

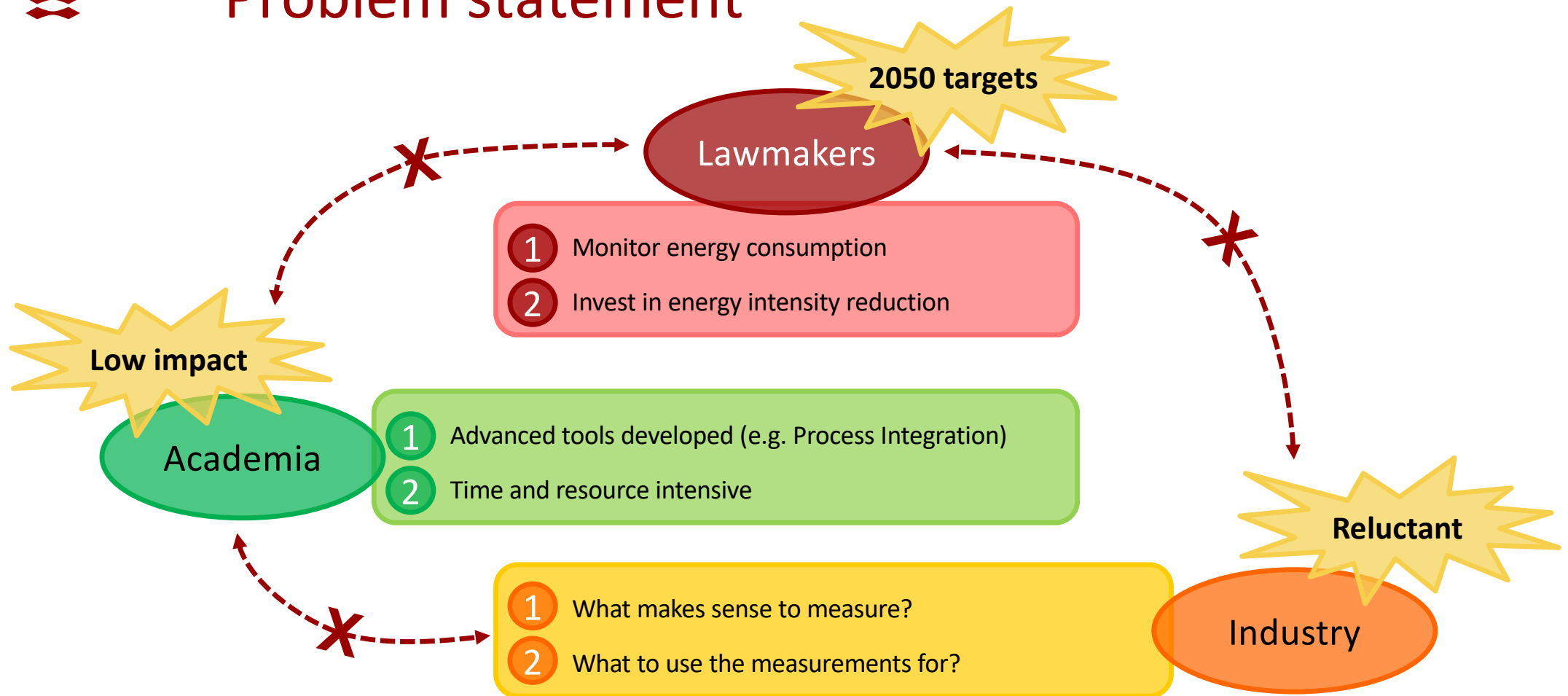


Riccardo Bergamini

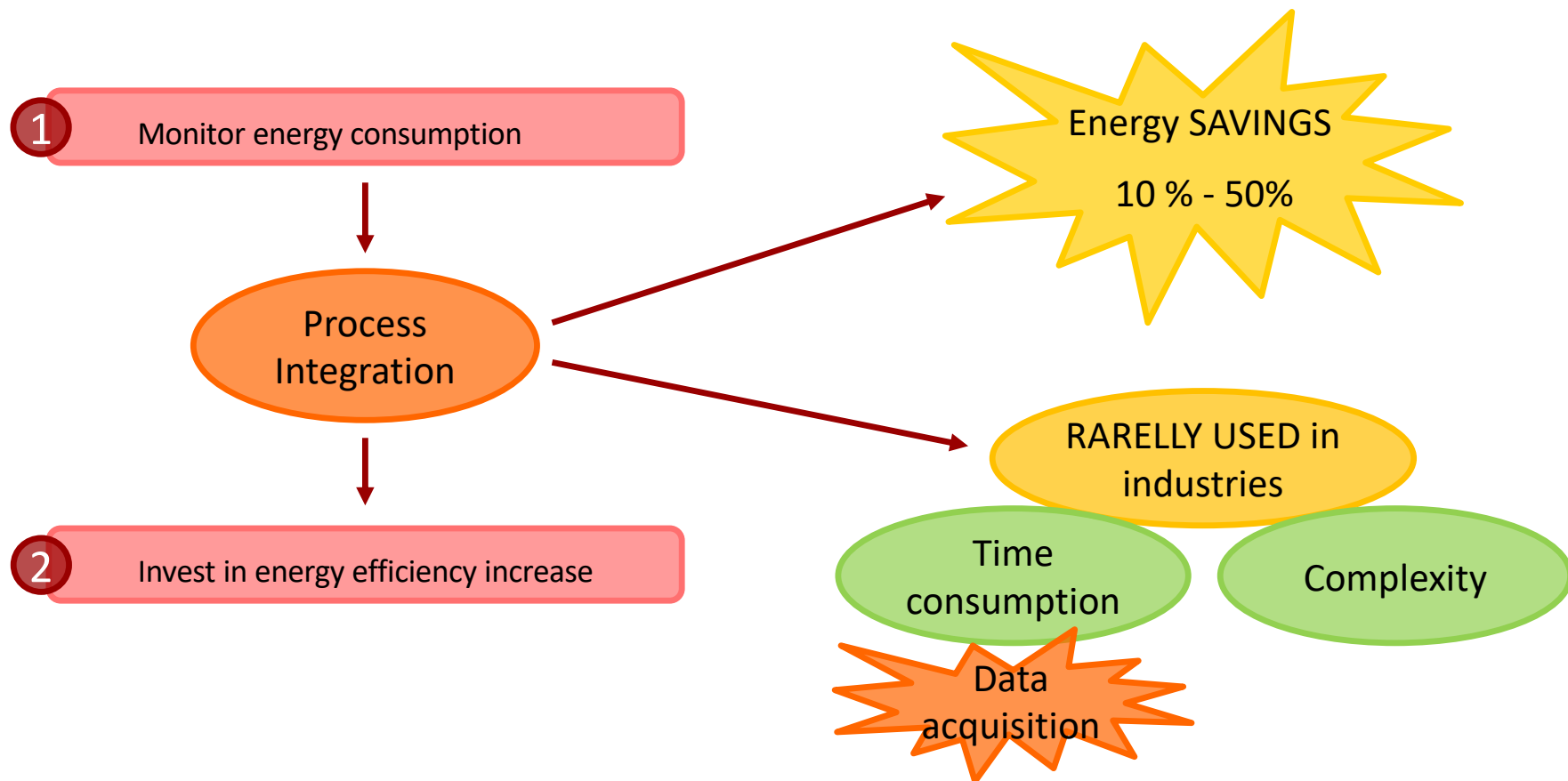
PhD student

Identification of optimal measurement points for energy monitoring of industrial processes

