

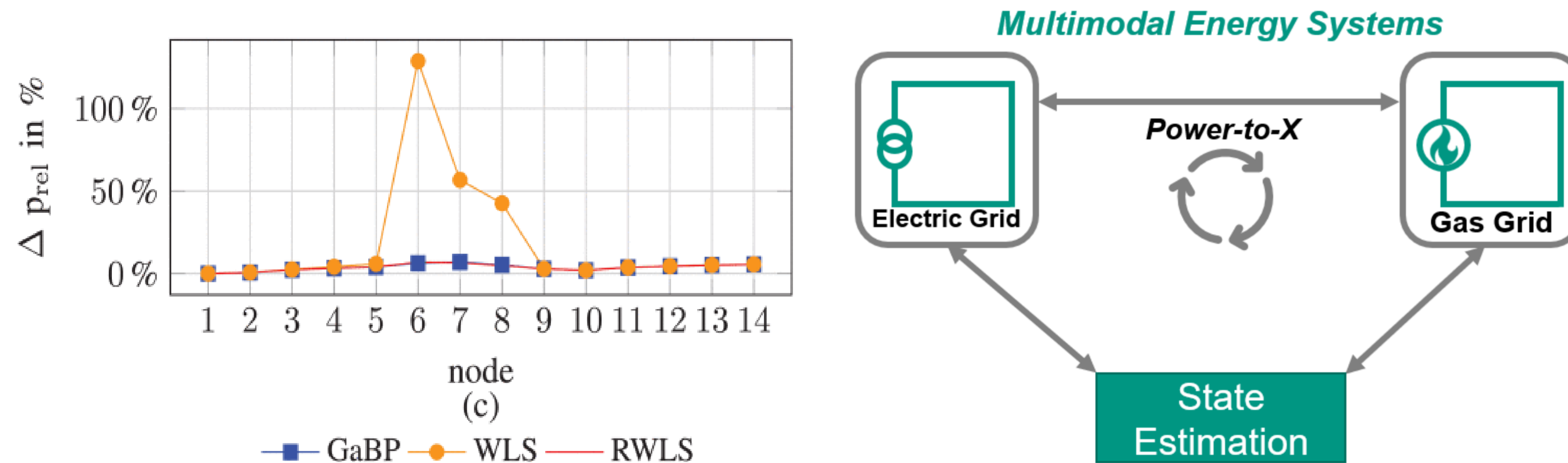


Master Thesis

Multimodal State Estimation for Coupled Electricity and Gas Distribution Networks

To boost the energy transition, multi-carrier energy systems of the future must be coupled to leverage the benefits of more flexibility as power-to-X plants become more widely available. These complex and coupled energy systems require state estimation. The first pioneer of state estimation with smart meters was developed in [3]. State estimation for coupled electricity and gas distribution networks used weighted least squares (WLS) [2]. The potential of the Belief Propagation (BP) algorithm is used to solve the highly nonlinear gas distribution network SE problem in [1].

This thesis aims to implement a state estimation, e.g. using BP for the coupled power and gas grid, and to compare it with WLS and an adaptively regularized weighted least squares (RWLS). Another approach would be to use machine learning-based methods for state estimation.



This sounds exciting? Then apply to us! The methods and scope of the thesis can be **adapted to your interests** and previous knowledge.

The proposed thesis consists of the following parts:

- Interest in the topics of grid calculations and renewable energies
- Literature research about State Estimation in Electricity and Gas Distribution Networks coupled via Power-to-X Technologies
- Designing a Multimodal State Estimation scheme
- Implementation of state estimation algorithms (e.g. WLS, RWLS, BP, ML)
- Evaluation of the implemented methods

We are happy to answer any questions you might have. Feel free to ask for an appointment or directly ask at our offices!

Die Arbeit darf natürlich auch in deutscher Sprache geschrieben werden.

References

- [1] G. Demirel, S. d. Jongh, F. Mueller, and T. Leibfried, "Data Fusion and State Estimation Using Belief Propagation in Gas Distribution Networks," 2022 57th International Universities Power Engineering Conference (UPEC), 2022, pp. 1-6, DOI: [10.1109/UPEC55022.2022.9917770](https://doi.org/10.1109/UPEC55022.2022.9917770).
- [2] M. Pfeifer et al., "Weighted Least Squares State Estimation for Coupled Power and Gas Distribution Networks," 2018 53rd International Universities Power Engineering Conference (UPEC), 2018, pp. 1-6, DOI: [10.1109/UPEC.2018.8542013](https://doi.org/10.1109/UPEC.2018.8542013).
- [3] A. Abdel-Majeed and M. Braun, "Low voltage system state estimation using smart meters," 2012 47th International Universities Power Engineering Conference (UPEC), 2012, pp. 1-6, DOI: [10.1109/UPEC.2012.6398598](https://doi.org/10.1109/UPEC.2012.6398598).

Advisor:

Gökhan Demirel, M.Sc.
Simon Grafenhorst, M.Sc.

Programming language:

Python

System, Framework(s):

Windows, Linux, or macOS

Required skills:

- Solid mathematical foundations
- Advanced Python knowledge

Language(s):

German, English

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