Building Energy Management System for Transactive Energy Framework

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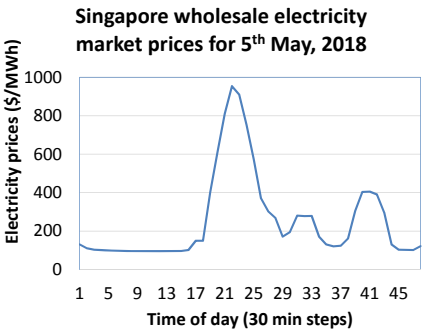
Background & Introduction

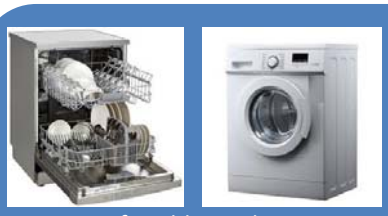
- In future smart grids, billing of electricity usage will be based on electricity plans such as time-of-use (TOU) prices or Dynamic pricing
- Businesses in Singapore with an average monthly consumption of at least 2,000 kWh can buy electricity from wholesale market at half-hourly wholesale prices
- Incentivize customers to align their electricity usage with availability patterns across the day
- Building Energy Management System (BEMS) based on Transactive Energy (TE) principles schedules the household appliances according to applicable TOU prices, expected distributed energy resource generation, and user preferences for economy (γ)



Methodology

- Proposed BEMS minimizes the cost of electricity used, along with minimizing the virtual costs such as degradation of storage devices, thermal discomfort and waiting for services of different appliances
- The problem is formed as a non-linear constrained optimization problem which is solved using a hybrid gradient descent algorithm.

Here, γ = 0 signifies comfort preference, and γ = 1 signifies economy preference



Deferrable Appliances

Constant power demand for each cycle

$\min(\gamma . Cost_{elec} + (1-\gamma) . Cost_{waiting})$

Power Controllable Appliances

Controlled power demand

$\min(\gamma . Cost_{elec} + (1-\gamma) . Cost_{temp\_variation})$

Proposed BEMS Algorithm

Uncontrolled Devices

Critical appliances or low power consumption

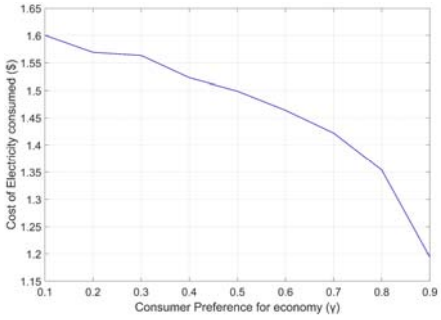
Energy Storage

Controlled electricity storage and extraction

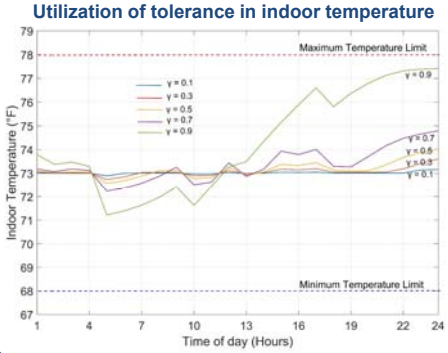
$\min(\gamma . Cost_{elec} + (1-\gamma) . Cost_{ageging})$

Simulation Results

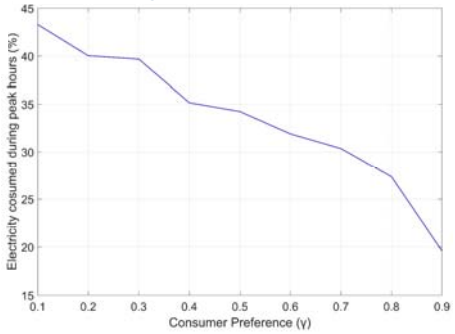
Reduction in electricity cost with economy preference(γ)



Utilization of tolerance in indoor temperature



Shifting demand to Off-peak hours



Conclusions

- Substantial reduction in cost of electricity used by consumer possible by utilizing available flexibility in the operation of household appliances
- Can be utilized for estimating demand response (DR) from the consumer for given change in TOU prices
- Proposed future works include practical implementation of proposed BEMS

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