Problem statement



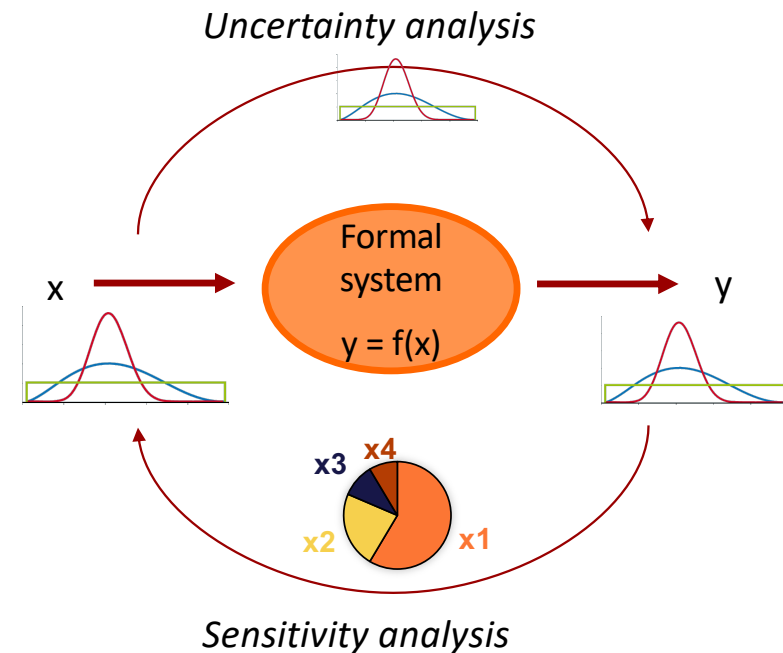
Objectives



Developed Method

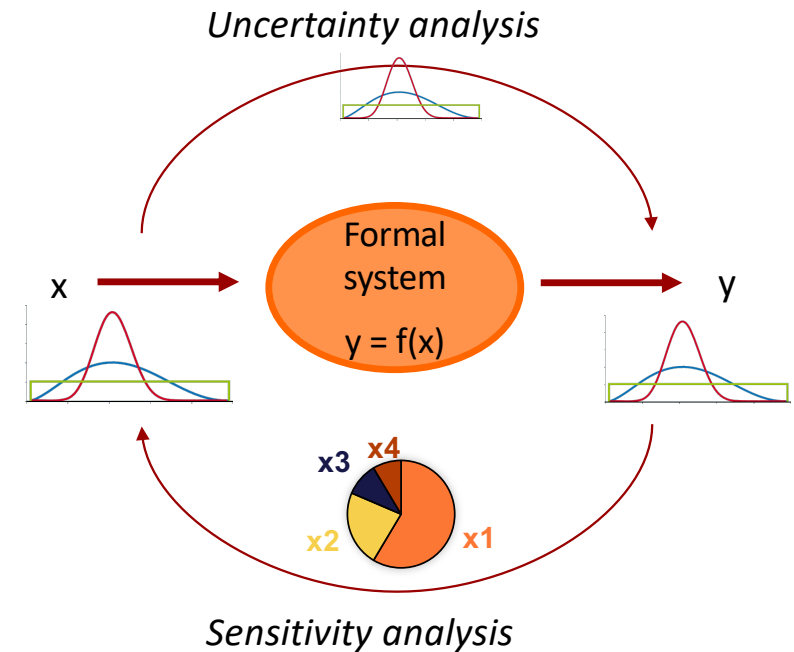
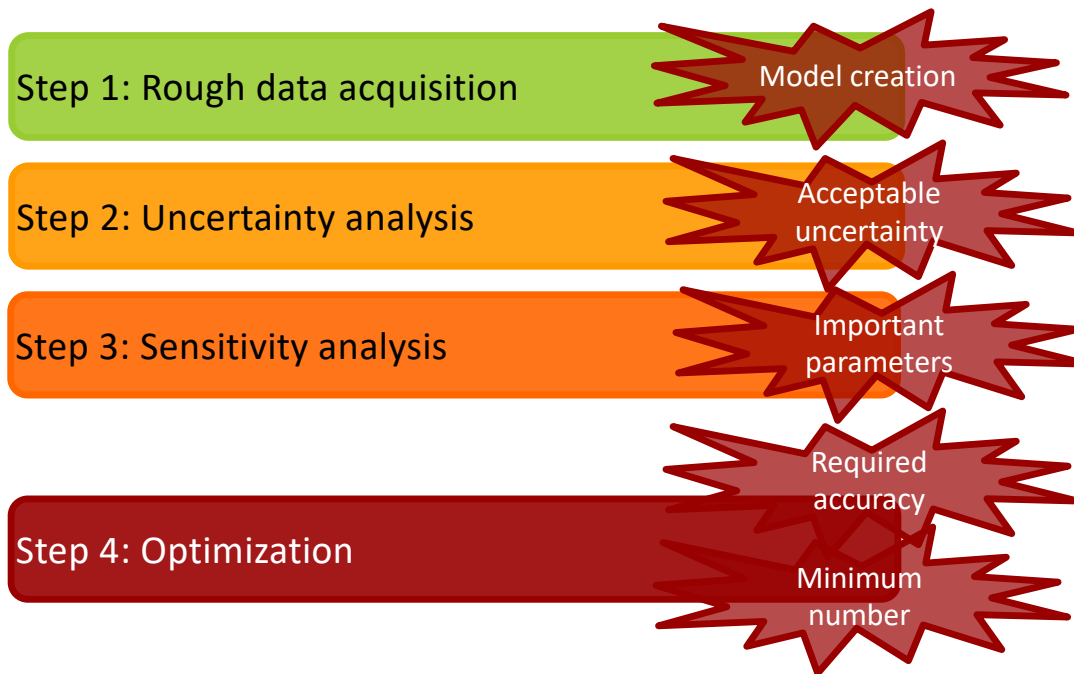
RDRA (Required Data Reduction Analysis)

- Aim: Identify required measurement points based on roughly acquired data
- Recognise the role of measurements: **provide knowledge**
