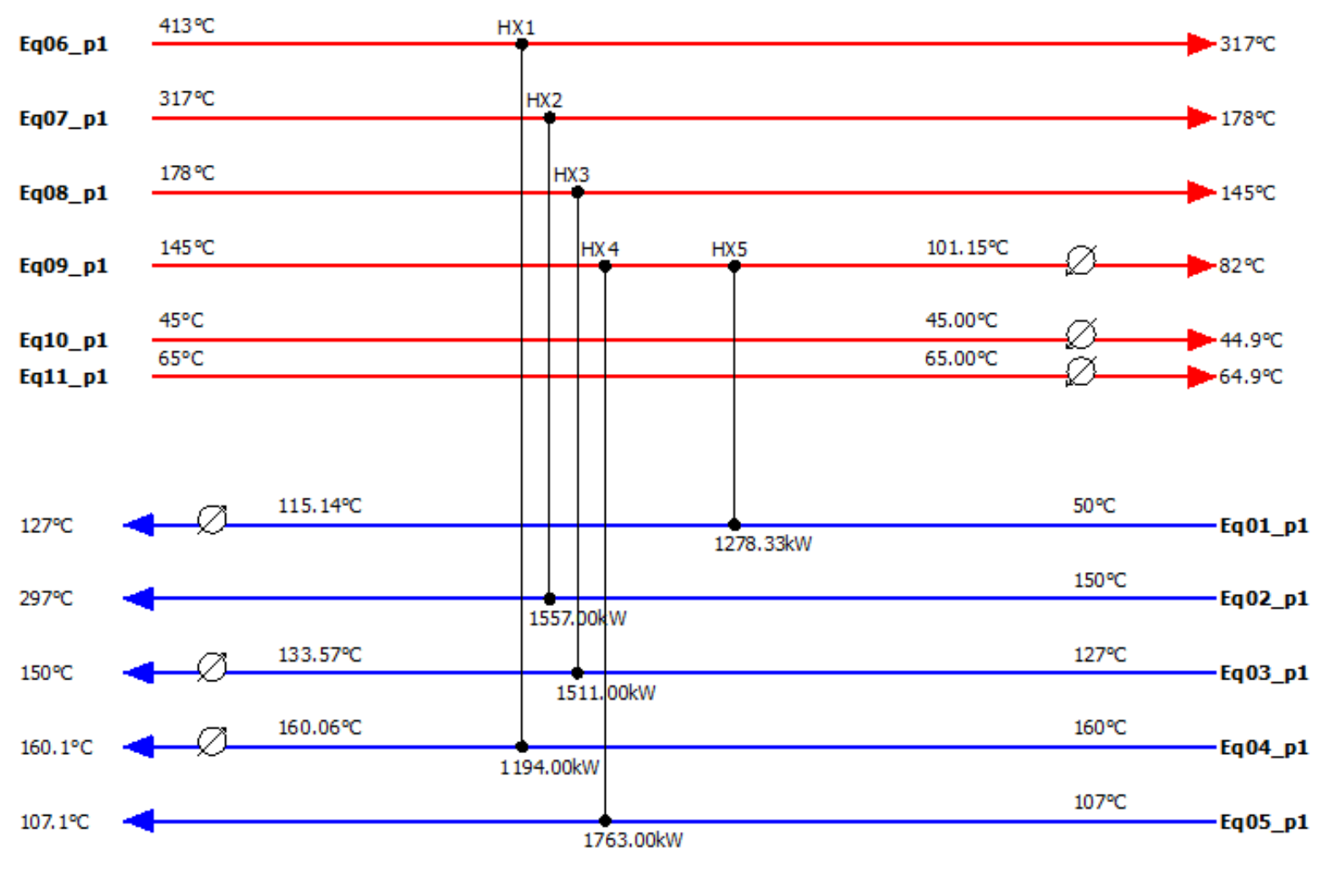
TOTAL SITE LEVEL





PROCESS LEVEL





Heat exchanger network for process A

Scope of evaluation:

➲ **Heat recovery targeting**
(for ideal heat integration):
- Minimal heat duty for cooling
- Minimal heat duty for heating
- Maximal heat transfer within each process

➲ **Optimal choice of utilities for heating and cooling with the help of temperature profiles**

➲ **Optimal design of heat exchanger network structure**

➲ **Total site targeting**
(for ideal heat integration):
- Potentials for cogenerated power
- Steam savings due to indirect heat transfer