Multi Energy Systems (MES)

Investigating Unknown Flexibilities Provided by Power-to-X Converters Considering Grid Support Strategies

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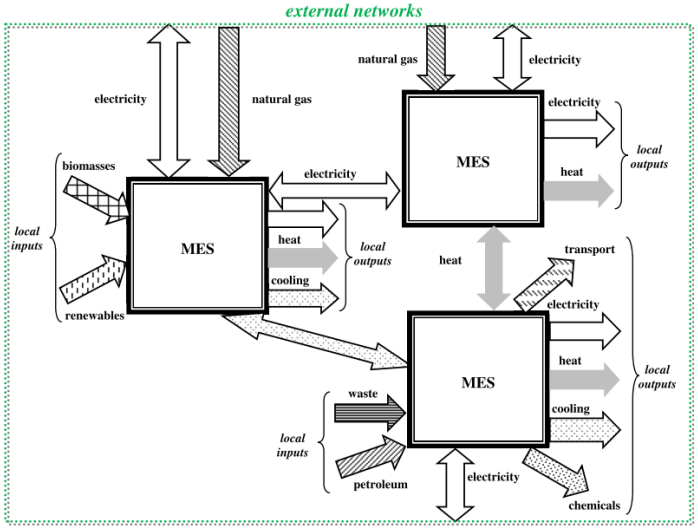
Content

- Problem
- Research Questions
- Methodology
- Modelling
- Cases & Results
- Further Improvements

Problem

- Energy systems need more flexibility and ways to measure it
- Power-to-X systems are able to provide this flexibility
- However, existing models are too simplified for control and flexibility analysis



P. Mancarella, “MES (multi-energy systems): An overview of concepts and evaluation models,” Energy,vol. 65, pp. 1–17, 2014.

Research Questions

1. What are the hidden flexibilities provided by Power-to-X modelling? (Demand-side flexibility, Demand Side Management)

2. How much district heating demand can be supplied from curtailed renewable energy in Maasvlakte 2, Port of Rotterdam and what is its effect on system flexibility?

3. How the existing flexibility affected when another flexible load is connected to the system? (Supply-side flexibility, Curtailment)

This project investigates the impact of MES flexibility service providers on balancing the stochastic variability of renewable energy sources by using co-simulation in OpenModelica environment.

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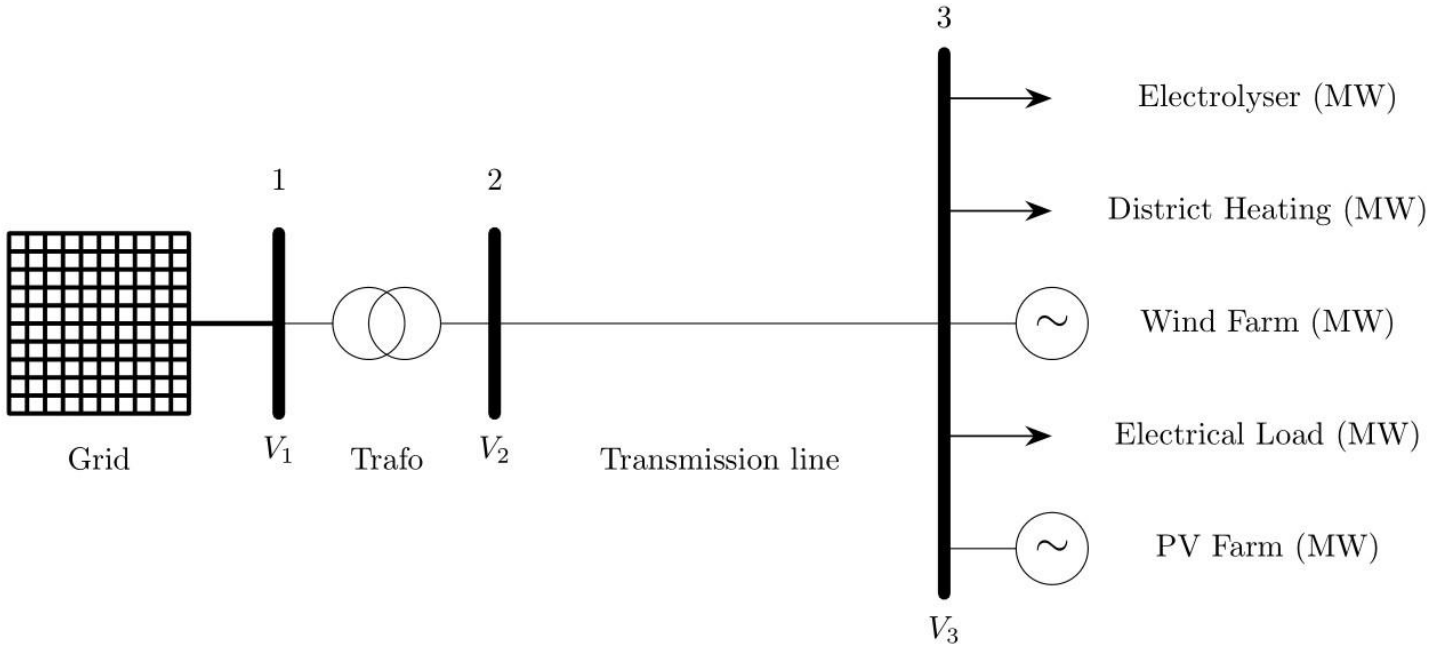
Methodology – Maasvlakte Energy Park

