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A methodology for designing flexible multi-generation plants

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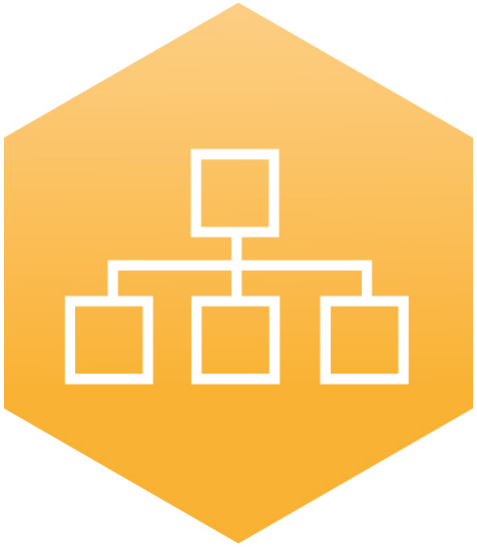

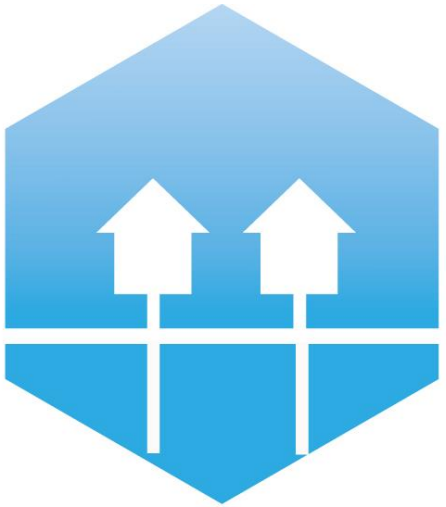

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Agenda and purpose

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1. **Introduction**
2. **Design methodology**
3. **Summary**

Main point: Synergies from process integration ought to be considered in energy system models!

1. Introduction

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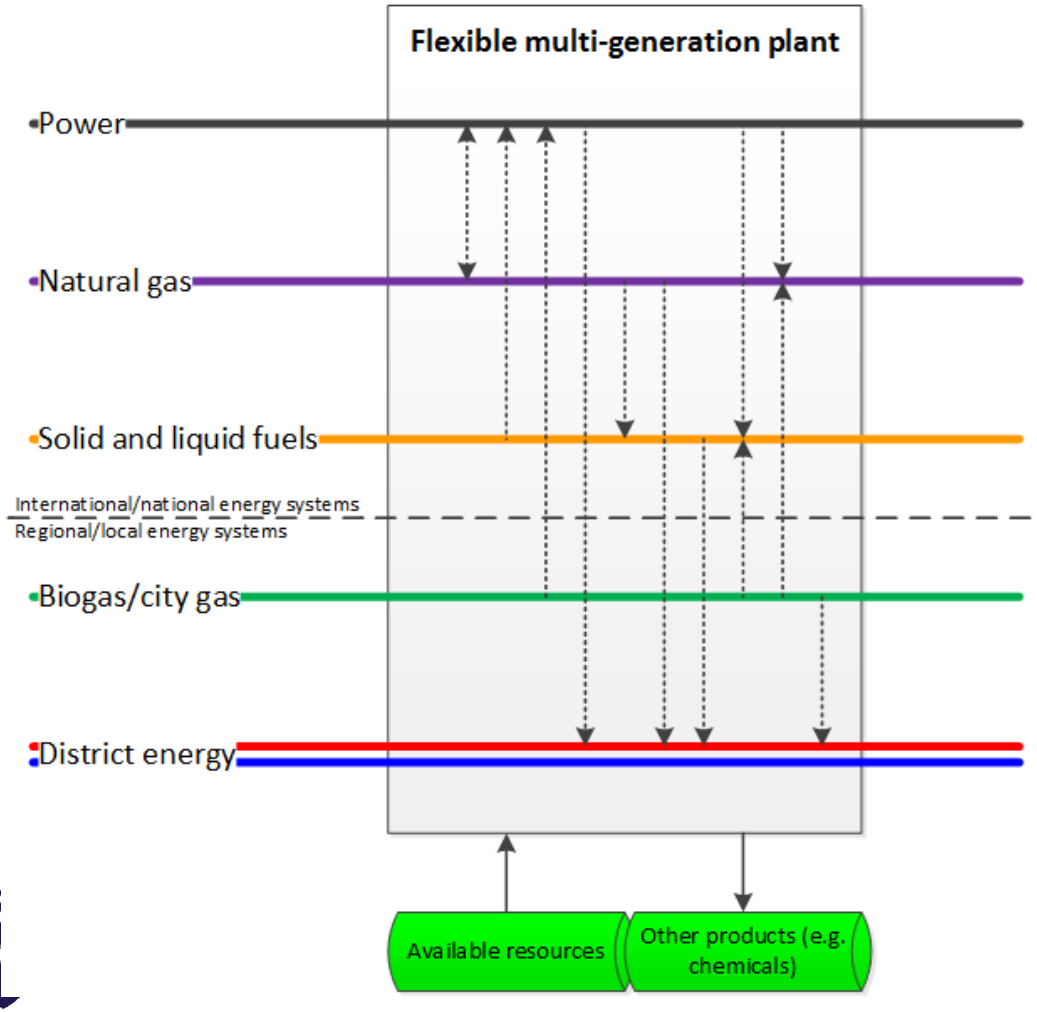
What are flexible multi-generation plants?