- Quantify knowledge in terms of **uncertainty**



Developed Method¹

RDRA (Required Data Reduction Analysis)



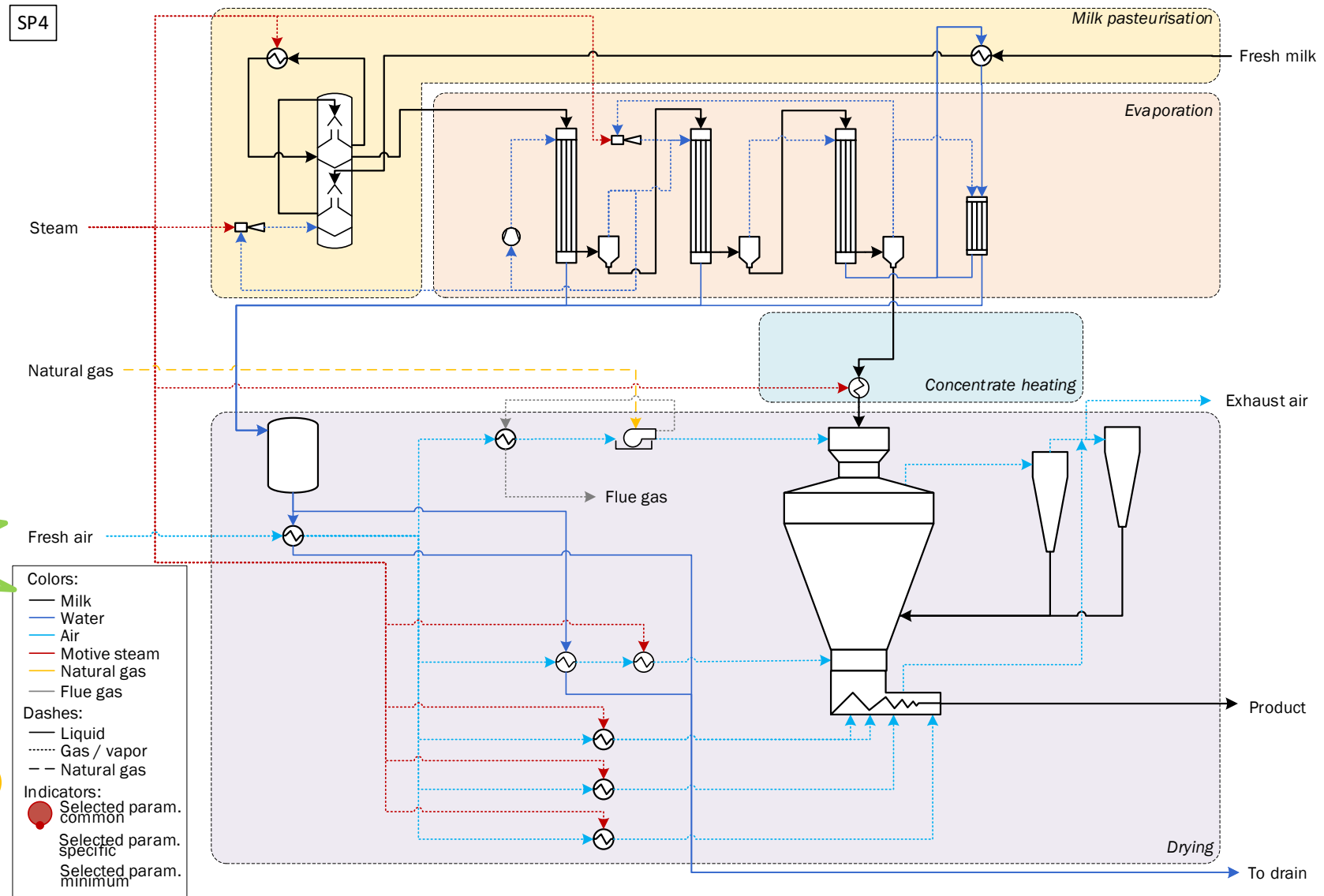
¹Bergamini R, Nguyen T-V and Elmegaard B (2019) Simplification of Data Acquisition in Process Integration Retrofit Studies Based on Uncertainty and Sensitivity Analysis. Front. Energy Res. 7:108.

