Smart Grid State Indicator

The future to save on electricity bills and improve energy efficiency

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I. Do you care...?

- Electricity price changes every five minutes
- There is a smart way for you to budget your electricity consumption and to save energy!

II. Where to start?

The smart grid technology will enable the electricity users to make grid-friendly decisions based on grid states (120Volt & 60Hz). To manage electronic devices response, consumers will need the information on electricity prices and power system conditions, received from grid indicators.

Figure 1. Potential prototype of grid indicator

III. First Glimpse...

Goal: Create an electricity signal consistent with grid states in New York State, and to assess the electricity demand response associated with the signal by adopting Q-learning algorithm (AI).
Signal components: LMP(locational marginal price), location, reliability index, and advisory indicator.
Signal representation: CMP(composite market price) driven by wind power.
New York State has 11 zonal areas as listed in Figure 2, and each area will need its own CMP.

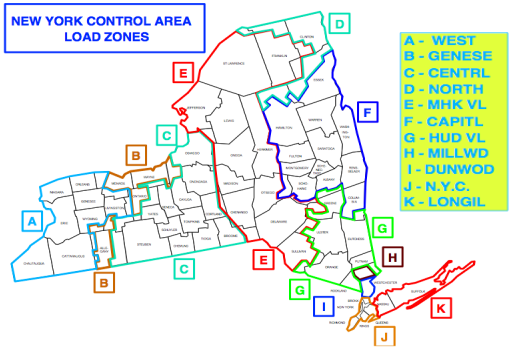

Figure 2. New York State load zones

IV. Creating Electricity Price Signals

- Downloaded real-time market price LMP, ancillary service price, and load from New York Independent System Operator website[1].
- Created a Matlab program to convert the composite price to signal index

Table 1. Signal Index value

Meaning	Signal Index	Lower Limit	Upper Limit
Use More	0		-30
	1	-30	30
	2	30	off peak avg
Use Freely	3	off peak avg	on peak avg
	4	on peak avg	1.1*on peak avg
	5	1.1*on peak avg	1.33*on peak avg
Use Cautiously	6	1.33*on peak avg	1.67*on peak avg
	7	1.67*on peak avg	2*on peak avg
	8	2*on peak avg	3*on peak avg
Use Sparingly	9	3*on peak avg	8*on peak avg
	10	8*on peak avg	

V. Signal Response Modeling

Predicted responsive load by applying Q-learning algorithm (Artificial Intelligence)

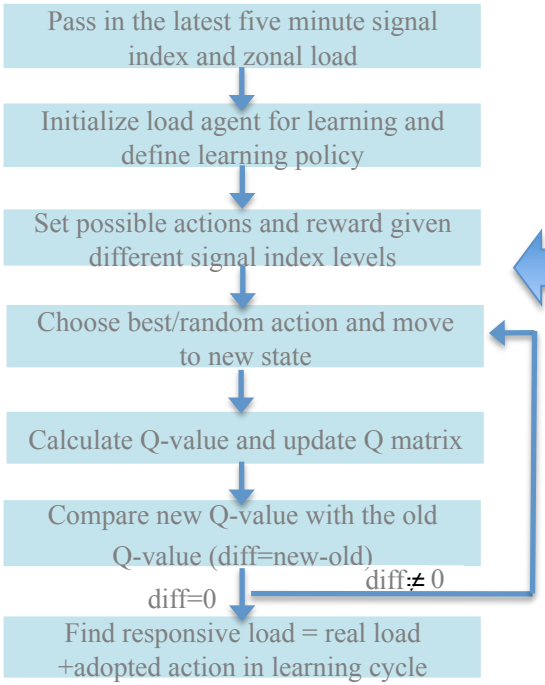

Figure 3. Q-learning Flow Chart

VI. What can be achieved?

➢ Load response expectation
- Signal index 0-2: increase load by 20%
- Signal index 3-5: increase load by 10%
- Signal index 6-8: decrease load by 10%
- Signal index 9-10: decrease load by 20%

➢ Predicted load after learning cycle
- Load response in the same direction as expected
- The amount would be less than expected

Acknowledgement

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