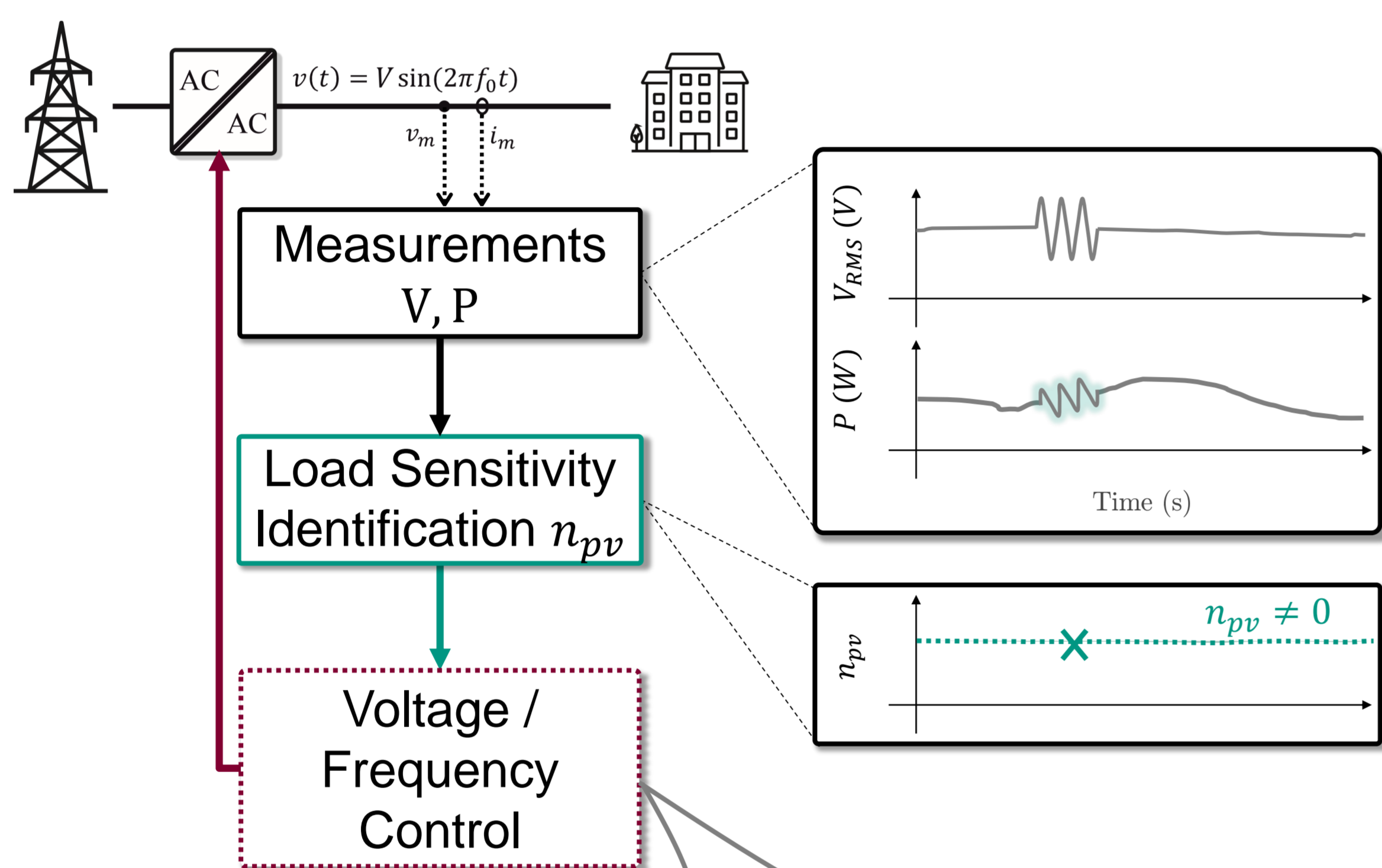


More than 50 Hz: Controlling the Grid under Wider Voltage and Frequency

Qiucen Tao, Maëva Courcelle, Felix Wald, Giovanni De Carne

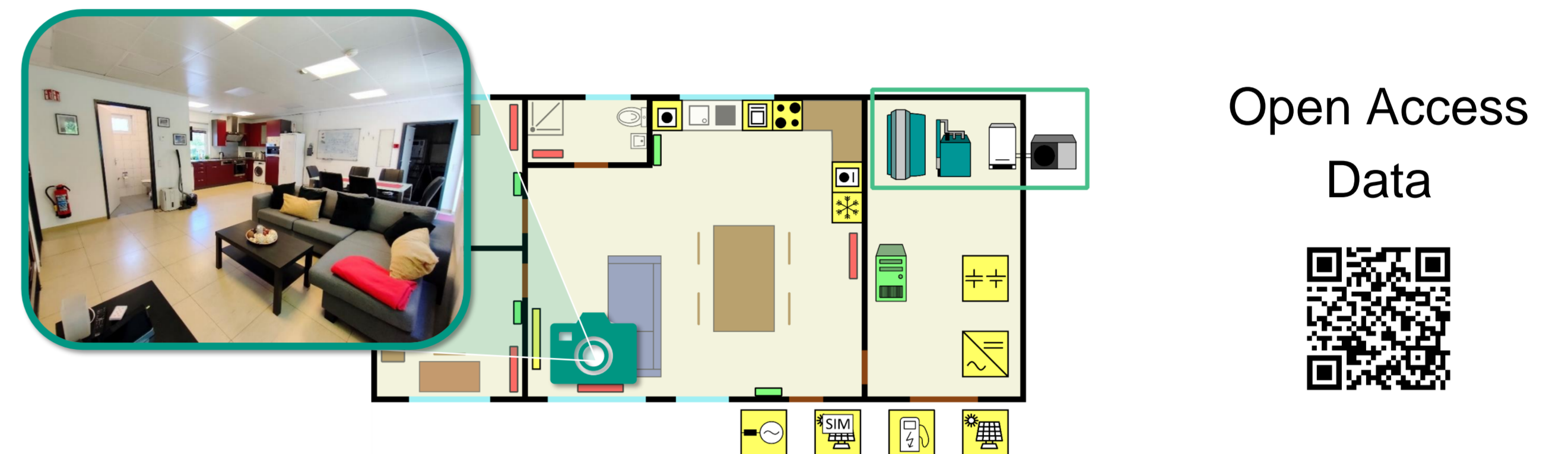
Motivation

- More power flexibility is required for high penetration of renewable energy resources,