Case study

Milk powder production

4 different plants

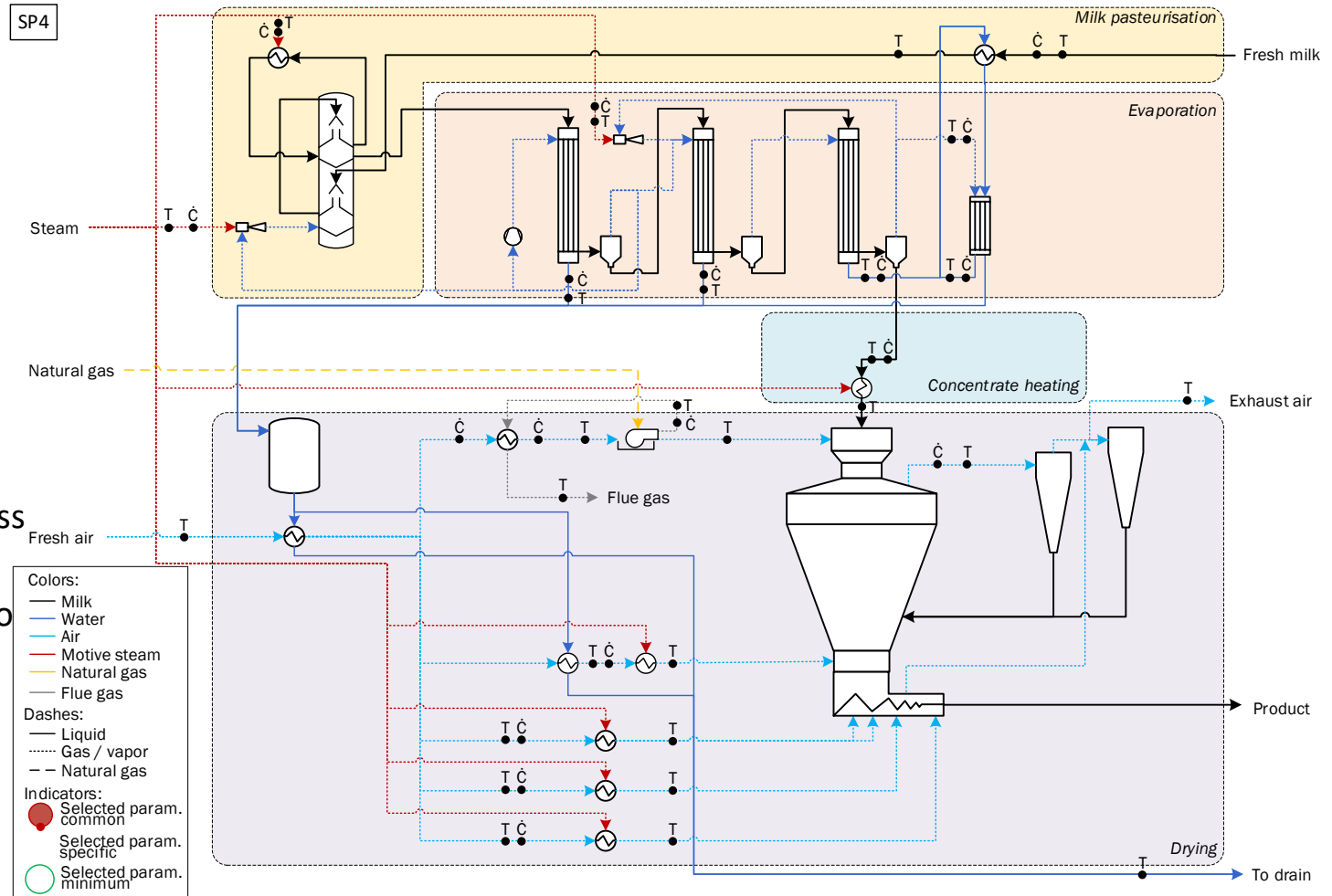
Analyse plant
"SP4"



