Transactive Applications of OpenADR

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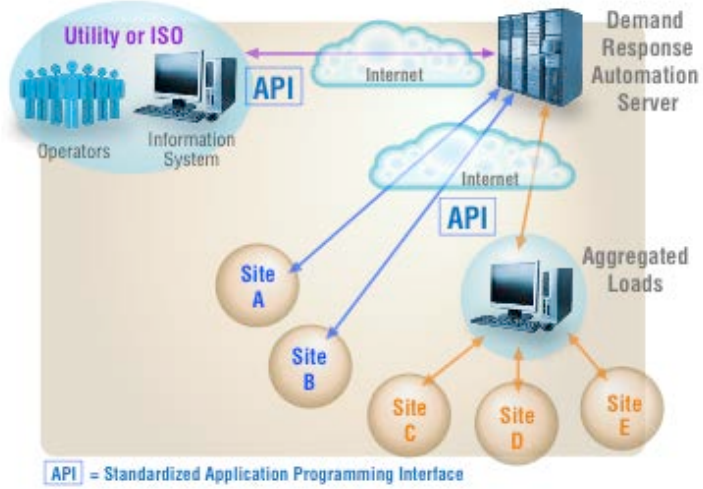
Outline of the Presentation

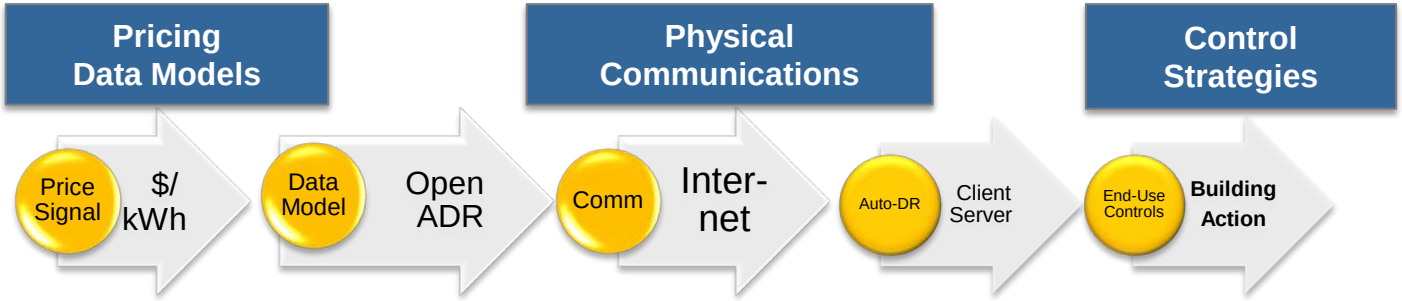
- Overview of OpenADR
- **Sample** transactive applications of OpenADR (2009-present)
  - Small Commercial Buildings (Taco Bell)
  - An Office Building in CAISO's Participating Load Program
  - Price Response in NY
  - Automated Demand Bidding Program
  - Automated Capacity Bidding Program

Automation is key to participation

openADR ALLIANCE

- Provides non-proprietary, open standardized DR interface
- Allows electricity providers to communicate DR signals directly to existing customers
- Uses common XML language and existing communications such as the Internet



