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Smart Energy Systems
4th Generation District Heating, Electrification, Electrofuels and Energy Efficiency
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Heating demand peak shaving in smart homes

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    - Production side (Curtailment)
    - Demand Side Management

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  - Heating demand flexibility
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ENERGYLAB
NORDHAVN
Nordhavn. Denmark
Leading sustainable City district
Full-scale smart city energy lab
Demonstrate future energy solutions

Experiment

- Demand side management (DSM) - Peak Shaving
- Field tests in 16 smart apartments (heating season of 2018/19)
- Schedule control of the temperature setpoint of thermostats
- Focus on the learning process of the methodology

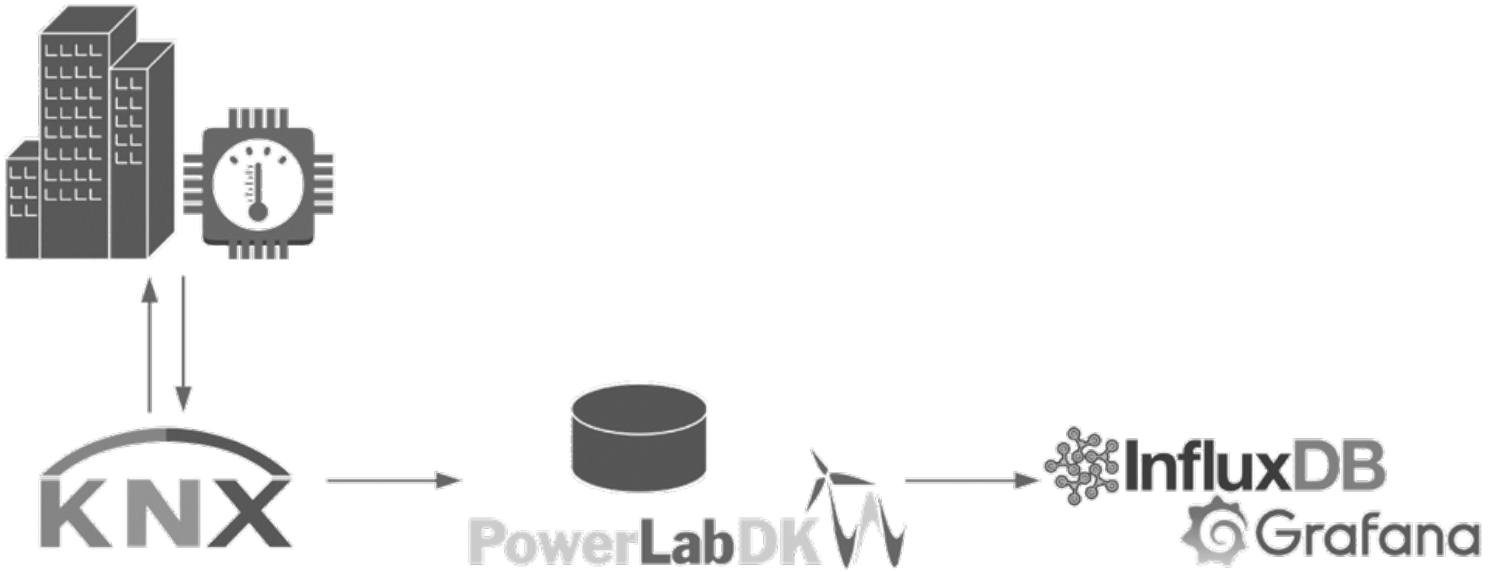
Testing
Dec 2018

Algorithm 1
Jan 2019

Algorithm 2
Feb 2019

Algorithm 3
Mar 2019

ICT System

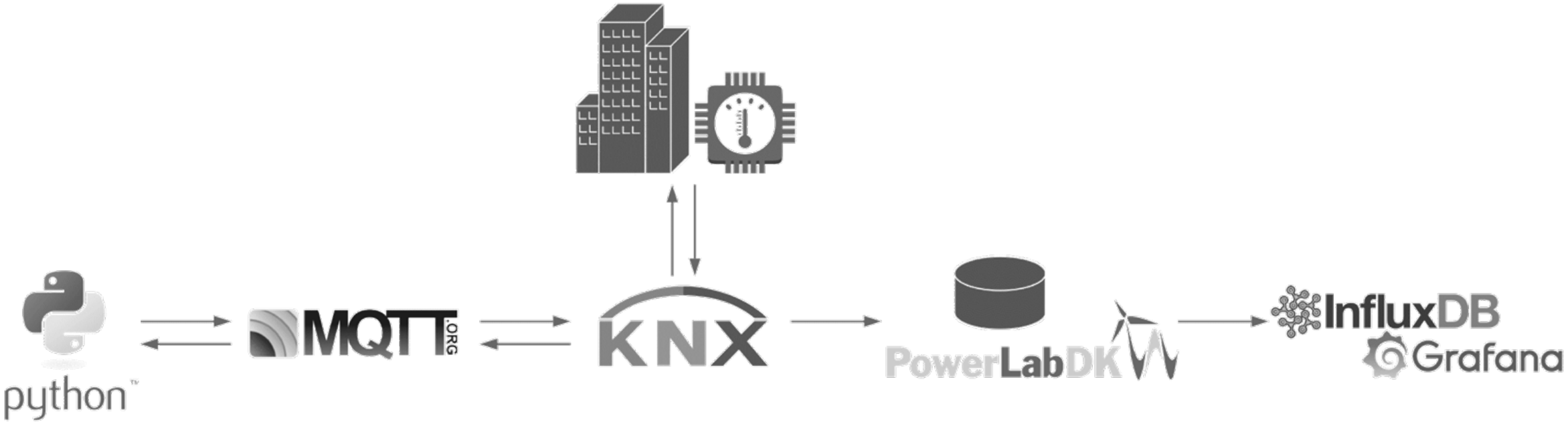


Monitoring side

Partners

HOFOR ABB BALSLEV DTU Center for Electric Power and Energy Department of Electrical Engineering | DTU Civil Engineering Department of Civil Engineering

ICT System



Control side

Monitoring side

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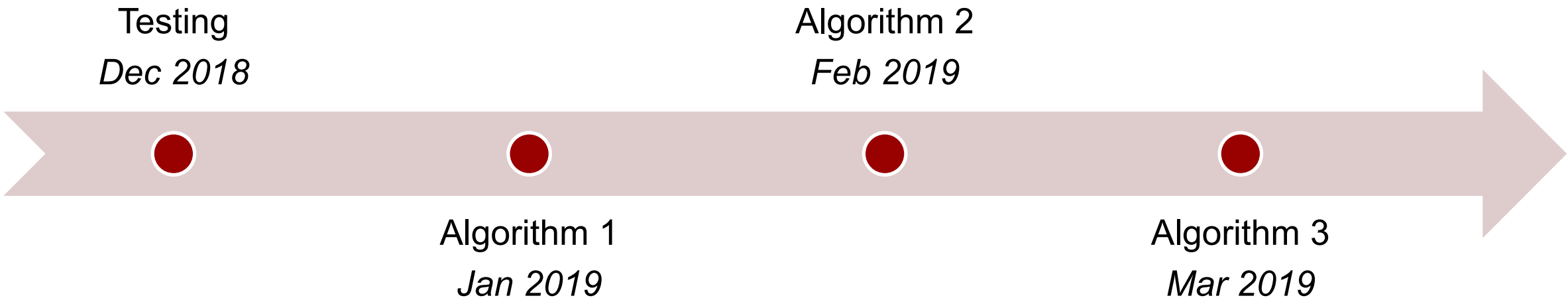
Project timeline