Application

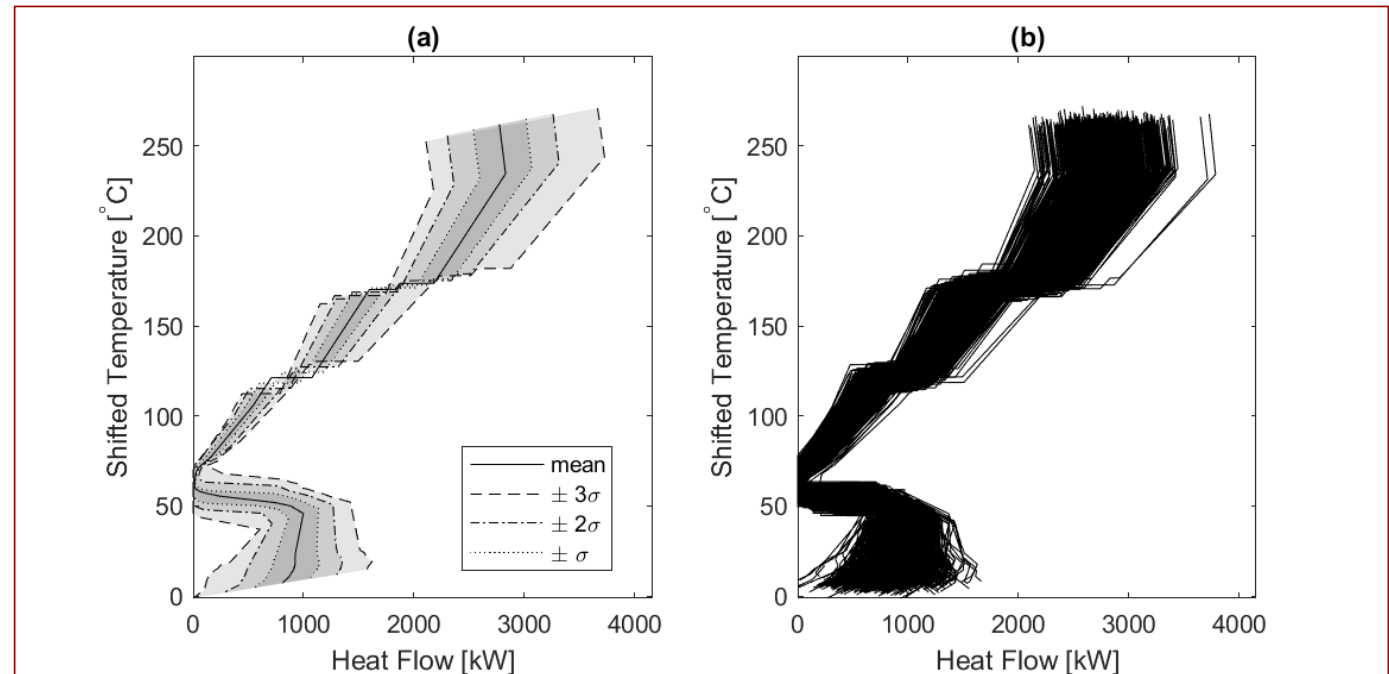
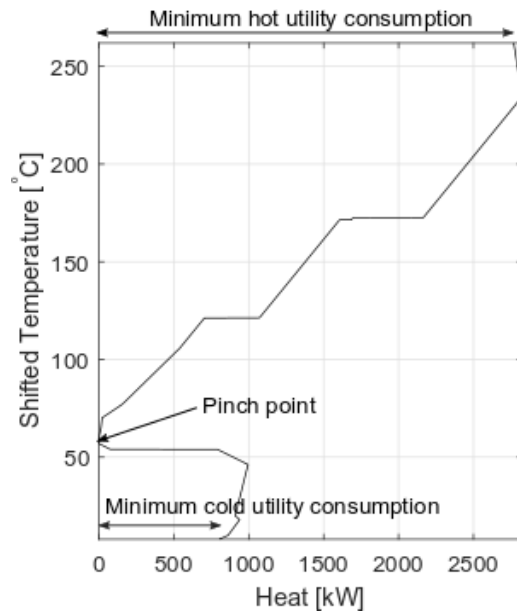
Rough data acquisition

- Identified parameters : 45
 - Temperature [$^{\circ}\text{C}$]
 - Heat capacity rate [kW/K]
- Selected outputs:
 - Actual energy consumption (process heating)
 - Minimum energy consumption (process heating)
 - Energy saving potential