- Power quality standard EN 50160: Voltage and frequency variations up to $\pm 10\%$ and ± 2.0 Hz are allowed
- Load power sensitivity to voltage and frequency [1]

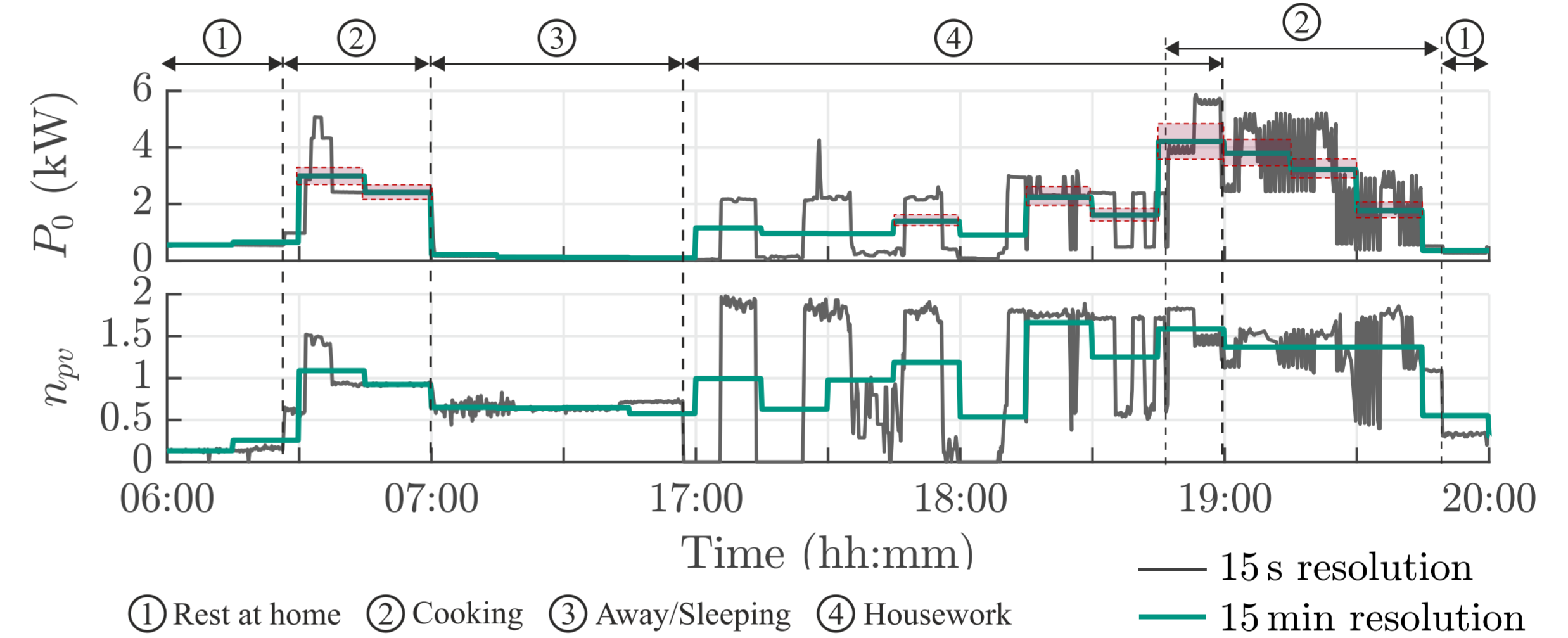


Methodology

- Identify load sensitivity [2]: Measurements of the load sensitivity to voltage and to frequency of over 20 loads.

