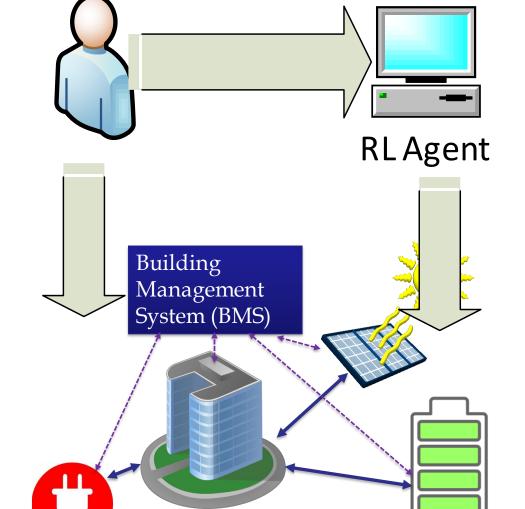
Collaborative Research: CPS: Medium: Adaptive, Human-centric Demand-side Flexibility Coordination At-scale in Electric Power Networks

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Project goal - Aggregation and coordination of demand-side flexibility at many small consumers in power grid by adequately representing the user constraints regarding electricity usage and their interactions with the system and the energy provider.

Price-responsive HEMS control - Desired level of aggregated consumer flexibility

Thrust 1 Autonomous decision-making to aggregate building/ home-level flexibility



- Learn consumer's temporally evolving constraints for energy usage
- Design HEMS cognizant of customer's constraints to orchestrate the sub-metered loads.

Incentive design Aggregated consumer flexibility

Thrust 2 Incentivise and coordinate flexibility at the system-level

- Tractable model to represent aggregated consumer flexibility Use the model for the
- aggregated consumer flexibility to design pricing (incentive) signal at the aggregator-level

Incentive (pricing) signal to incentivize the desired level of consumer flexibility

Evaluation/Experimentation Plan **High-fidelity Simulators**





- Prototype the algorithms in MATLAB/python.
- Evaluate the algorithms using a high-fidelity model of the system via extensive simulations.
- Evaluate the algorithms on real-world data obtained with the help of industry partners.

Technical Accomplishments:

- Model prosumers' demand flexibility: data-driven models to estimate and predict buildinglevel thermal load demand for residential and commercial gridinteractive efficient buildings.
- Dynamic electricity pricing: incentive design in principal agent game with incomplete information for the agent's private payoff function
- Policy gradient-based learning algorithm for general sum stochastic Stackelberg games with theoretical guarantees for its convergence

Broader Impacts:

- Provided solutions to adaptive and smart infrastructure systems with active participants, methods broadly applicable to other CPS
- Undergraduate research, recruit and train women students and other underrepresented minority students.

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