Definition: '*A flexible multi-generation plant (FMG) is an integrated, flexibly operated facility that provides multiple links between layers of the energy system*'

1. Introduction



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1. Introduction

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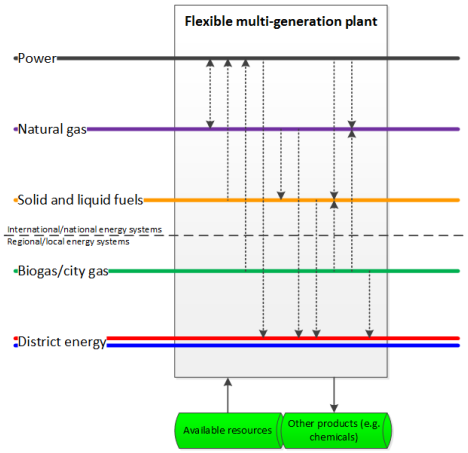
Why should we be interested in FMGs?

Hypothesis: If carefully designed, FMGs may

- achieve high aggregated energy conversion efficiencies through process integration and connection to district energy systems (*synergies*)
- balance production from intermittent renewable energy resources in a cost-efficient way (*energy system valves*)



2. Design methodology

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What must be considered when designing FMGs?

- Synthesis of processes from many technological alternatives
- Design with respect to process dimensioning and integration
- Operation optimization with respect to hourly demand and price fluctuations and long-term energy system development
- Local resource availability
- Investment planning
- …

2. Design methodology

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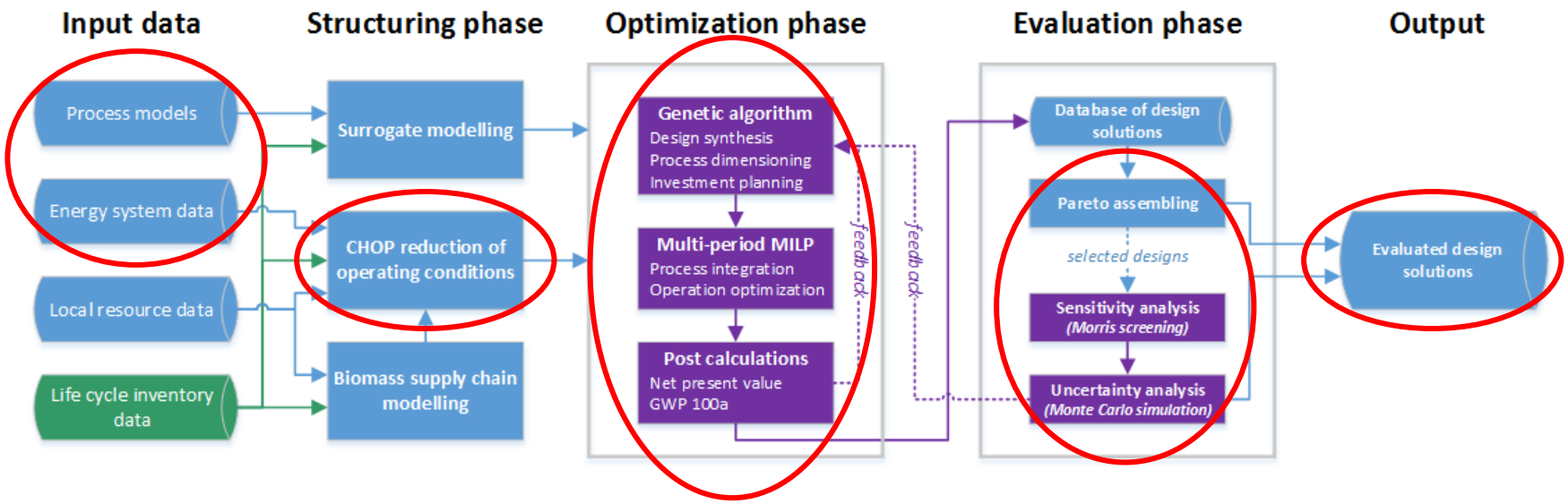
Methodology overview