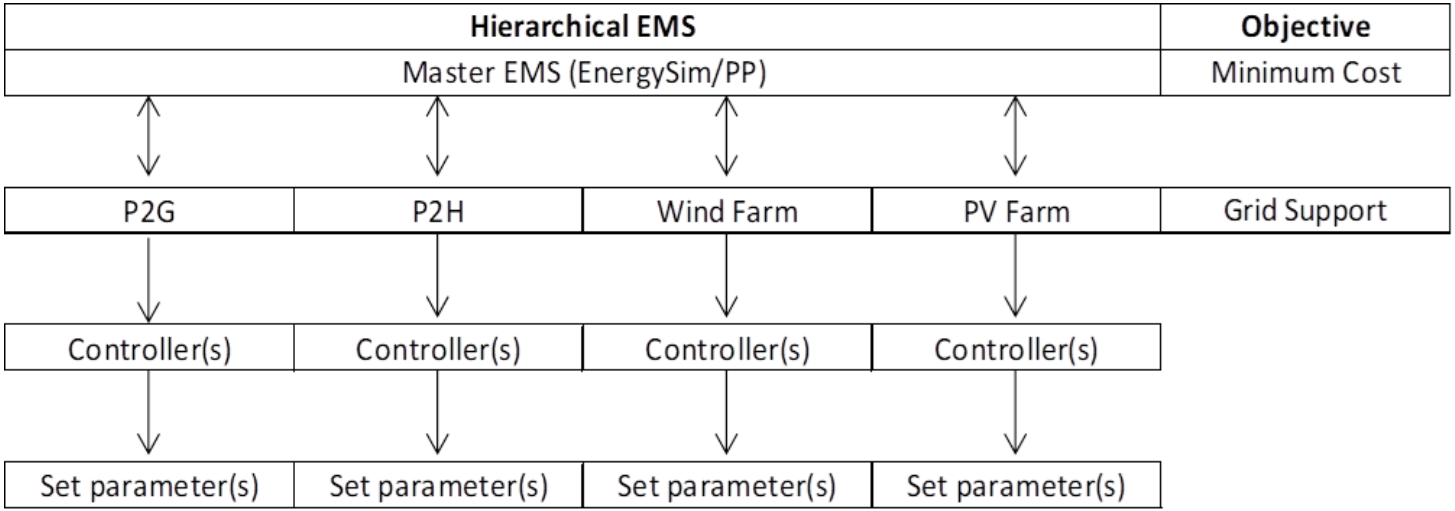


Methodology – Flexibility

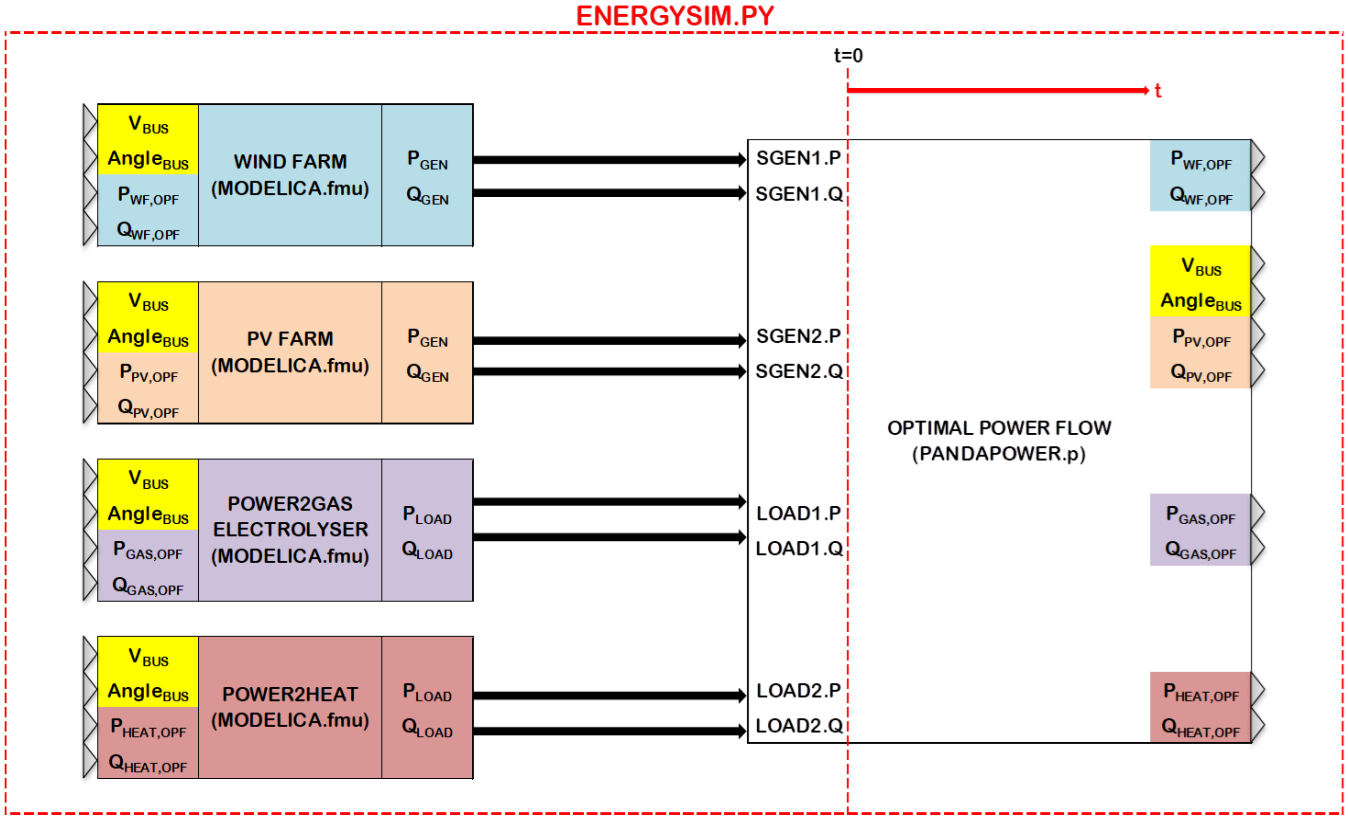
”*Ability of a system to response challenges caused by power fluctuations [1].* ”

1. Electrical System Flexibility (for Grid Operator)
   a) Supply-side Flexibility (Curtailment)
   b) Demand-side Flexibility (DSM)
2. Cost Flexibility (for Indutry)