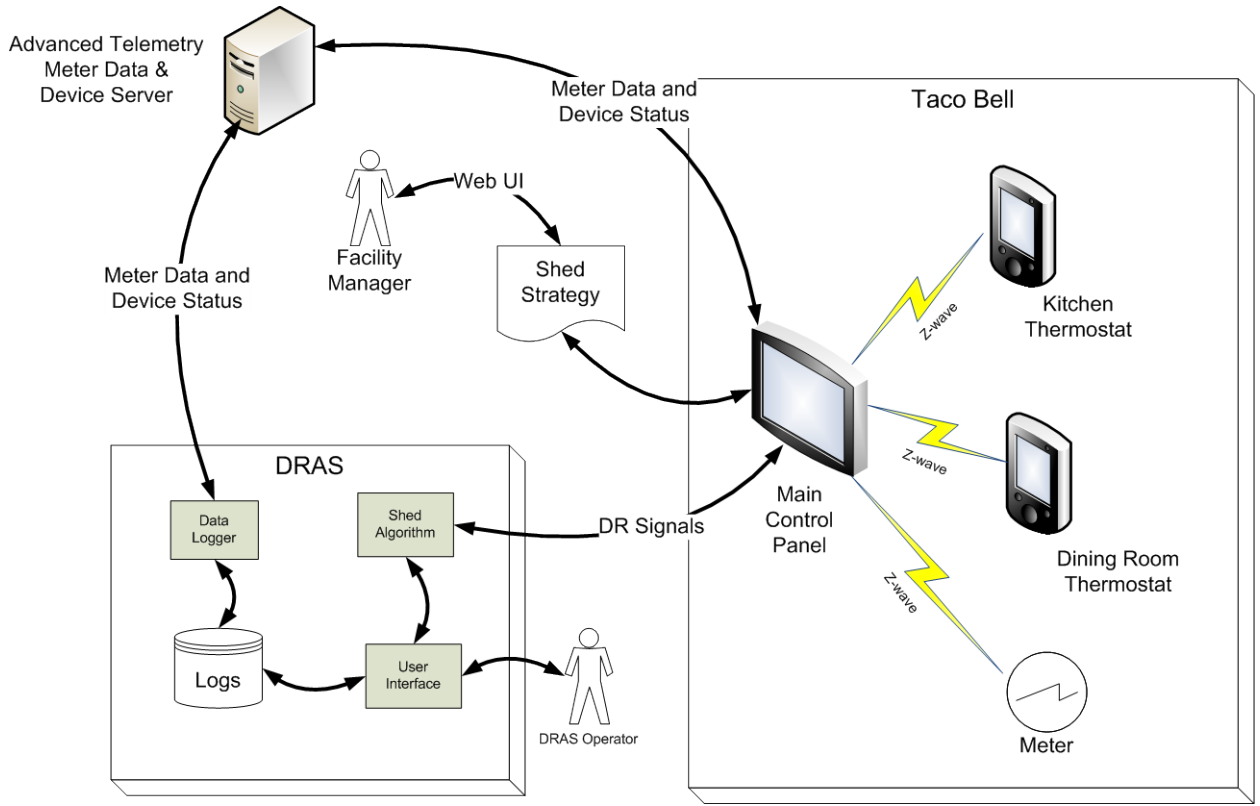


Small Commercial Buildings

- Small Commercial study with SCE
- Two Taco Bell sites in SCE's territory

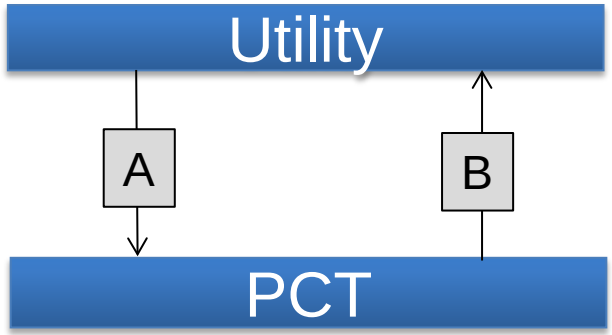
Objective:
To evaluate the use of programmable communicating thermostats (PCT) in small commercial buildings in closed-loop control with utility demand reduction signals and understand the market for the PCT beyond residential buildings.

Small Commercial Building - Architecture



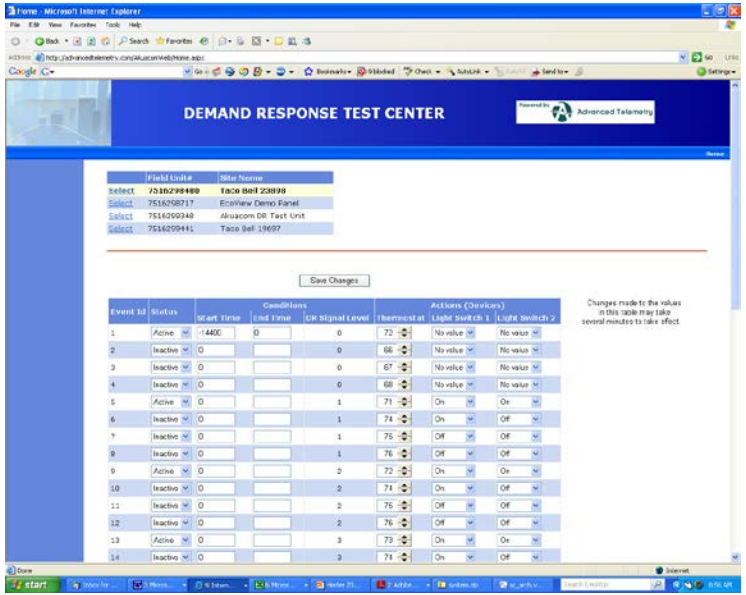
Small Commercial Building – Extent/Transactions/Parties

- Designed to be used from end-to-end (utility to end-use)
- Multi-site (two Taco Bells in two cities)



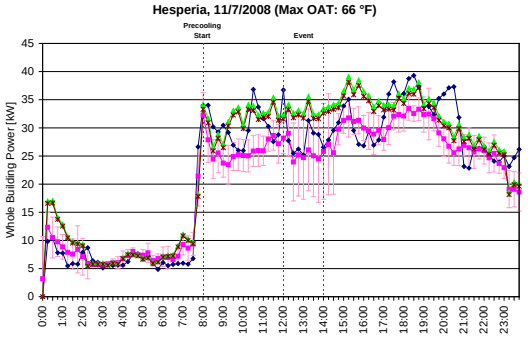
A Event, Baseline, and % load shed request

B Meter data



Small Commercial Building – Cont.

