Implementing a Grid State Indicator for Responsive Retail Demand

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Overview

- CAISO Grid State Indicator
- Indicator Signal Model Design
- Customers Response Modeling
- Pricing Rates Scenarios
- Benefits Assessment
- Challenges

CAISO Grid State Indicator

- Representation
  - Composite Market Price
- Components
  - Locational Marginal Price (LMP)
  - Highest Ancillary Service Price
  - Ramping Capacity Price

Indicator Signal Design

Figure 1. The LMP over time in NYC
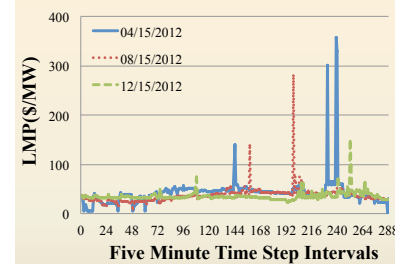
- Composite Market Price = LMP
- Signal Index levels

Table 1. The Specified Signal Index Levels

Signal Index	Lower Limit ($/MWh)	Upper Limit ($/MWh)
0	NA	-20
1	-20	0.25*off-peak average
2	0.25*off-peak average	0.5*off-peak average
3	0.5*off-peak average	0.75*off-peak average
4	0.75*off-peak average	0.9*on-peak average
5	0.9*on-peak average	1.1*on-peak average
6	1.1*on-peak average	1.3*on-peak average
7	1.3*on-peak average	2*on-peak average
8	2*on-peak average	5*on-peak average
9	5*on-peak average	10*on-peak average
10	10*on-peak average	NA

Customers Response Modeling

$$\epsilon = 0.5(1-t/T)+0.5 \text{ (Eq. 1)}$$

Input → Possible Actions → Learning Policy → Choose Action → Load Reduction → Result
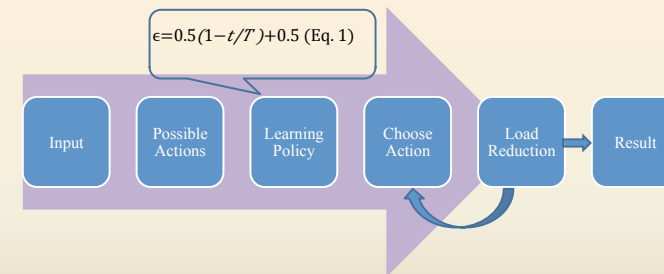
Figure 2. Q-Learning Flow Chart

Demand Response Scenarios

- Dynamic Pricing Rates
  - ➤ Savings = load reduction * LMP
- Flat Rates
  - ➤ Reward = (LMP − Flat Rate) / MW
  - ➤ Savings
    - ◆ Bills = Load reduction * Flat rate
    - ◆ Incentives = Load reduction * Reward

Assessing Benefits

- ■ Total load reduction
  - • 11.5-23.0 GW
  - • Percentage < 1%
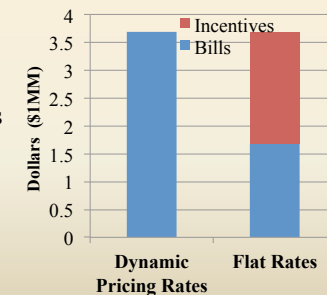- ■ Total money savings
  - • 3.7- 7.5 million dollars

Figure 3. The Column Chart of savings

Challenges

- High Price Spikes vs. Peak Intervals
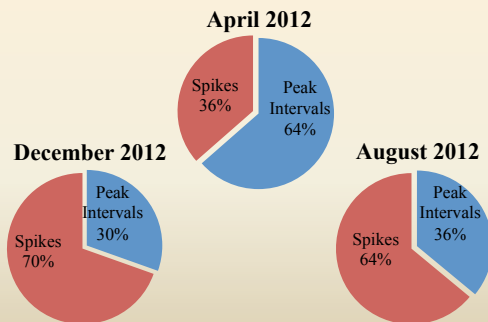
April 2012

December 2012

August 2012

Figure 4. The Pie Charts of High Price Spikes vs. Peak Intervals

Challenges

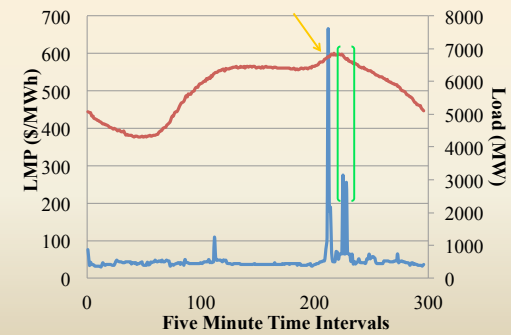- High Price Events & Load Correlation

Figure 5. LMP Corresponding with Load on December 14th, 2012

Conclusion

- Modeling
- Potential Outcomes
- Future Adaptation

Thank you!

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