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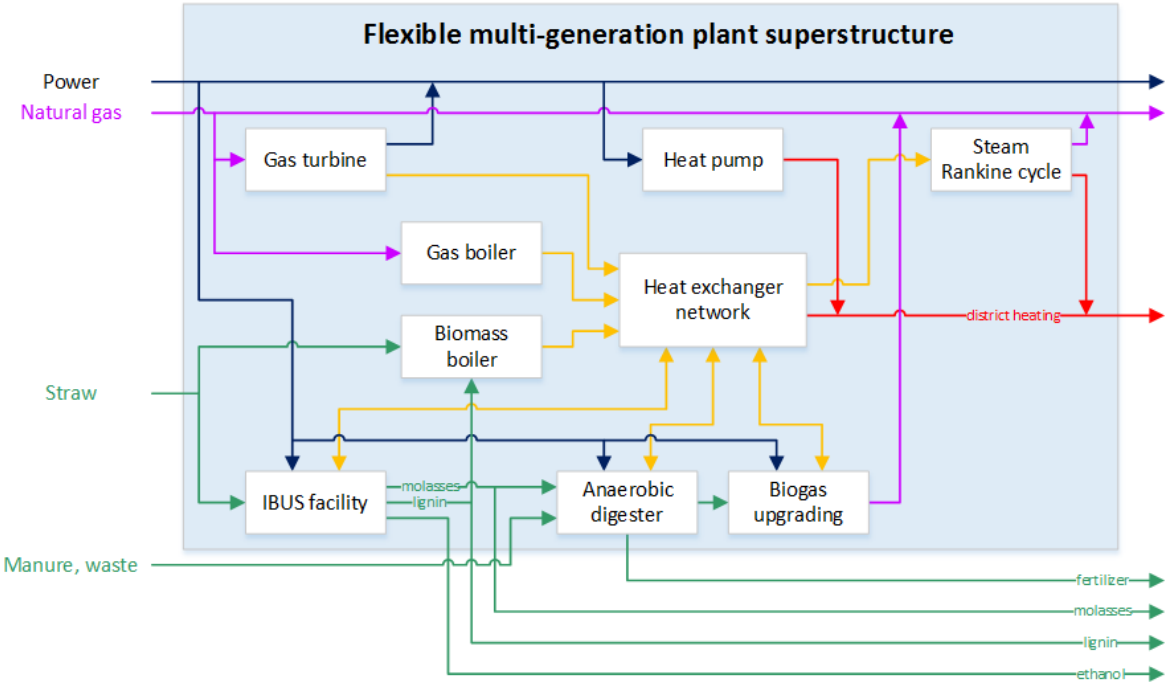
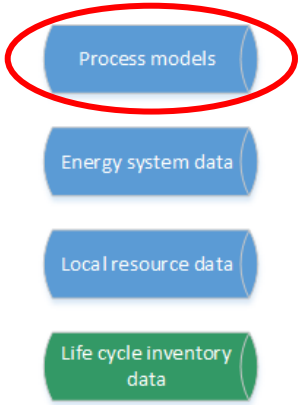
Case study – input data