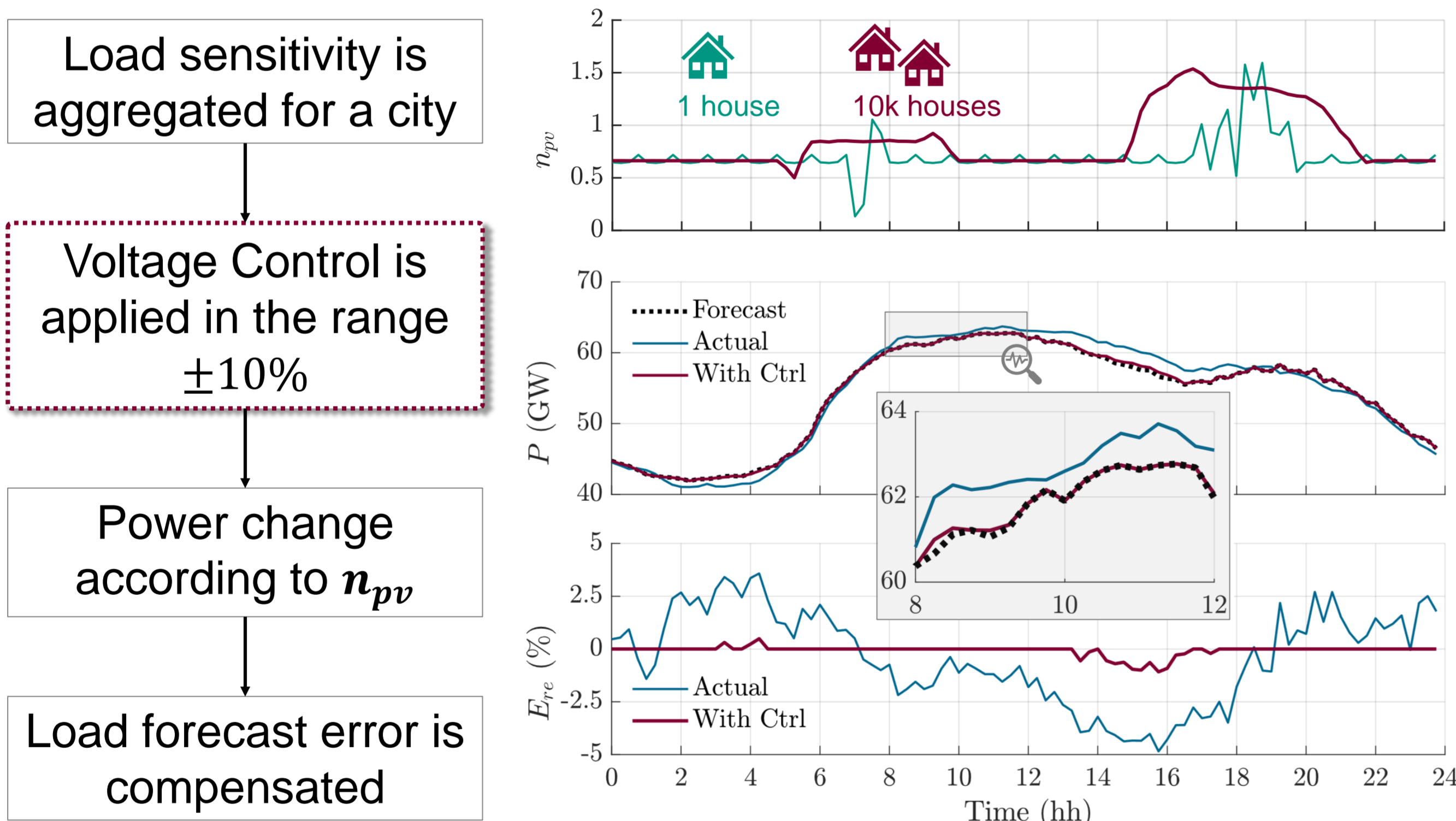


- Demonstrate power flexibility: insights from a daylong test

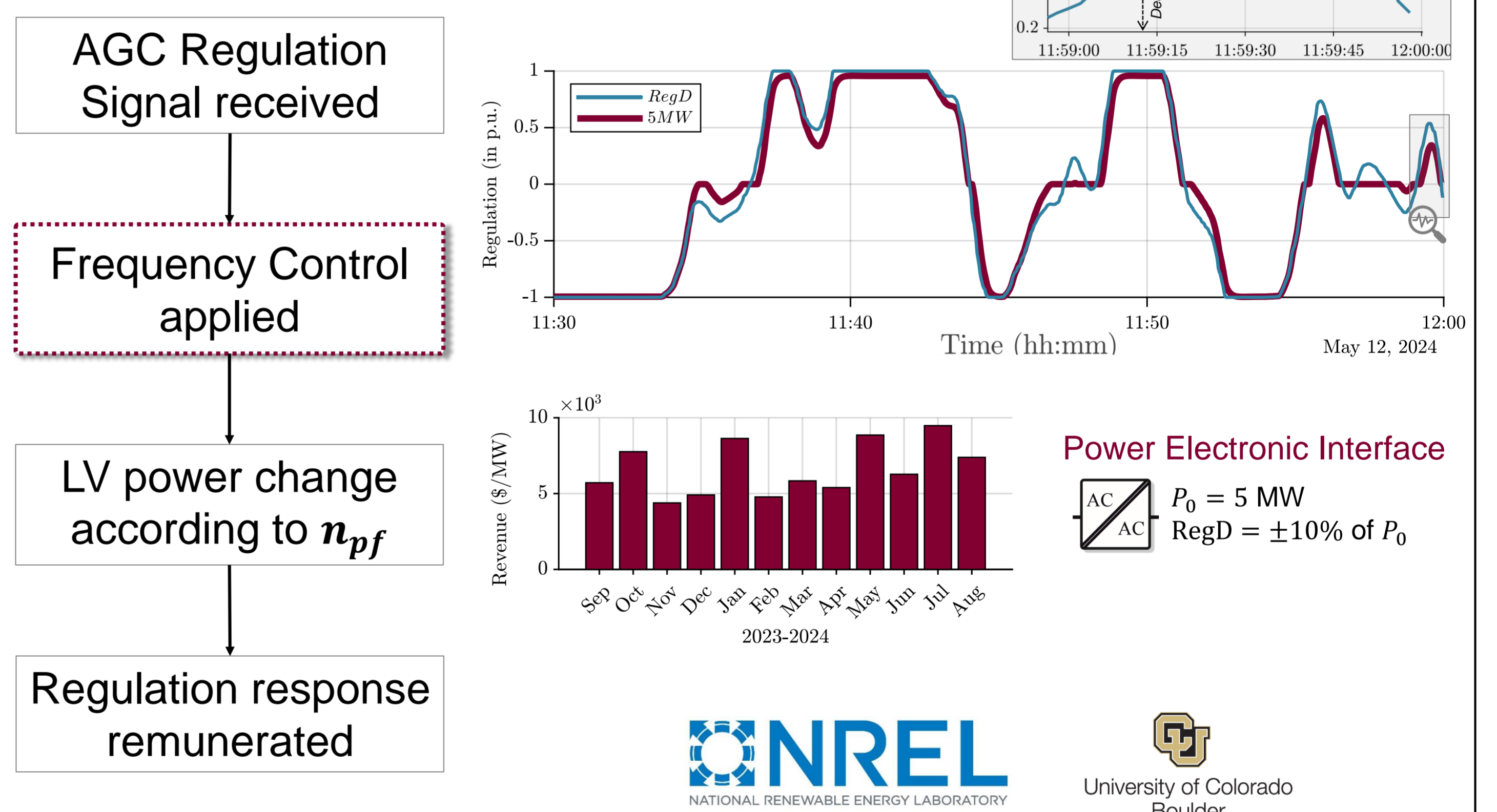


Exploitation

1. Compensating for Generation/Load Unbalance



2. Frequency Response Service



Summary

- Achieve flexible load control without communication through exploitation of existing resources.
- Enhance grid control with high granularity, low additional costs or generation of revenue from ancillary services.
- Have transfer potential worldwide, especially in Solid State Transformer applications.

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[1] M. Courcelle, Q. Tao, J. Geis-Schroer, T. Leibfried and G. De Carne, "Perturbation-Based Load Sensitivity Identification for Smart Transformer-Based Load Control," in *IEEE Transactions on Power Delivery*, vol. 39, no. 6, pp. 3114-3125, Dec. 2024.

[2] Q. Tao, M. Courcelle, J. Geis-Schroer, T. Leibfried and G. De Carne, "Experimental Investigation of Power-to-Voltage Sensitivity Profiles of Residential Loads for Load Management Studies," in *IEEE Transactions on Power Delivery*, vol. 39, no. 6, pp. 3243-3254, Dec. 2024