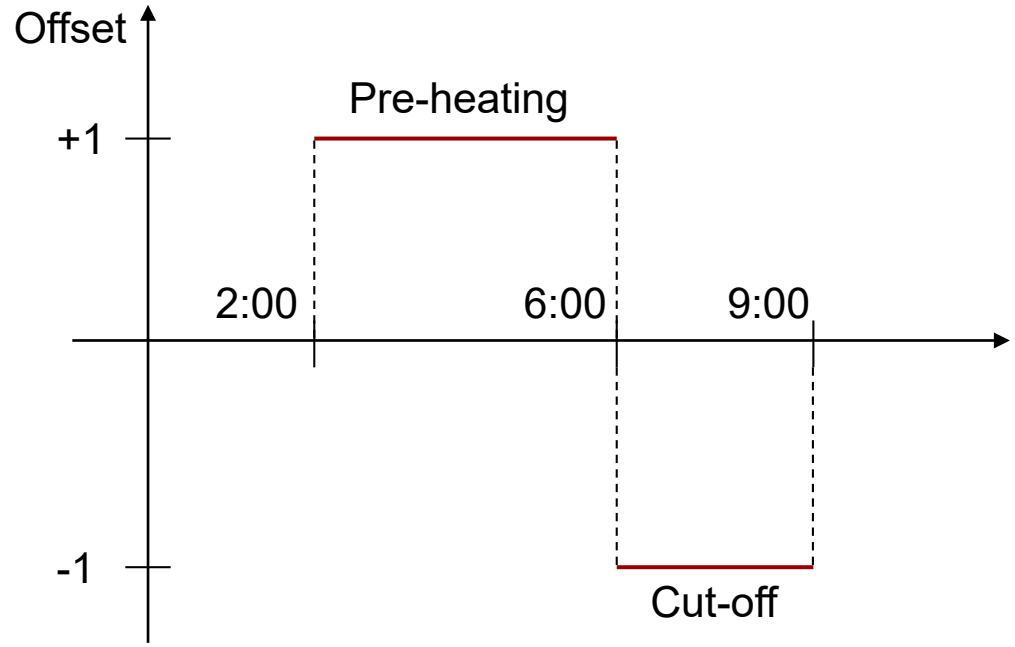
Testing phase – December 2018

- Making sure that the all systems was working correctly
- Fixing issues in the ICT system
- Single living room → Multiple living rooms
- Response of the heating system (indoor temperature) to simple control signals

- **Outcome**
  - Data available + monitoring/visualization tools → Detect issues in the system

Algorithm 1 – January 2019

- **Definition of reference temperature setpoint:**
  - Offline calculation using historical data of indoor temperature
- **Pre-heating between 2:00 and 6:00:**
  - Only living rooms
  - Offset of +1°C
- **Peak shaving between 6:00 and 9:00:**
  - All rooms
  - Offset of -1°C

