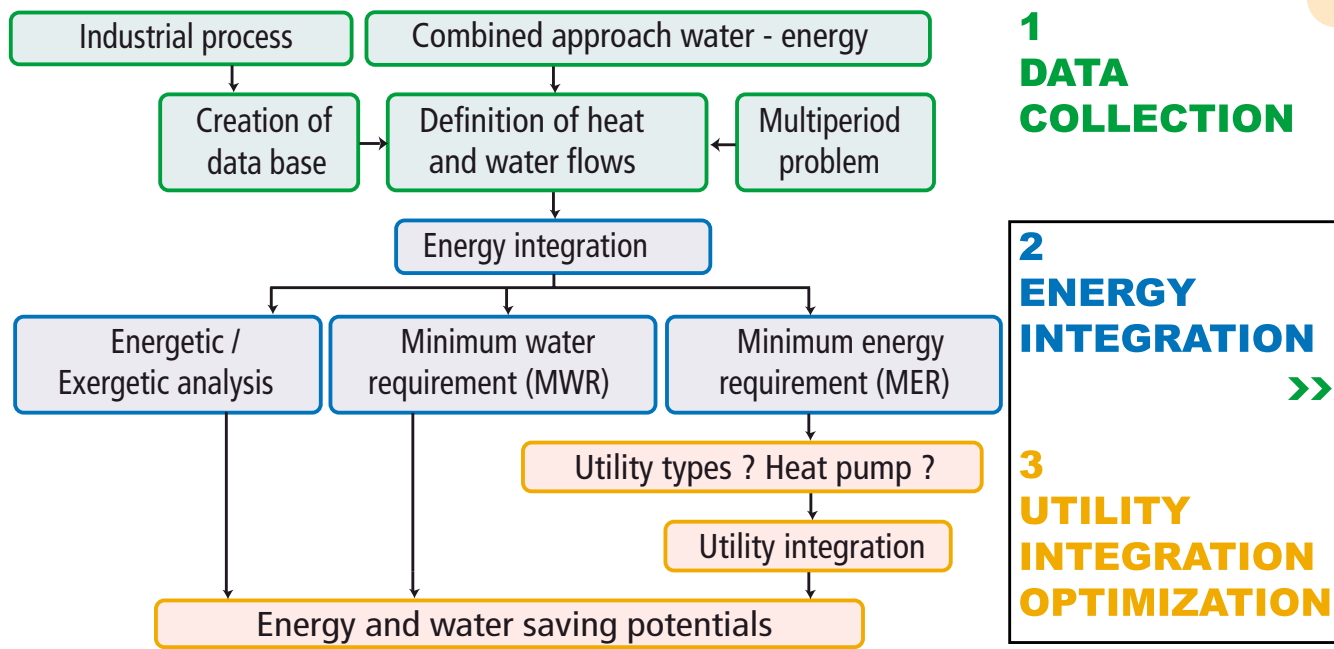


PROCESS INTEGRATION METHODOLOGY



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CONTEXT / APPROACH



OBJECTIVES

- Development of a methodology to integrate heat pumps in industrial processes
- Optimization of industrial processes

TOOLS & CHALLENGES

- Pinch Analysis & Process Integration

Limits of the methodology

Heat exchange restrictions due to industrial constraints:

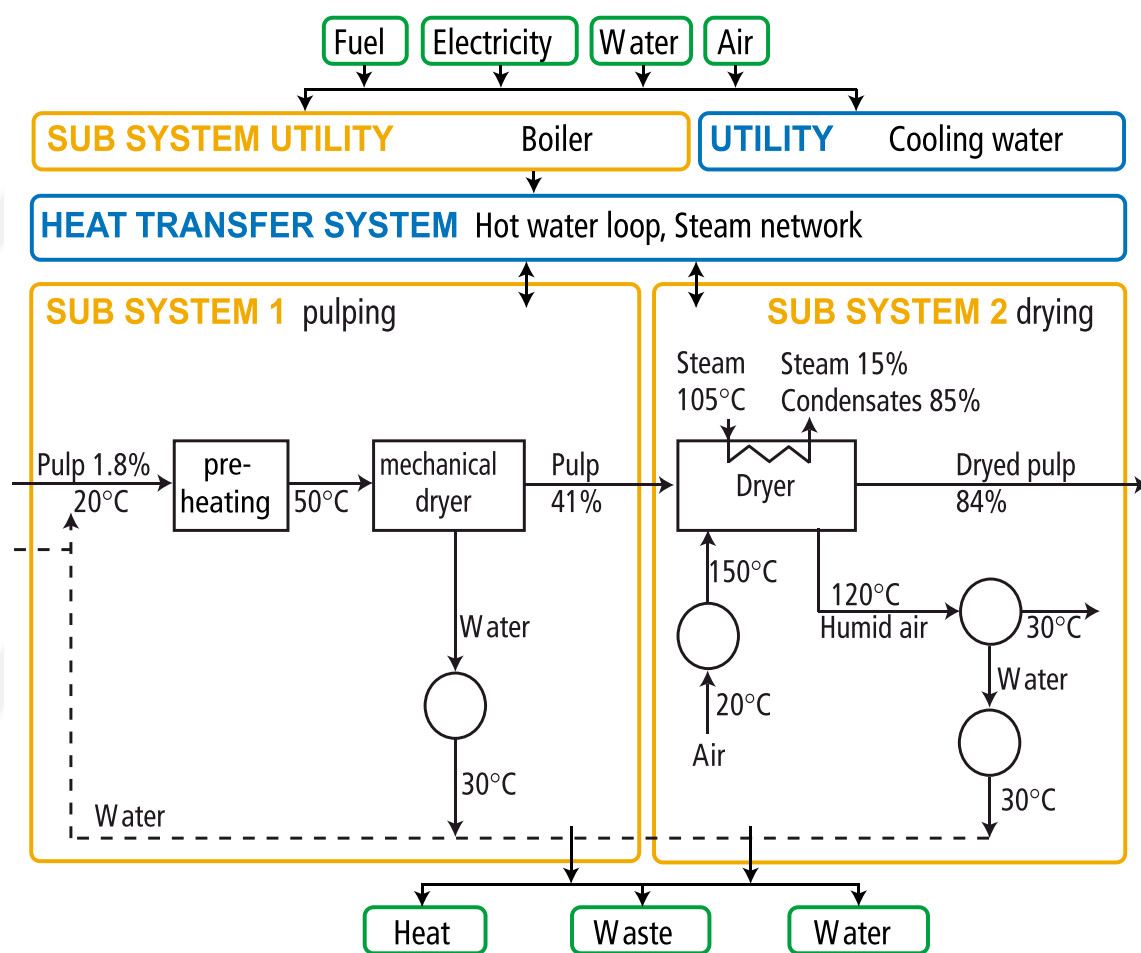
- Distance between streams
- Quality and/or safety reasons

Multi-period processes

HEAT EXCHANGE RESTRICTIONS

- Introducing sub-systems
 - Heat can be exchanged inside a sub-system but no direct heat exchange with other sub-systems is allowed.
 - The integration of a heat transfer system (hot water loop or steam network) gives the possibility of indirect heat exchange between sub-systems.

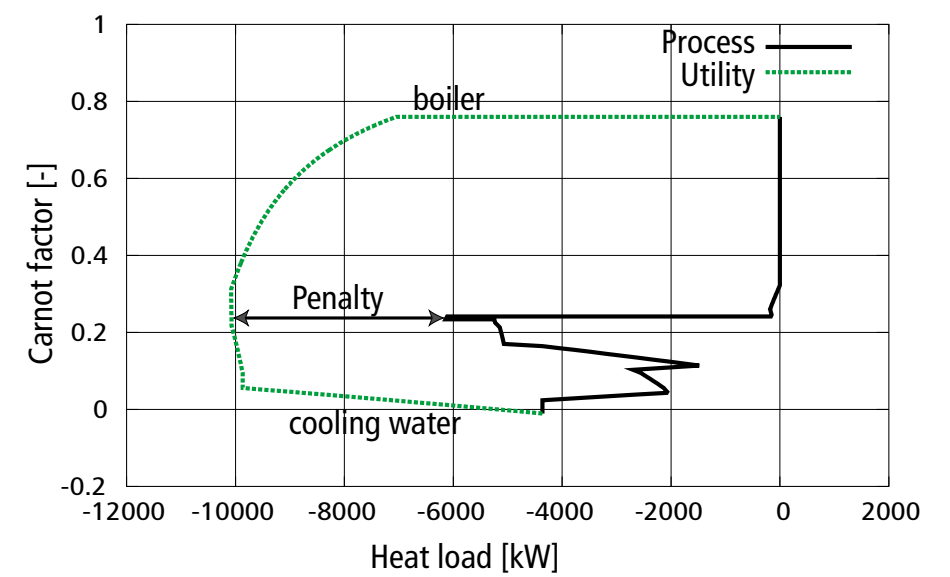
• Example:



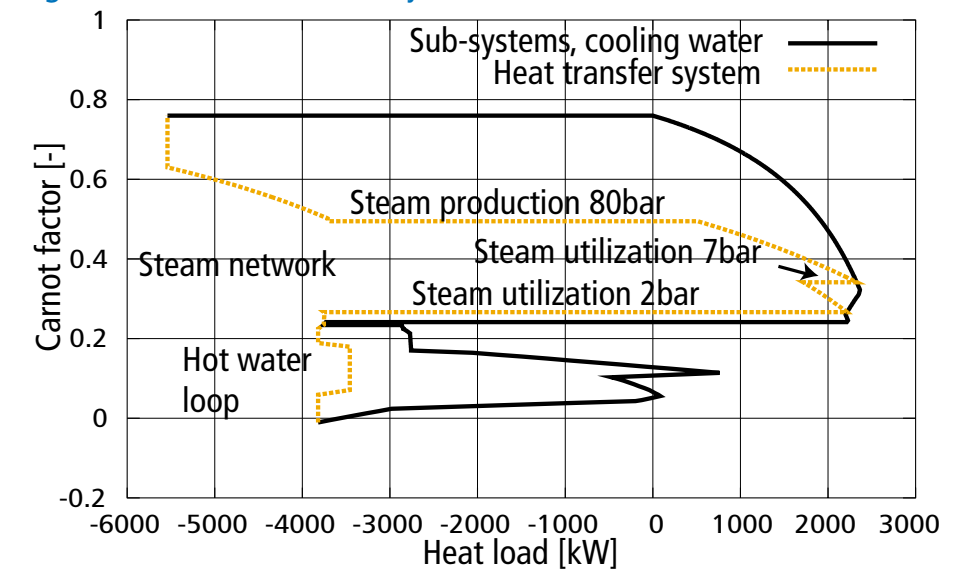
- Advantages:
 - Heat exchange inside sub-systems is favored
 - Design of heat exchanger network becomes easier
 - Simultaneous optimization of utility integration and heat transfer system

• Results:

1. Integration without heat transfer system (Case 1)



2. Integration with heat transfer system (Case 2)



	Unit	No constraint	Case 1	Case 2
Fuel	[kW]	6014	9868	7760
Cooling water	[kW]	1651	5505	1676
Electricity	[kW]			-1684

MULTI-PERIOD

- Calculation of the heat cascade in each period
- Adding storage devices & storage equations
- Advantages:
 - Operating time of heat pumps can be increased
 - Simultaneous optimization of utility, heat transfer system and storage devices

References:

Becker, H., Maréchal, F., and Vuillemoz, A. 2009. Process integration and opportunity for heat pumps in industrial processes. 22nd International Conference on Efficiency, Cost, Optimization Simulation and Environmental Impact of Energy Systems - ECOS2009
Becker, H., Girardin, L. and Maréchal, F. 2010. Energy integration of industrial sites with heat exchange restrictions. 20th European Symposium on Computer Aided Process Engineering - ESCAPE20

PERSPECTIVES

- Multi-period problems and energy storage
- Heat pump technologies and multi-objective optimisation to choose the optimal heat pump
- Case study on a cheese factory in collaboration with EDF

ACKNOWLEDGEMENTS

The author wish to thank ECLEER for supporting this research and collaboration in its realization.



LEADING THE ENERGY CHANGE