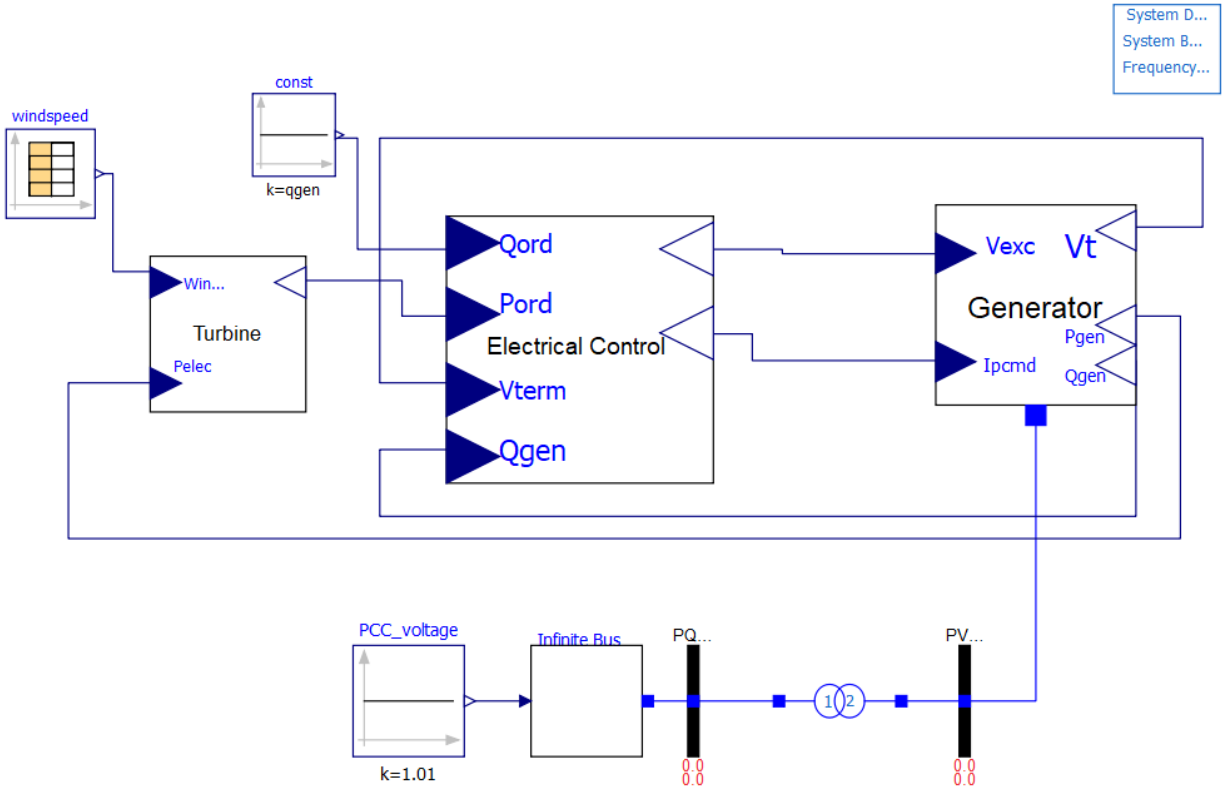
Methodology – Hierarchical Control



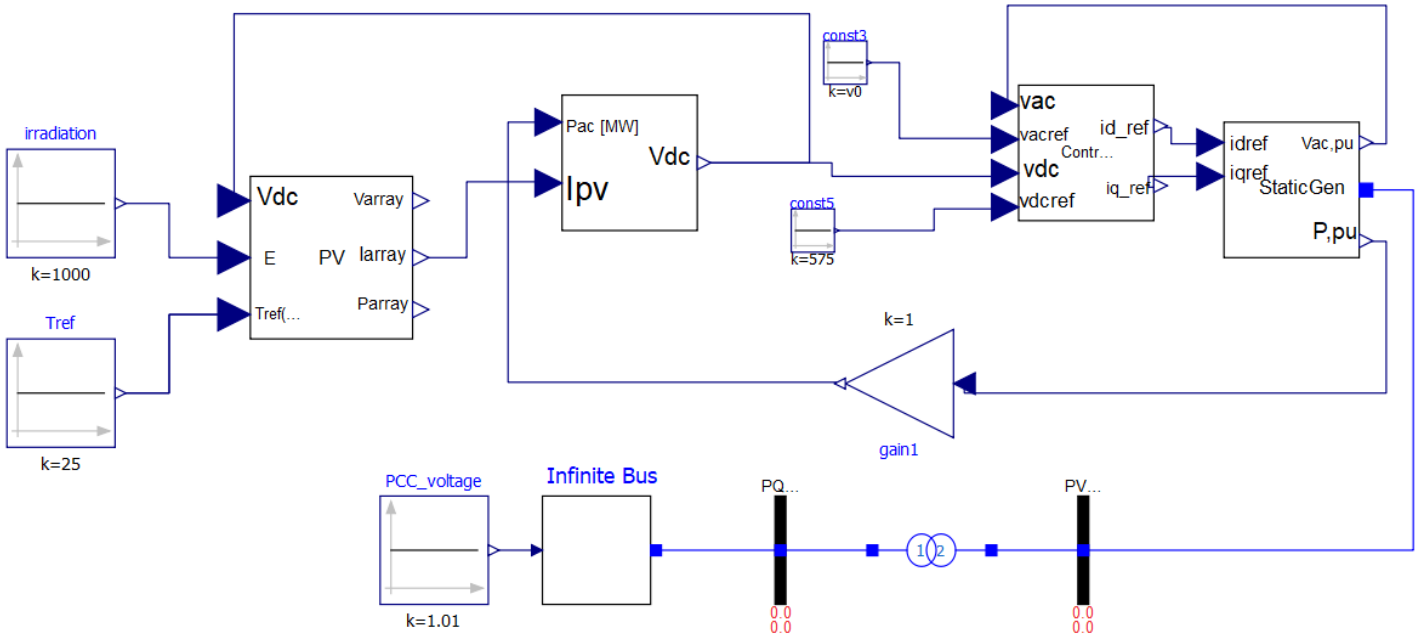
Methodology – Co-simulation



Modelling – Wind Turbine Generator



Modelling – PV Farm

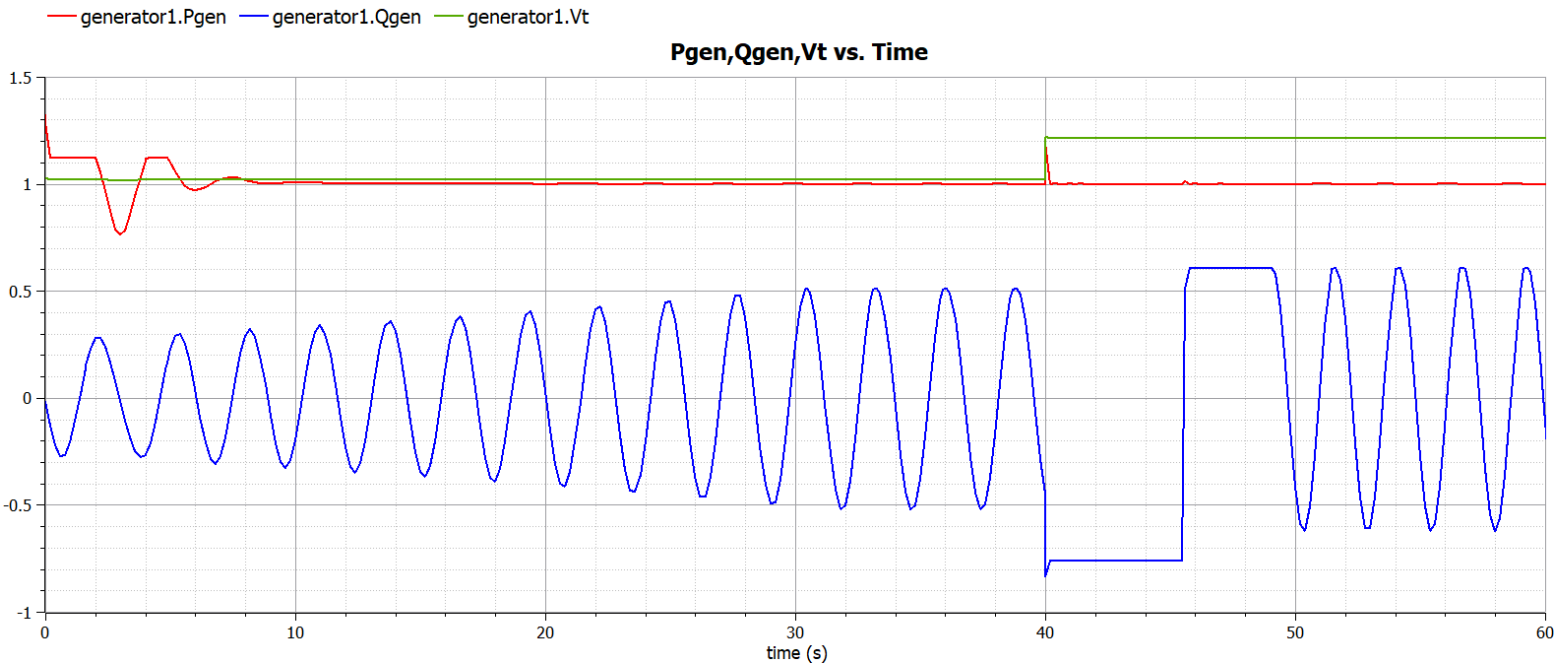


Cases

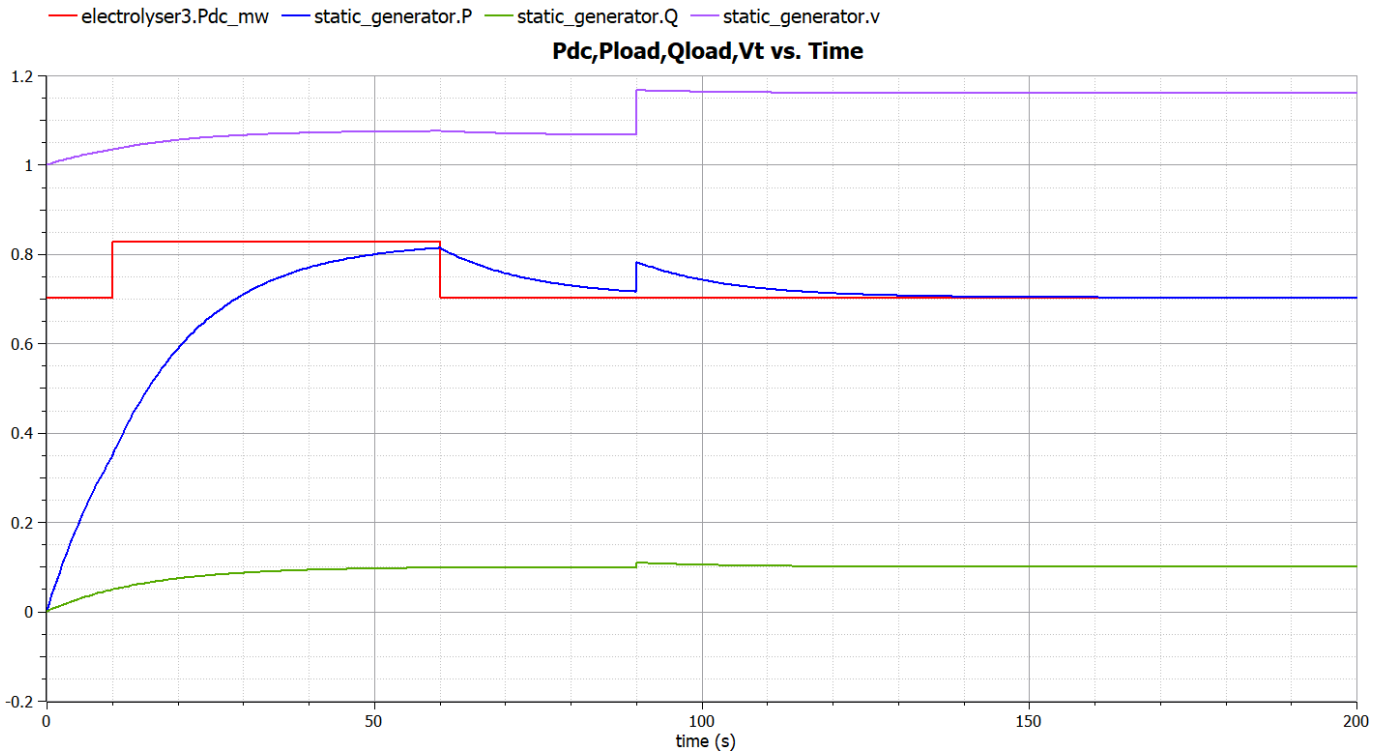
First case:
Simulate P2G connected to RES and plot system parameters in Energysim. Measure the flexibility of electrolyser, system and excess RE.

Second case:
Connect P2H (flexible load) to the previous system and do the same measurements. Expecting reduced excess RE, better grid performance (less power injection to/from grid, more stable active power on feeder) and smaller storage size. Measure the flexibility.

Initial Results



Initial Results



Conclusion & Expected Outcomes

- Recommendations for,
  - Multi-energy system modelling for ancillary services and control
  - Flexibility Measurement and Analysis
  - Maasvlakte 2 RES
- Flexibility(excess RE, power balance, cost) vs. $t_{flex,on}$
- P,Q injected/withdrawn vs. time on feeder bus3

References

[1] P. Schott, J. Sedlmeir, N. Strobel, T. Weber, G. Fridgen, and E. Abele, “A generic data model for describing flexibility in power markets,” Energies, vol. 12, no. 10, pp. 1–29, 2019.

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Version Control: https://github.com/caneryagci/Multi-Energy-Systems-Thesis-Project.git

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