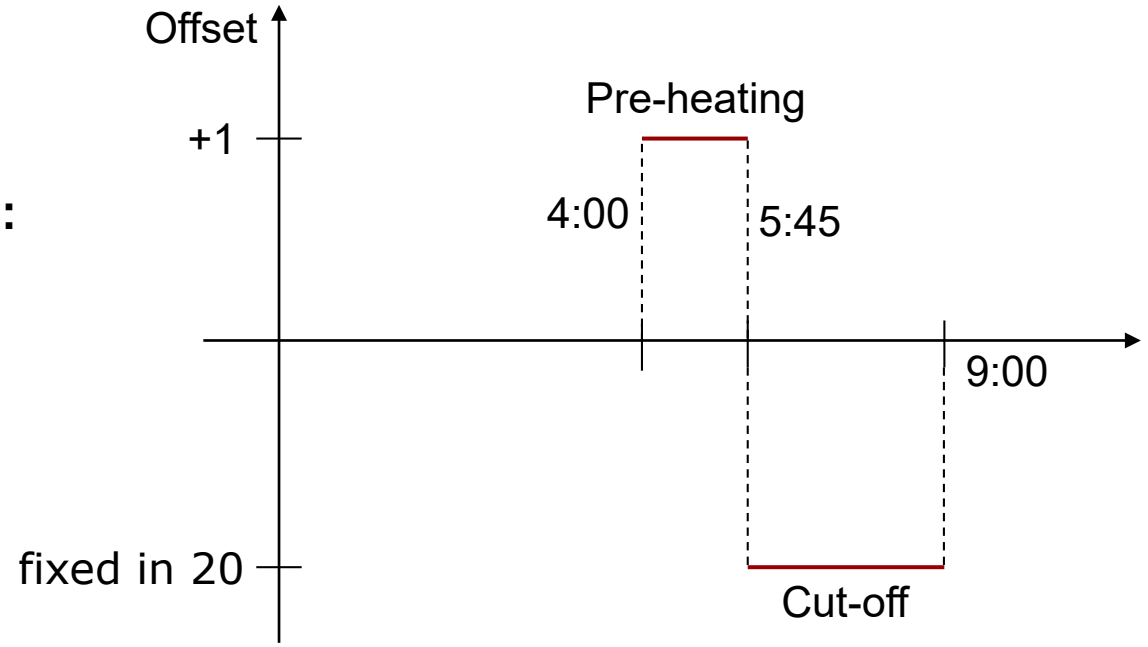


Algorithm 1 – January 2019

- **Outcomes**
  - Historic setpoint was not OK
  - Pre-heating time of 4 hours was too long
  - Delay of 15 minutes was observed in the system response

Algorithm 2 – February 2019

- **Definition of reference temperature setpoint:**
  - Defined as the current setpoint at 2:30
- **Pre-heating between 4:00 and 5:45:**
  - Only living rooms
  - Offset of +1°C
- **Peak shaving between 5:45 and 9:00:**
  - All rooms
  - Setpoints fixed in 20°C

