

Coordinated distributed model predictive control of zones and energy storage units in a building



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1. Introduction

Buildings hold a significant position as major energy consumers on a global scale. They account for 40% of energy consumed and 36% of energy-related direct and indirect greenhouse gas emissions [1], with a trend of expressed increase in number of installed air conditioning systems. Today's emphasis is put on strategies that enhance the thermal performance of buildings and ensure high energy efficiency. This can be gained by using advanced control technologies such as model predictive control (MPC).

2. Problem Description

- grouping zones in coalition models based on semi-physical models for each room, while adjacent rooms' coupling is based on resistive-capacitive (RC) analogy

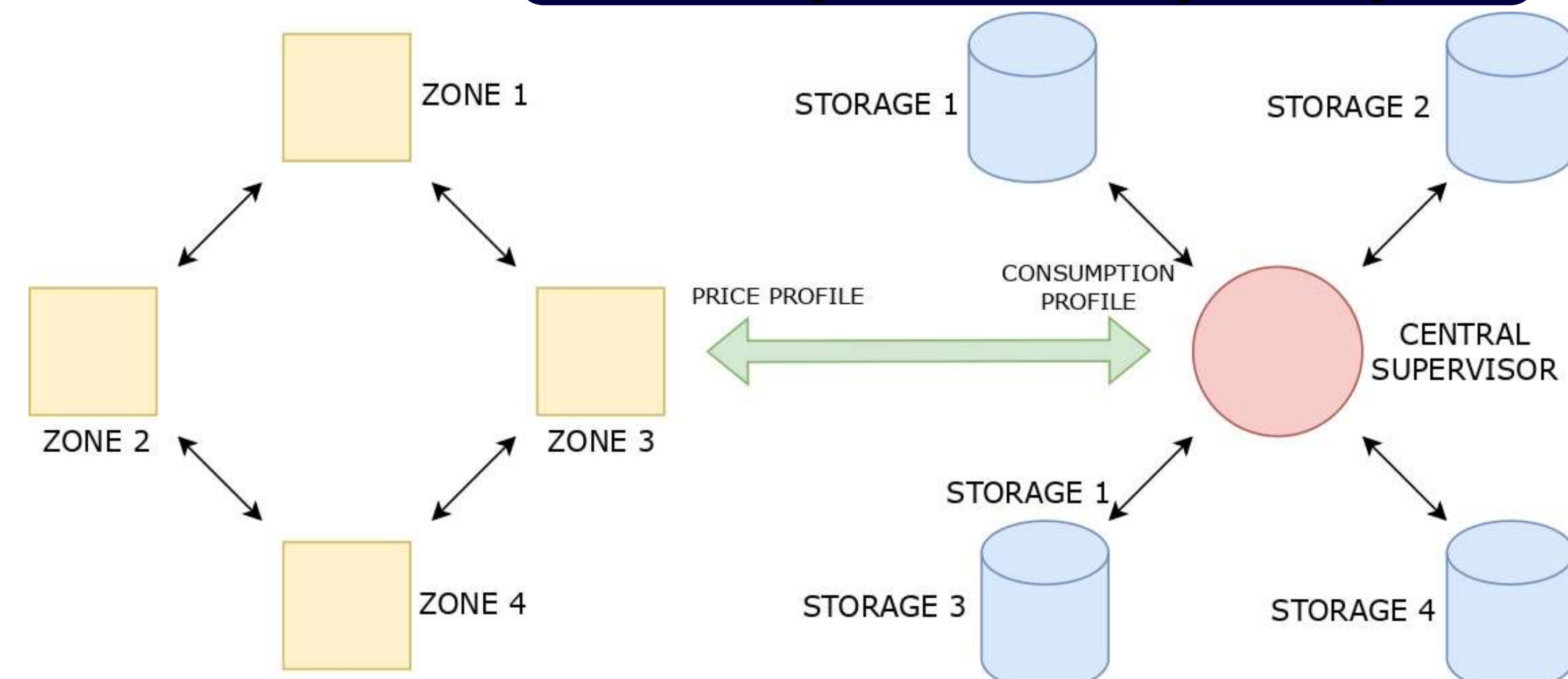


- thermal storage with phase-change material (PCM) based on mixed logical dynamics to bridge the gap between energy production and consumption
- heterogeneous storage system within a microgrid