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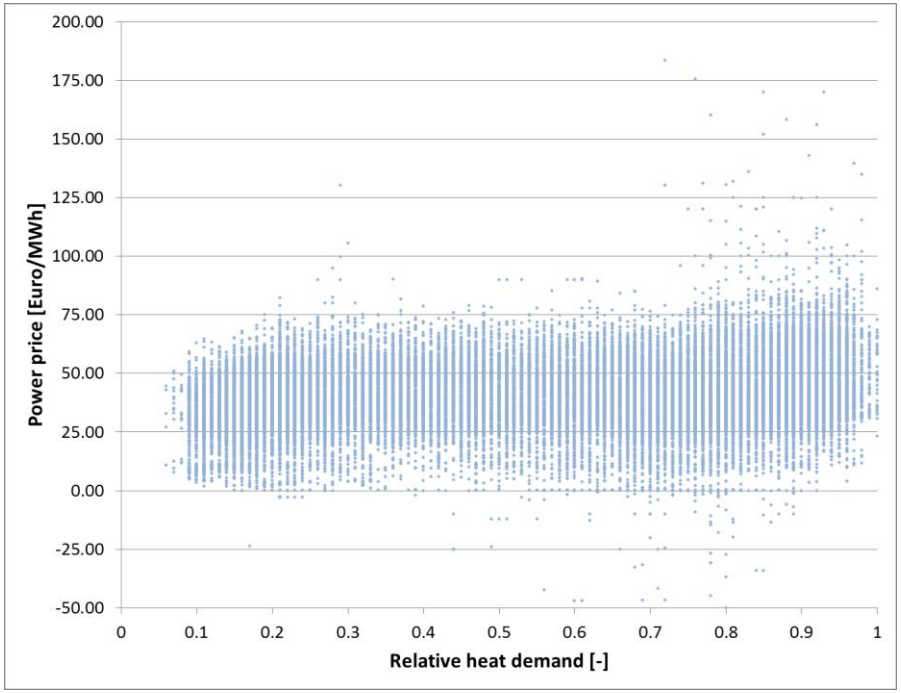
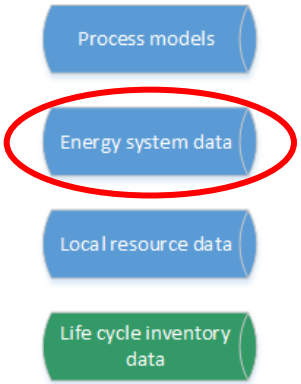
Case study – input data

Scatter plot from [Lythcke-Jørgensen et al. 2015]





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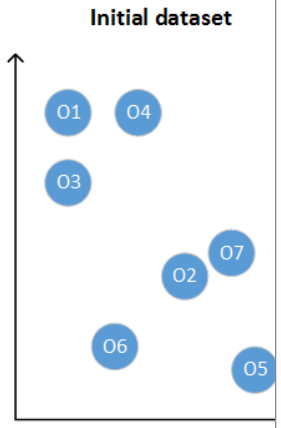
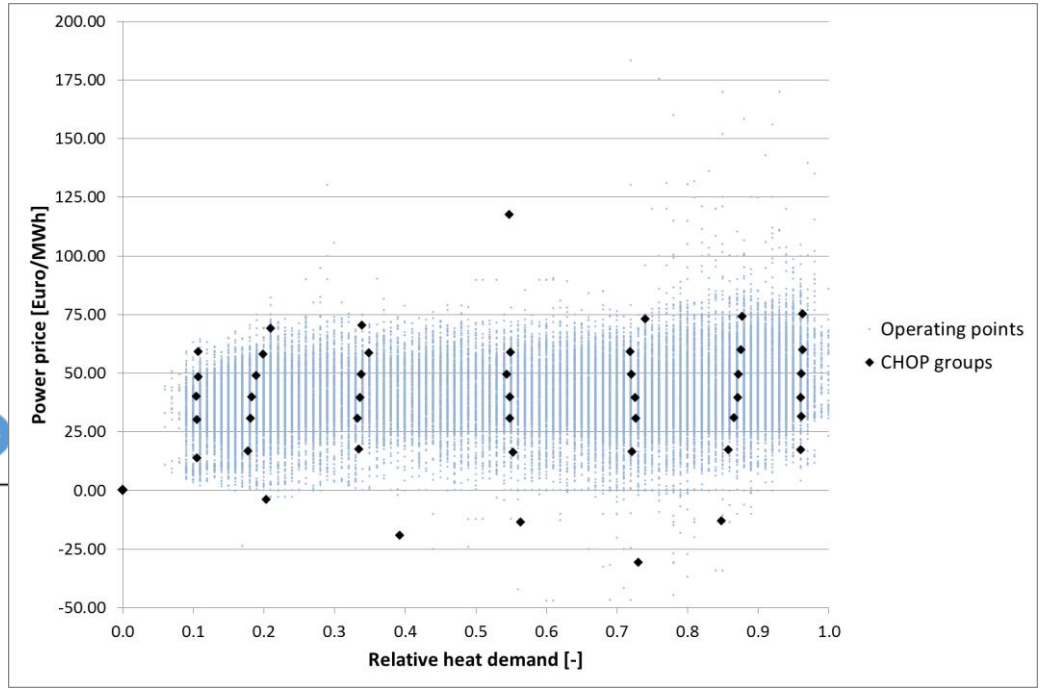
Case study – structuring phase

