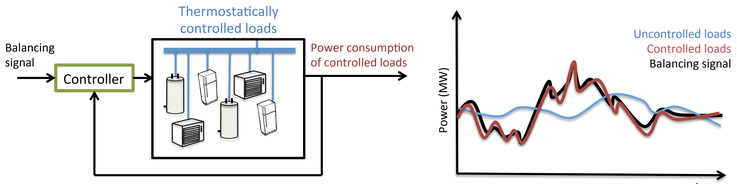
Overcoming the Technical Challenges of Coordinating Distributed Load Resources at Scale

PI: Johanna Mathieu (University of Michigan) - Co-PIs: Duncan Callaway, Drew Geller, Scott Hinson, Ian Hiskens

Project Overview

Network-aware, communication-constrained, non-disruptive load coordination strategies with stability guarantees that achieve the performance requirements of typical balancing services



Network-Aware | Communication-Constrained | Stability Guarantees

Uniqueness: How is this project different?

- Goal: Establish credibility for electric load coordination at scale.
- Approach: Identify the technical issues and develop solutions to those issues such that consumers, utilities, system operators, aggregators, regulators, and other stakeholders both trust the technology and understand its capabilities and limitations.
- Anticipated result: Resolve fundamental technical obstacles to widespread adoption and large-scale deployment of electric load coordination for grid balancing services.

Team Strengths

Expertise in control theory and application, power systems, data analytics, software/hardware development, experimental design, field testing

Project Summary

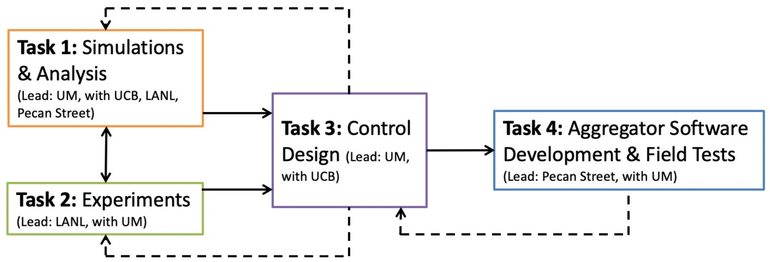
• Technical issues

Distribution Network Issues: Over/under voltages, transformer overheating, etc.
Stability Issues: Synchronization leading to power oscillations and instability, e.g., FIDVR
Communication Network Issues: Trade-offs between quality of control and communications network sophistication/cost

• Research Questions

1. What network, stability, and communication issues might arise in practice when we coordinate large aggregations of loads?
2. How can we coordinate loads to achieve performance objectives in a cost effective manner while avoiding these issues?

• Approach



• Final Milestone (June 2022)

Controllers that enable aggregations of residential air conditioners to provide frequency regulation with sufficient quality to meet an ISO's performance requirements, with no stability or distribution network issues, utilizing sufficiently low-cost communication networks and controllers
→ Metric for success: Cost/benefit analysis shows that the aggregator and all consumers would be able to profit
→ Why frequency regulation? It's the hardest service to demonstrate (closed-loop, fast). If we can do, FR we can do any balancing service (others may be more lucrative).

Project Outputs

- Simulation, experimental, and field test results demonstrating issues and solutions
- Control algorithms
- Aggregator software/hardware

Challenges & Risks

- Simulations and/or experiments that do not capture key phenomena in real world systems; *Mitigation:* using an iterative testbed development and validation process
- Control architectures that overcome all issues are not easily implementable in practice or expensive; *Mitigation:* development of sub-optimal controllers that balance performance, computational tractability, and system costs

Tech to Market (T2M)

- Commercial objective: Open-source software licensing
- Entities that may be interested in the technology: Aggregators, utilities, smart meter companies, home energy management companies, thermostat companies
- Which markets or segments is the team targeting? Texas, California, PJM; Ancillary services (frequency regulation), Demand response, Capacity markets/charges
- Commercial activities: Customer discovery and commercial strategy development through two I-Corps Programs

Key Takeaway

This project will establish credibility for load coordination for balancing services by resolving the fundamental technical obstacles to widespread adoption and large-scale deployment.

CONTACT:
Johanna Mathieu
jlmath@umich.edu