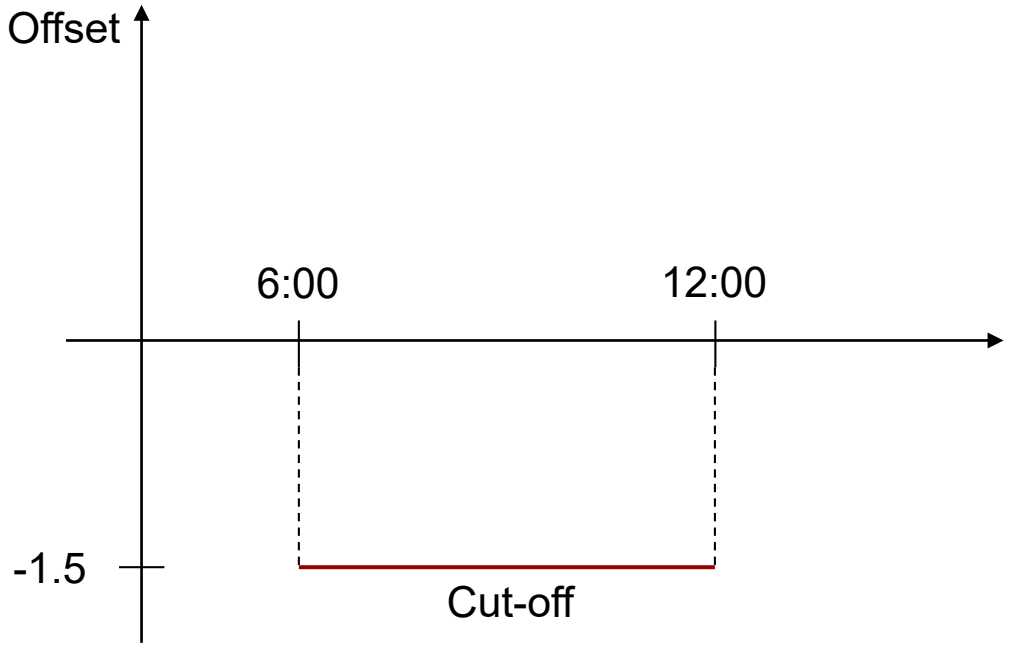


Algorithm 2 – February 2019

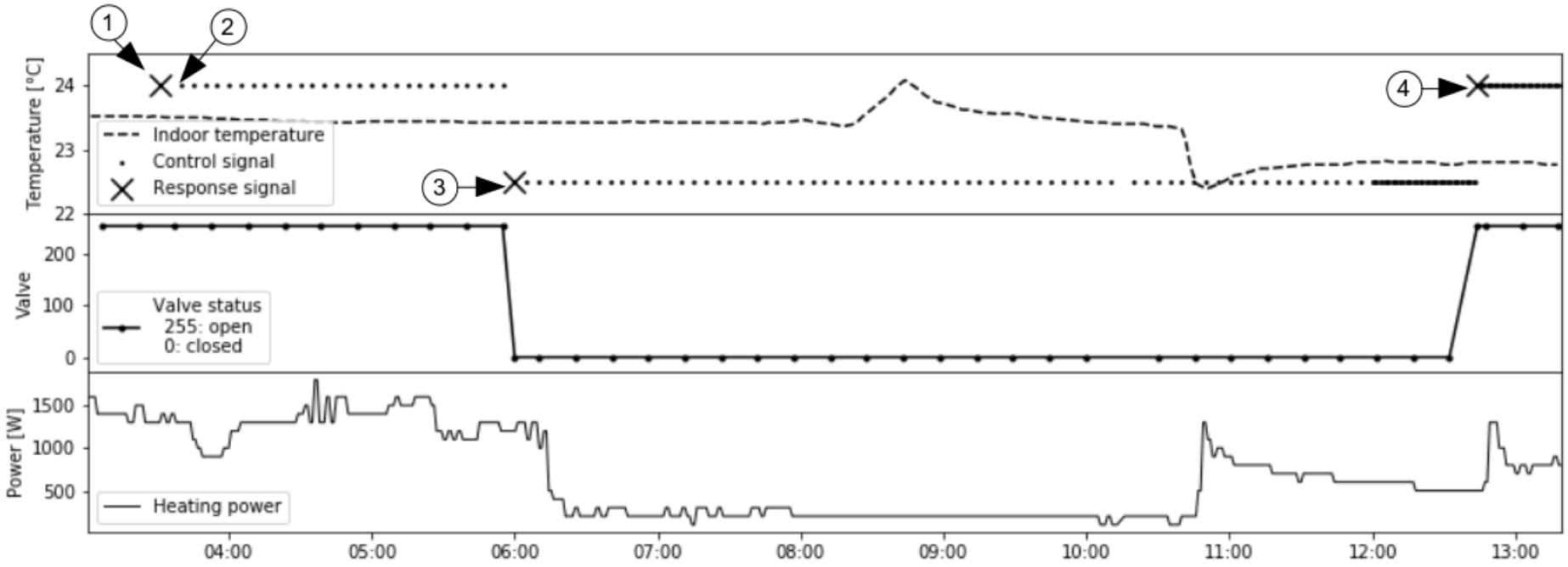
- **Outcomes**
  - Users feedback: bathrooms and toilets removed from experiments (warm floor)
  - Rebound effect observed when temperatures were increased back to reference
  - No pre-heating was needed (building's thermal inertia was enough)
  - It was possible to increase the heat cut-off period

Algorithm 3 – March 2019

- **Bathrooms and toilets were excluded from our control loop**
- **Definition of reference temperature setpoint:**
  - Defined as the current setpoint at 3:30
  - **No pre-heating**
  - **Peak shaving between 5:45 and 12:00:**
    - Offset of -1.5°C
  - Extra step at 12:00 to set back the setpoint
    - Delay of 1 minute between rooms



Results – Algorithm 3



1. Read of setpoint reference (3:30)
2. Beginning of DSM experiment (3:40)
3. Heat cut-off (5:45)
4. Setpoint back to reference (12:40)

Conclusion

- Significant reductions compared to non-experimental days with similar weather conditions
- Little impact on indoor temperature
- These methods can be applied to other smart homes where heating supply is controlled using room thermostats

Thank you

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