Figures from [Lythcke-Jørgensen et al. 2015]





Surrogate modelling

CHOP reduction of operating conditions

Biomass supply chain modelling

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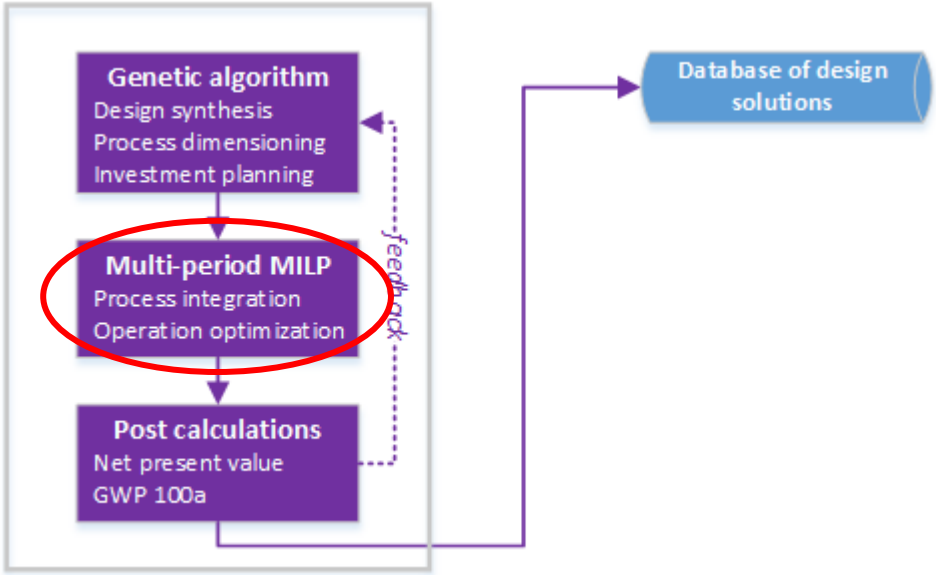
Case study – optimization phase



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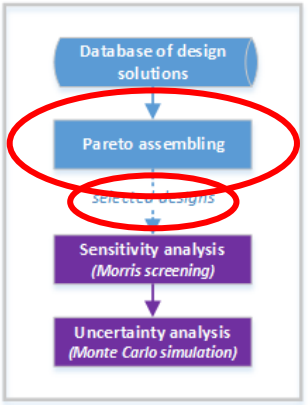
Case study – evaluation phase