Application

Uncertainty analysis



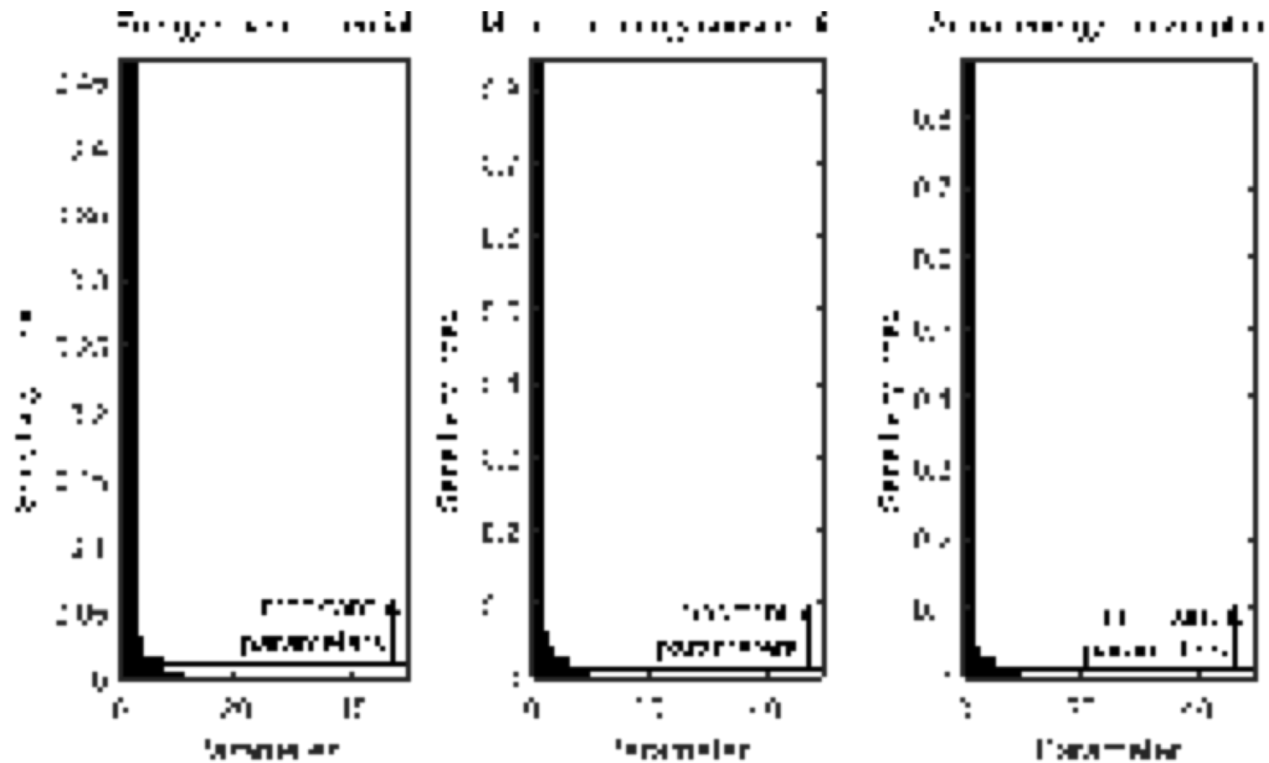
Uncertainty on energy-saving potential

46 %

Quantify need for measurement system

Application

Sensitivity analysis



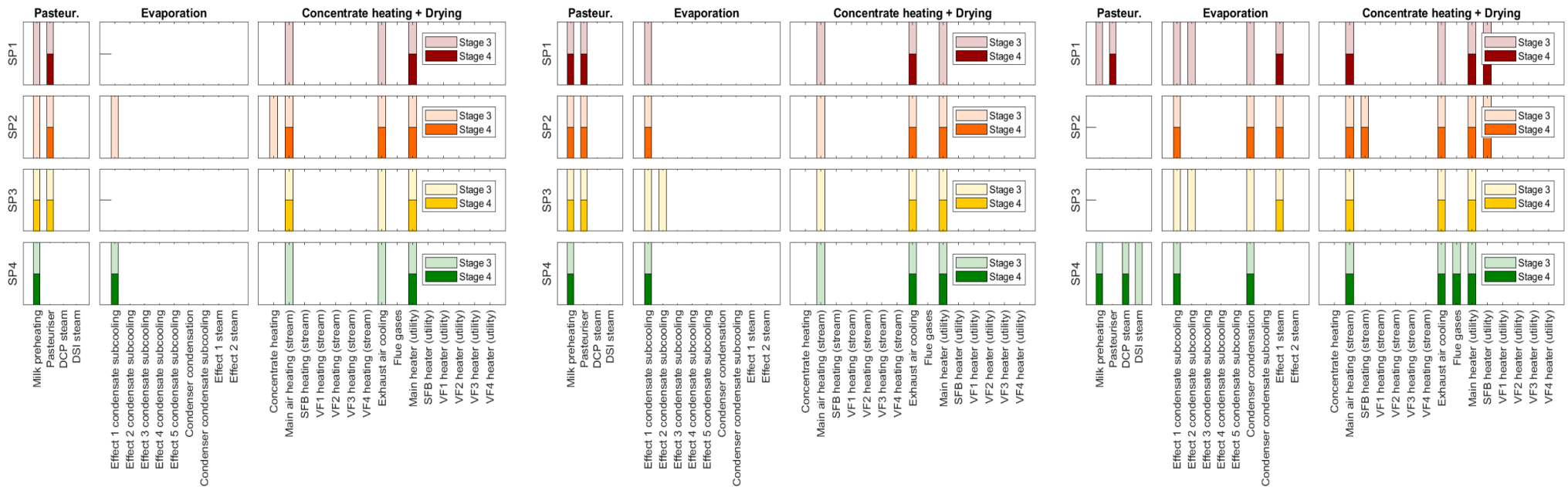
Only a few parameters are important

Plants comparison

Temperature inlet

Temperature outlet

