Incentive Design in Energy Systems: A social game

Occupants

Building Manager

mechanism
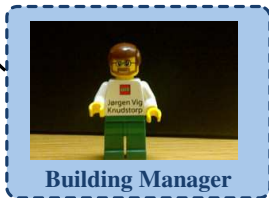
Light Group B
Target: 90.0%

Brighten

22.0%

Other Votes

Dim

occupant votes

Source: Lego

Social Game for Energy Savings – Energy Consumption

Lights energy savings

- Lights energy savings
- mean savings default 20
- mean savings default 10
- mean savings default 60
- mean savings default 90
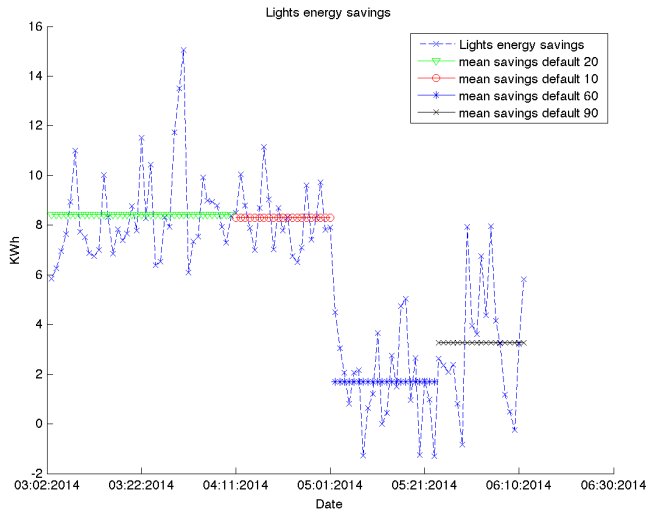
▶ Over the 100 day period, there is a savings of $70-$90 depending on price of energy.

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A Game Theoretic Framework for Societal Scale CPS

Non–Cooperative Game

Agent$_1$ $f_1(u, \gamma(u); \theta_1)$

Agent$_2$ $f_2(u, \gamma(u); \theta_2)$

$\vdots$

Agent$_n$ $f_n(u, \gamma(u); \theta_n)$

mechanism $\gamma(\cdot)$

agent feedback $\{u_i\}_{i=1}^n$

Social Planner

Incentive Design (Control)

parameters $\{\hat{\theta}_i\}_{i=1}^n$

Utility Learning (Estimation)

$f_P(u, v)$
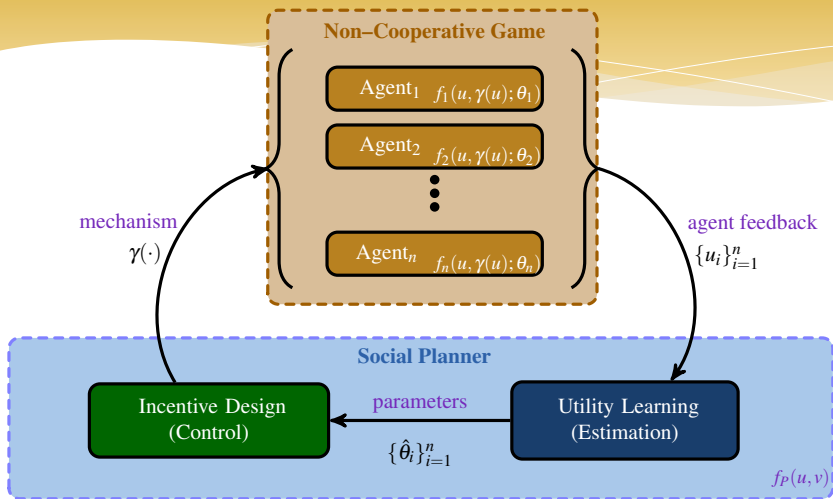
Ratliff, Burden, Sastry. Characterization and Computation of Local Nash Equilibria in Continuous Games. Allerton 2013.
Ratliff, Burden, Sastry. Genericity and Structural Stability of Non-Degenerate Differential Nash Equilibria. ACC 2014.

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Social Game for Energy Savings – Estimation and Simulation
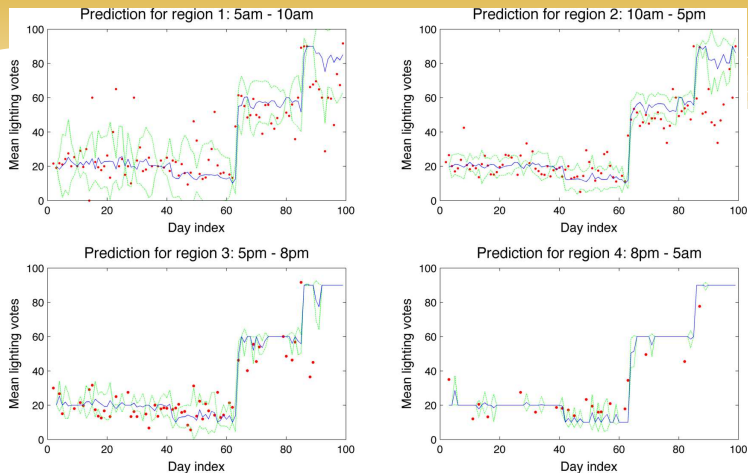
Blue: Mean of estimated Nash, Red: ground truth, Green: 1-std dev. of the estimated mean

Model	ARIMA(1,0,1)	Nash	Constant	Persistent
MSE	13.9183	**12.4561**	16.9585	13.4247

Social Game for Energy Savings – Future and On-going Work

- We are in the process of implementing an online utility learning and incentive design algorithm.

- In addition, we are currently deploying instrumentation that allows us to implement what amounts to a DLC scheme in the office (we can turn on/off large consuming devices at occupants desks).

- We are designing contracts to be offered to the occupants in which they select when they need power to their devices.

Ratliff, Dong, Ohlsson, Sastry, Incentive Design and Utility Learning via Energy Disaggregation. IFAC 2014.
Konstantakopoulos, Ratliff, Jin, Spanos, Sastry. Social Game for Building Energy Efficiency: Utility Learning, Simulation and Analysis. (Submitted) GameSec 2014.
Ratliff, Jin, Konstantakopoulos, Spanos, Sastry. Social Game for Building Energy Efficiency: Closing the Loop via Incentive Design. (In Prep) Allerton 2014.

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