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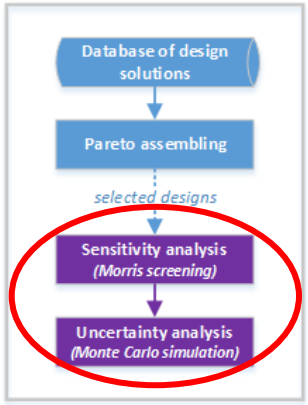
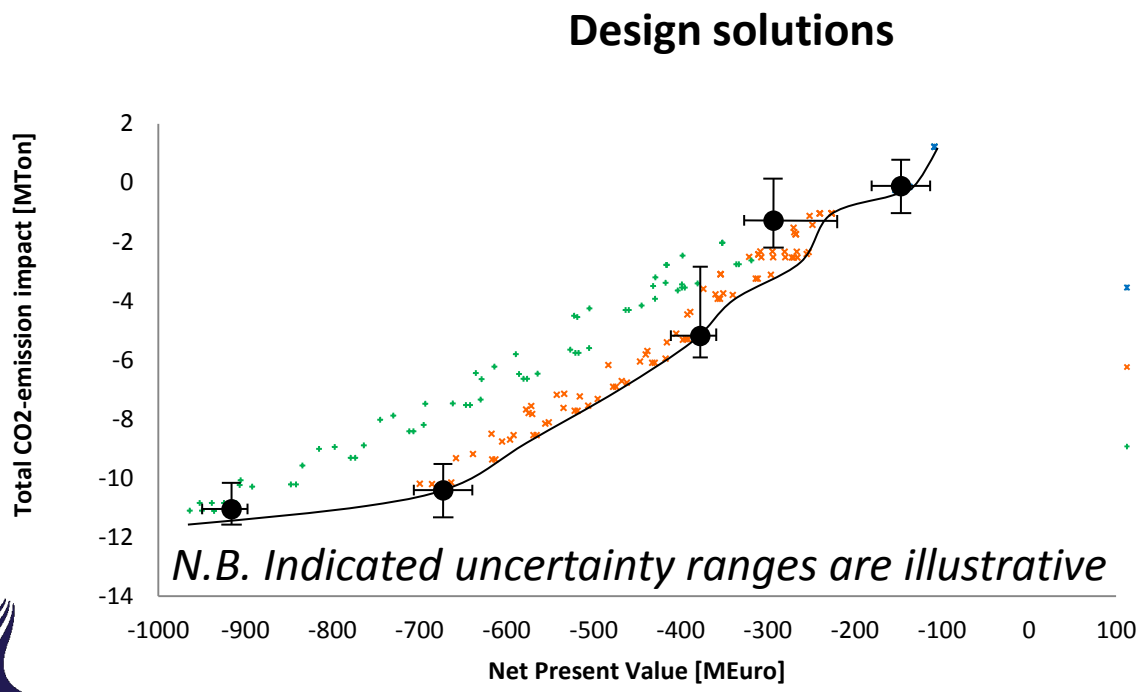
Case study – evaluation phase





