A Low-cost, Scalable Control Solution for Grid-Interactive Small and Medium Sized Commercial Buildings (SMCBs)

Energy Technologies Area
BERKELEY LAB

U.S. DEPARTMENT OF ENERGY

SMCBs are Huge Demand Resources

- Consistent HVAC configuration (Multiple RTUs)
- ~50% of total commercial indoor floor space
- ~50% of energy usage in the commercial building sector
- **Gap**: very **few commercial control solutions** for grid flexibility (optimal load shifting and shedding)
- **Scalability potential**: once an advanced control solution is developed for SMCBs, it could be highly scalable due to the consistent HVAC system

We propose a Low-cost, Scalable Solution

- By a **customized MPC** for SMCB that **only** uses web-enabled **thermostats** (**no additional sensors and networking**) and (2) automated modeling/implementation approach
- The **scalability** of the proposed MPC was **proven** through **multiple site deployments**

Background Works/Industry Involvement

- MPC-v1 demonstrated at multiple sites through multiple industrial supports
  (Duke Energy, Johnson Control, Southern California Edison, FDSI, Carrier, Emerson; 2015~2016)
- MPC-v1 was commercialized (FDSI/m-cloud; 2016)
- MPC-v2, for optimal load shifting and tested in a laboratory (2017~2018)

Project Highlights

- First **MPC demonstration** in K-12 school buildings for **peak demand reduction** and **load shifting**
- Experimentally demonstrated **the MPC** for multiple RTUs **without hardware retrofit**

Team

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LBNL develops and enhances modeling and control algorithms

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CEL evaluates and commercializes the technology

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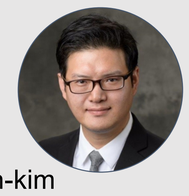
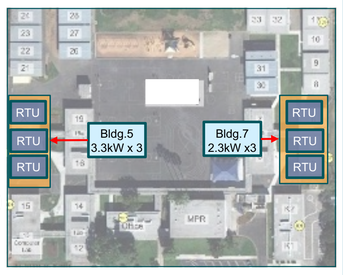


First Demonstration Site

MPC deployed for two bldgs. in an elementary school, CA. 6 RTUs were controlled to reduced peak demand & cost. (Secured by partner company*)

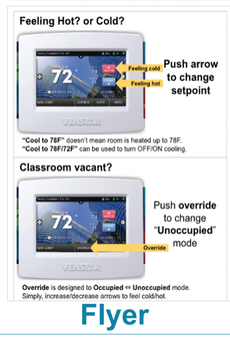
**Community Energy Labs. (CEL)*



Customer Engagement

CEL continues its work with Bonneville Environmental Foundation and other educators to find ways to integrate what they are learning into curriculum.

CEL worked with SCE to roll out a semi-annual training for building operators (54 participants in the April 2022 session). CEL is taking what we are learning and launching a formal Customer Success team for the K12 ecosystem.



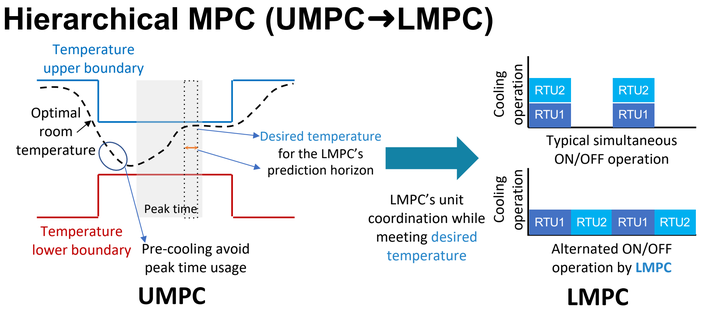
Flyer

LBNL, CEL, and School manager distributed educational Flyers/Video to share how to "properly" use thermostats to optimize MPC's performance with teachers and field operators

Video

MPC: Only Requires Thermostats!

Hierarchical MPC (UMPC→LMPC)



- Scalable MPC only requires a thermostat.
- UMPC: Optimal load shifting (24-hr prediction)
- LMPC: Peak demand coordination (15-min prediction)

MPC customization

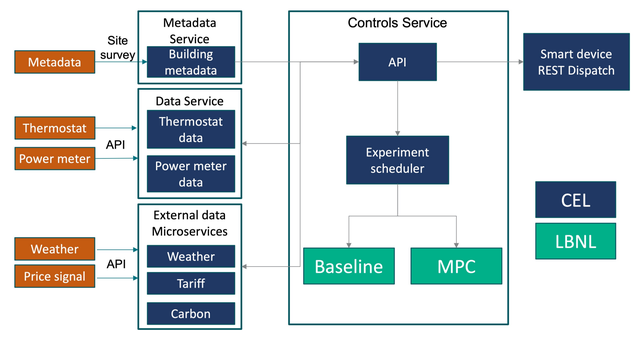
Customer's Override behavior

- Make MPC decision based on overridden action.