3. Methodology

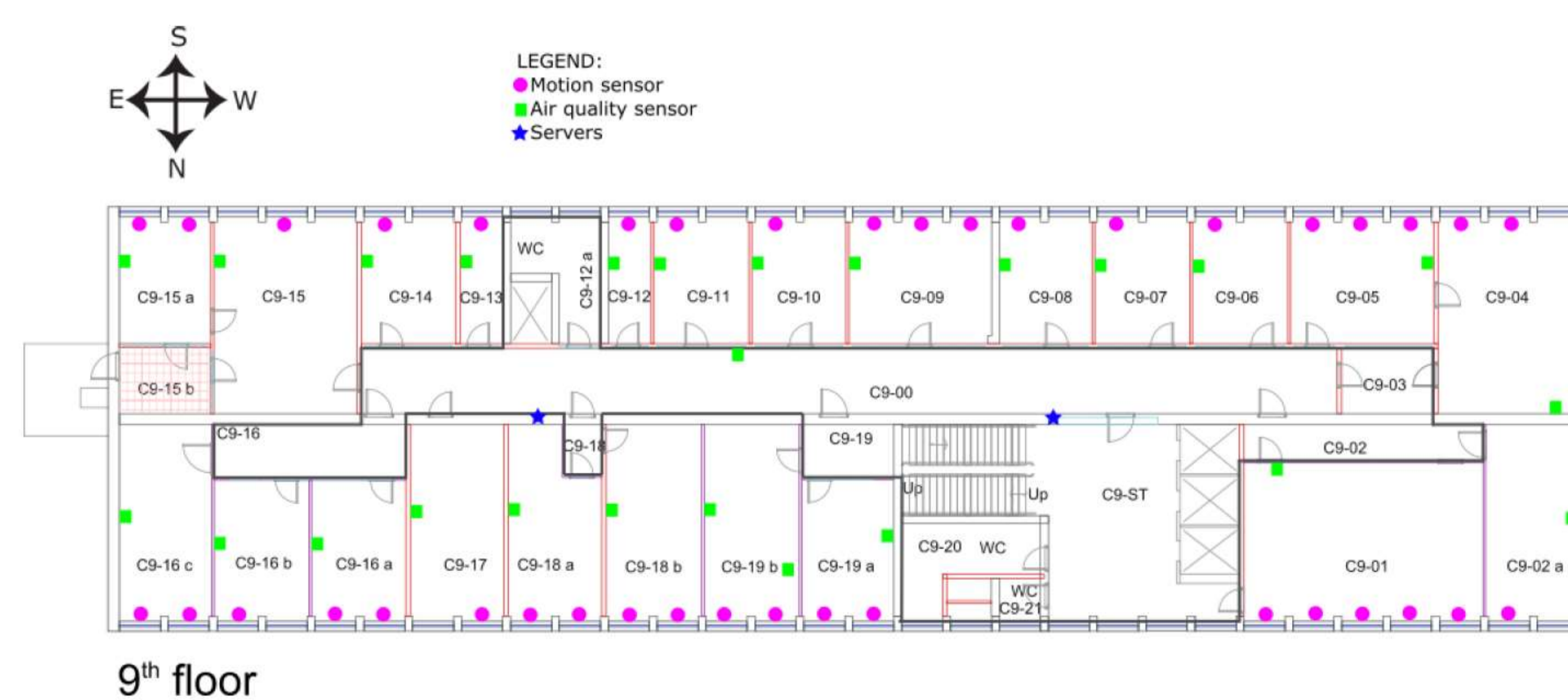
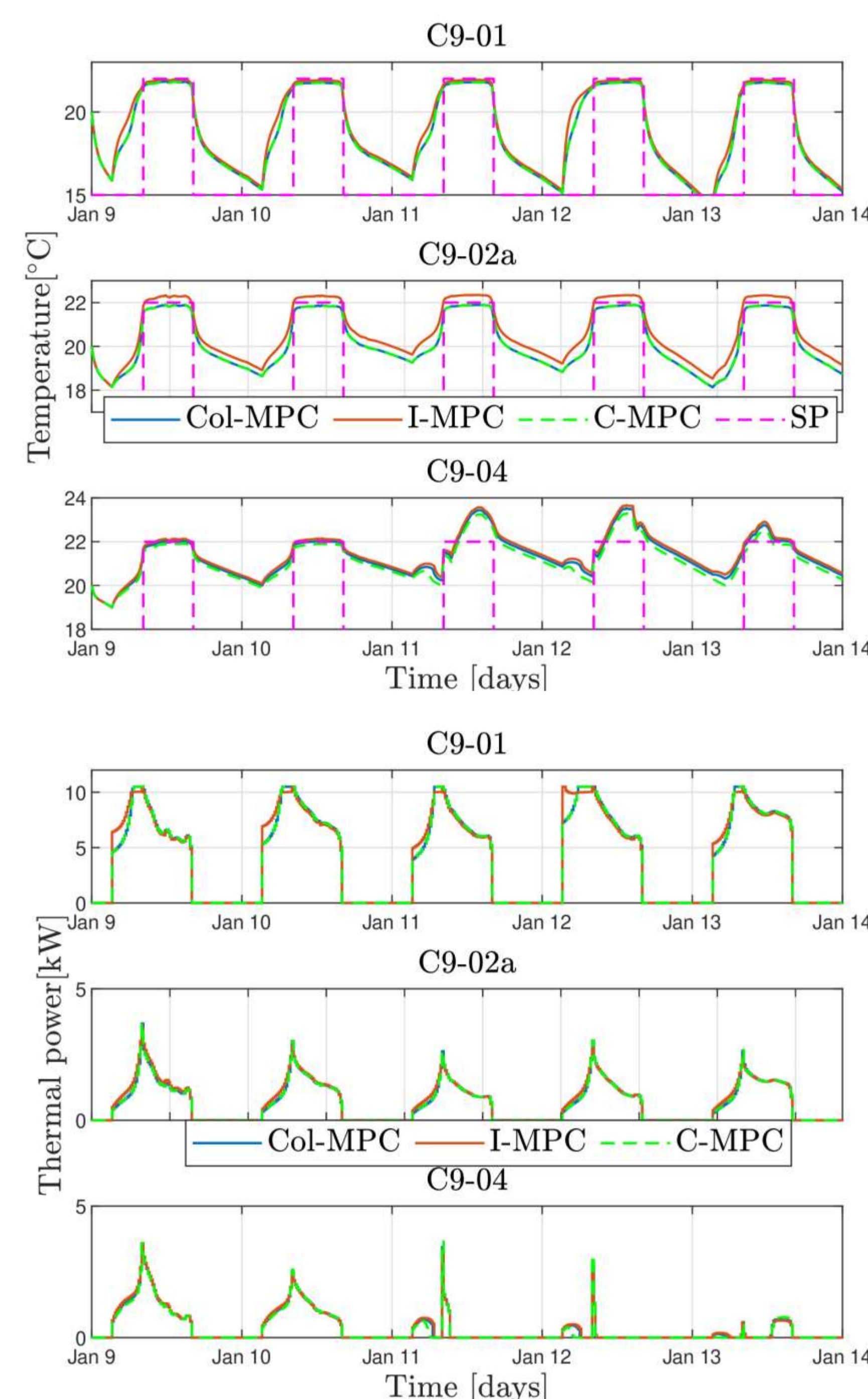
- distributed coalitional control for building zones
- bidding process between zones, where they independently calculate if joining a coalition improves own profit
- mixed-integer linear problem (MILP) for latent heat storage
- distributed control of variable efficiency heterogeneous battery storage in a microgrid based on asymmetric projection algorithm (APA)

Trade-off between user independency, energy savings and system complexity!



4. Results

- energy savings of coalitional control are 14.96% higher compared to decentralized control
- benefit of coalitional MPC is also high user privacy since data is not shared outside of coalition zones
- distributed APA-based control gains improvement of overall microgrid cost by 12.56% compared to decentralized control



5. Conclusion

Coordinated distributed control increases energy savings of building and also improves user independency, which implies comfort, fast zone digitalization and privacy.

Acknowledgment

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References

- [1] Directive of the European parliament and of the council on the energy performance of buildings, European commission, 2021

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