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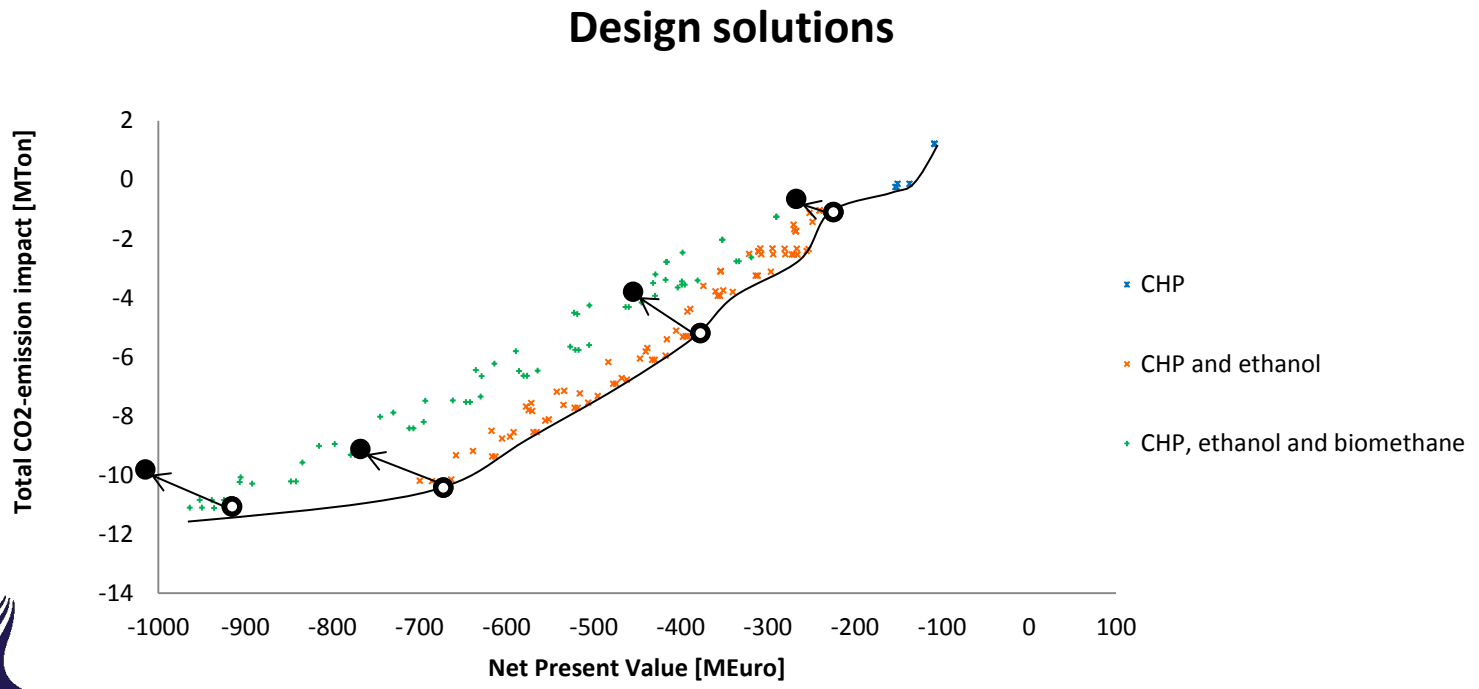
So, why should we care on the energy system level?



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3. Summary and perspective

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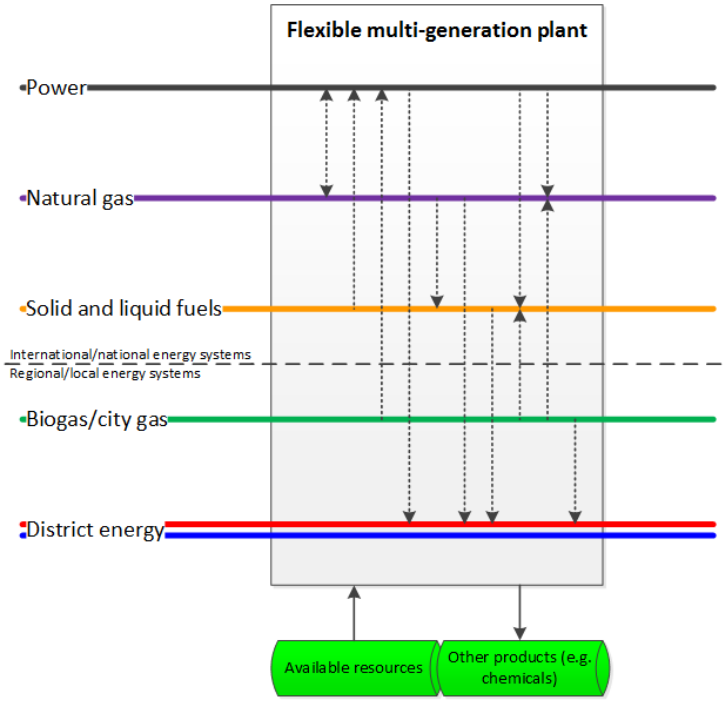
Main point: Synergies from process integration ought to be considered in energy system models!

- FMGs may provide efficient links between the layers of the energy systems (*energy system valves*)
- Future work: Various FMG case studies using long term energy system data to assess energy system impact



Thank you for your attention

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Questions & comments?

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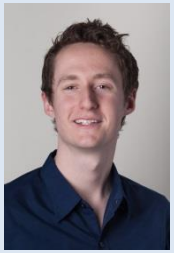

References

[Lythcke-Jørgensen 2015]: C. Lythcke-Jørgensen, M. Münster, A. V. Ensinas, F. Haglind, "A method for aggregating external operating conditions in multi-generation plant optimization models", *Applied Energy* (under review).