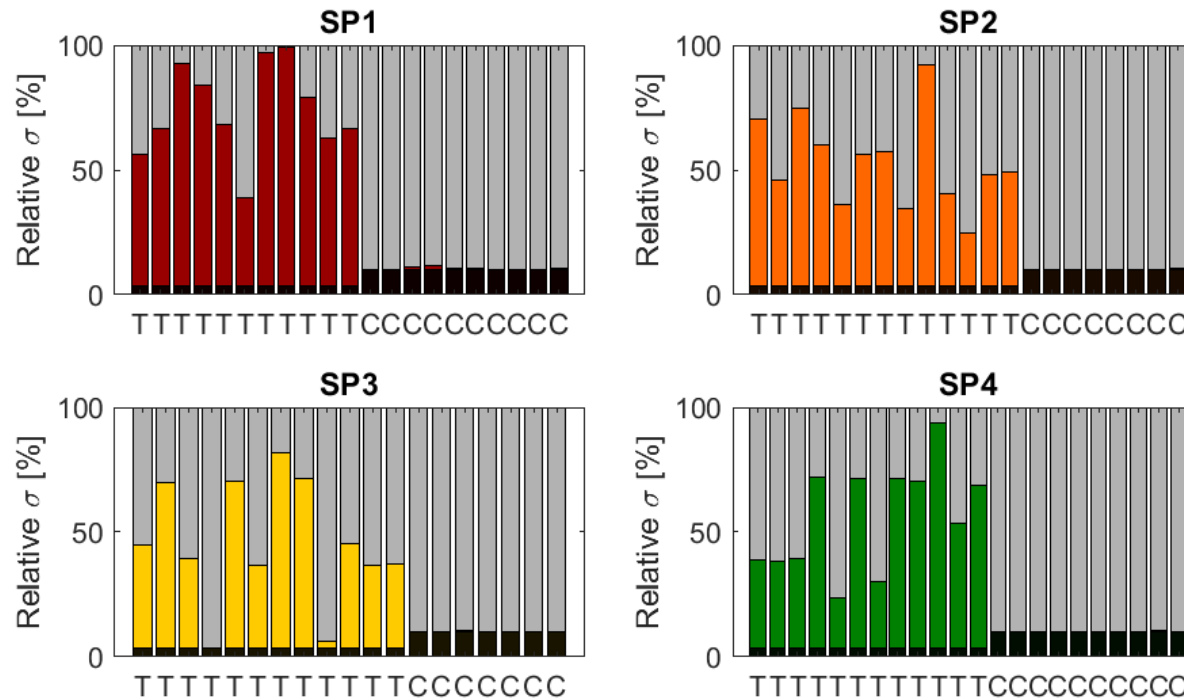
Heat capacity rate



Most of the important parameters are **common** among different plants (**15** in total)

Application

Uncertainty maximisation



Objective: maximise the allowed uncertainty of parameters

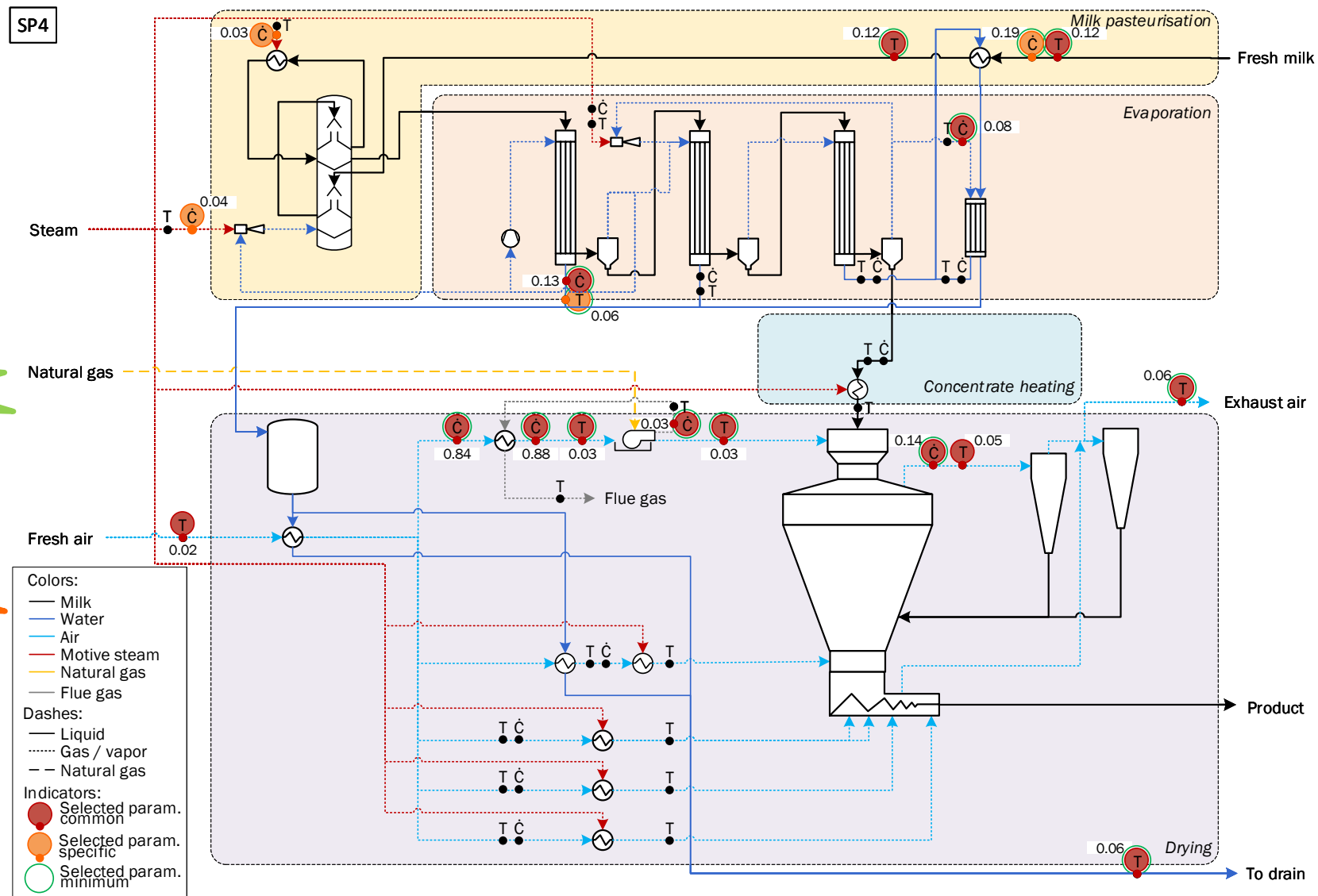
Constraint: output standard deviation below 10 % (of mean)