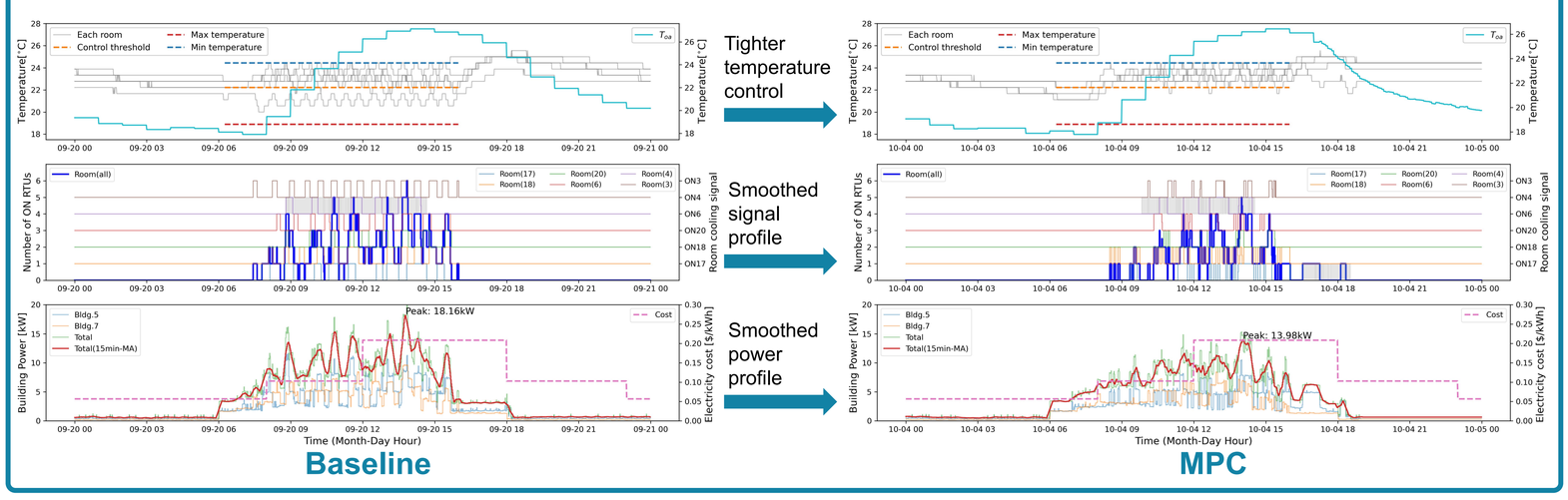
Integer resolution

- Rounding data in Kalman Filter to reduce feedback error.

MPC as a service in CEL's cloud service

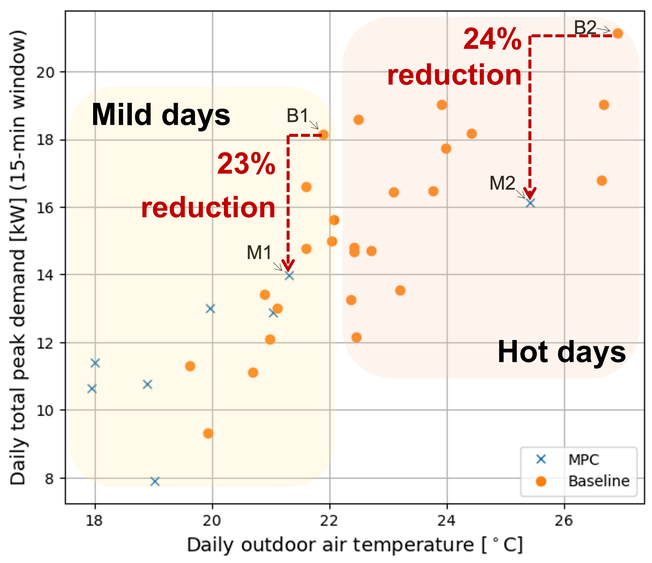


MPC's Peak Demand Reduction



First demo: 24% of Peak Demand Reduction and 16% of Load Shifting Potential

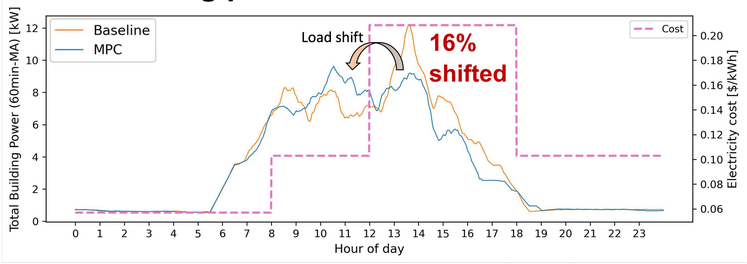
Peak demand reduction



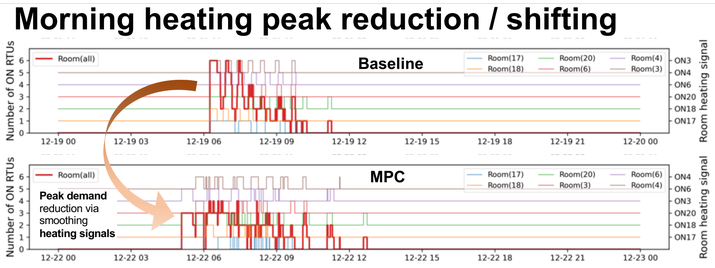
➜ Peak demand reduction of **24%** (total) and **30%** (HVAC)

➜ M2 is worst case: 4 out of 6 RTUs were overridden by users.

Load shifting potential



Morning heating peak reduction / shifting



Future work

- Scale up to all school buildings (17 RTUs in 7 bldgs.).
- More automated process and complete tech transfer.

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