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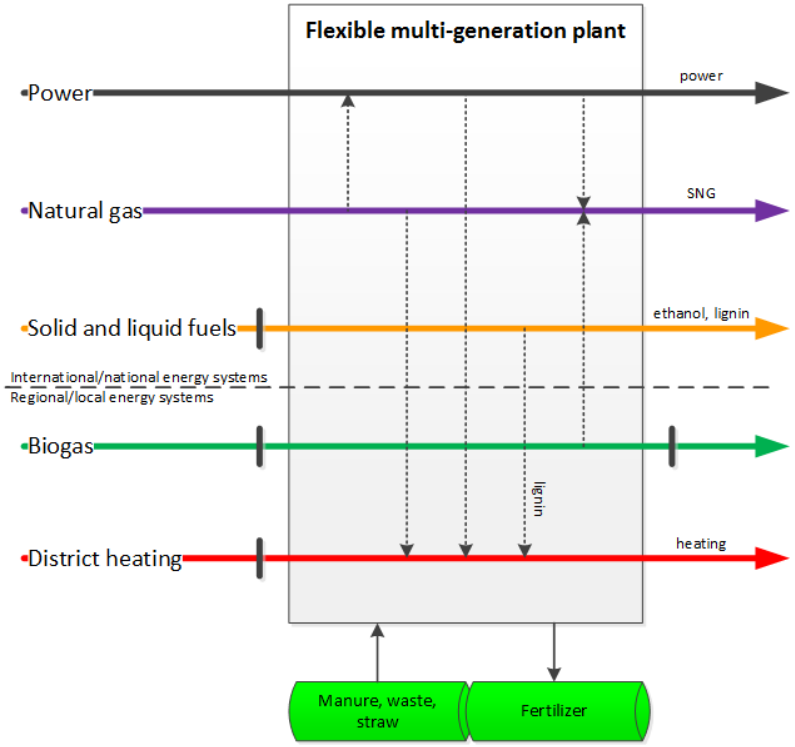
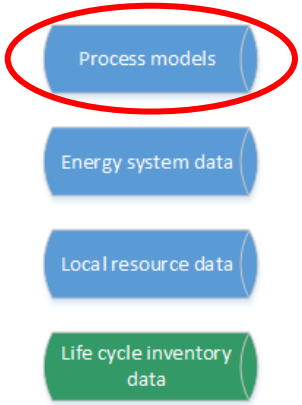
Case study – input data





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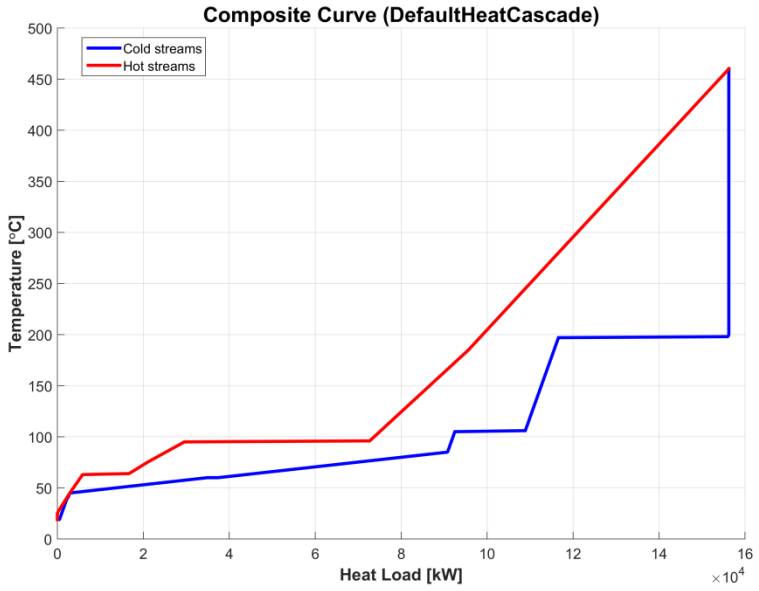
Case study – input data



- Process models
- Energy system data
- Local resource data
- Life cycle inventory data

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Case study – optimization phase