Heat capacity rate requires the **highest accuracy and precision** in all the plants

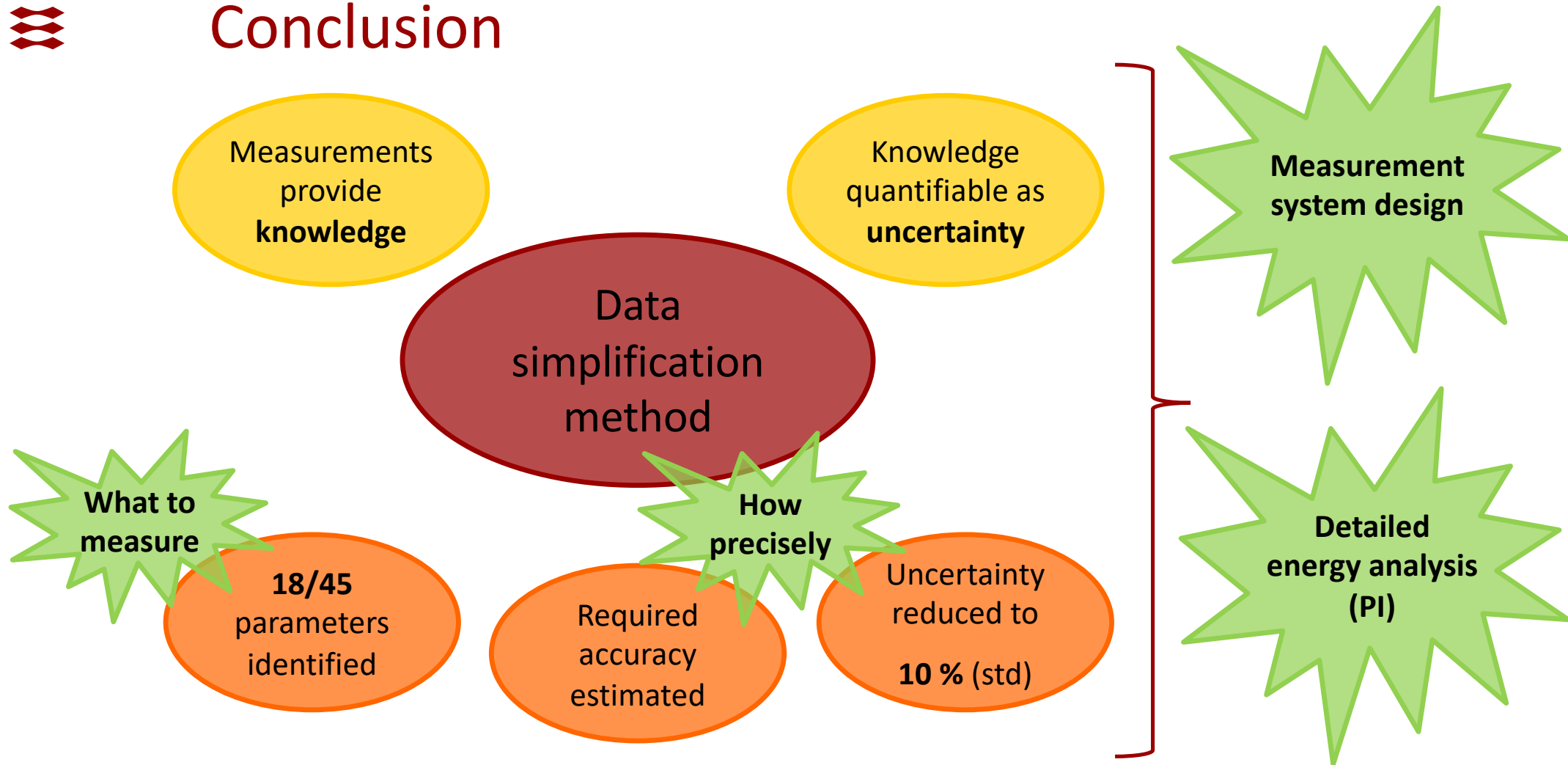
Summary SP4

45
parameters

18/45 Needed



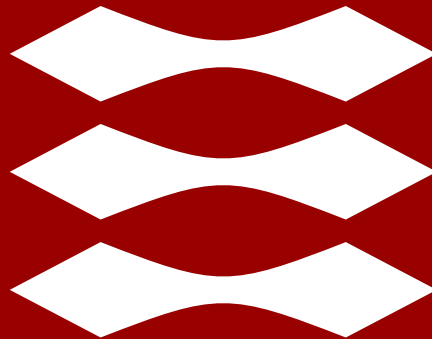
Conclusion



Further material:

Bergamini et al., *Identification of optimal measurement points for energy monitoring of industrial processes: the case of milk powder production*, Submitted to Journal of Cleaner Production, 2020

DTU



Riccardo Bergamini

PhD student

ricb@mek.dtu.dk