- Transactions: % reduction in load for a pre-negotiated $/kWh
- Transacting Parties: Utility and thermostat, fully automated.
- Temporal Variability: Event driven and hourly granularity
- Interoperability: OpenADR 1.0
- Value Assignment: Utility determined.
- Alignment of Objectives: Customer weight the cost/benefits of participation and set the limits. Opt-out available
- Stability Assurance: Utility monitors and controls it.



Date	Baseline	Event Time	kW		W/ft²		WBP%	
			Max	Ave	Max	Ave	Max	Ave
Nov-07	3/10	12:00-2:00	7	6	3.43	2.68	23%	17%
	3/10 MA		7	5	3.06	2.29	21%	15%
	OAT		1	-2	0.62	-0.94	5%	-8%

Kiliccote, S., M. A. Piette, J. H. Dudley, E. Koch, D. Hennage. Open Automated Demand Response for Small Commercial Buildings. July 2009. LBNL-2195.

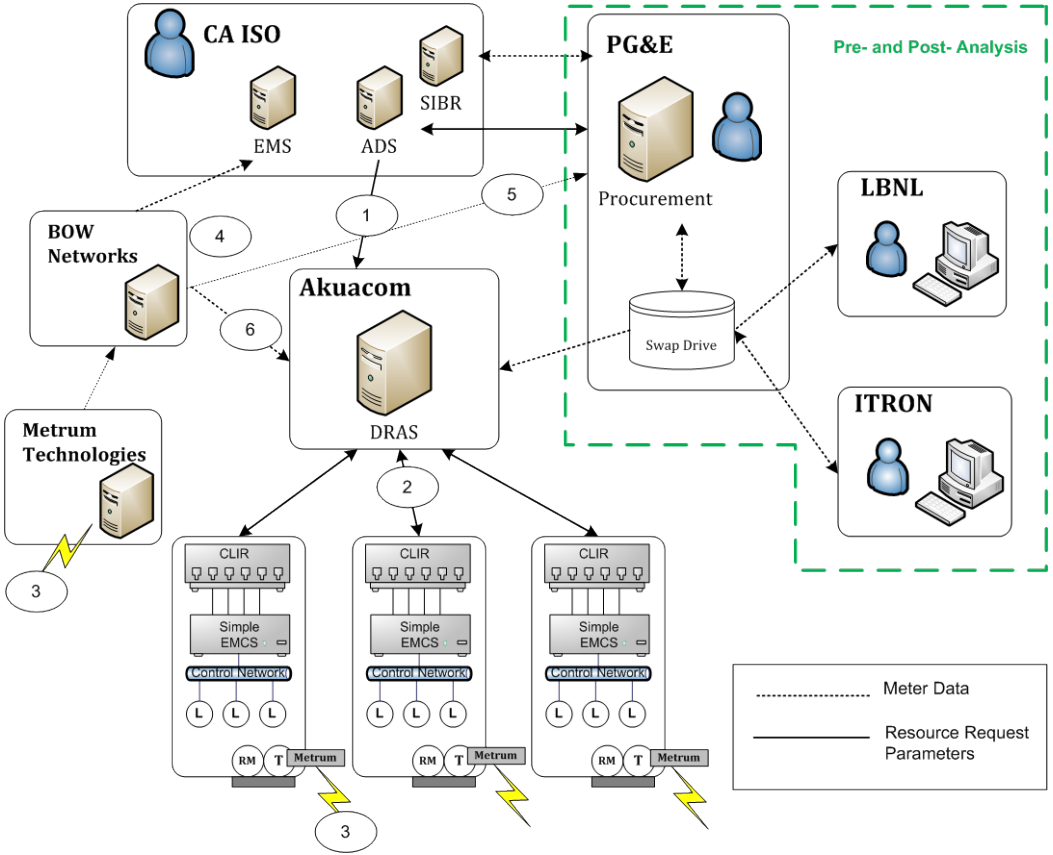
Participating Load – Office Building

- Participating Load Pilot with PG&E
- Three sites – focus is one of the sites

Objectives:

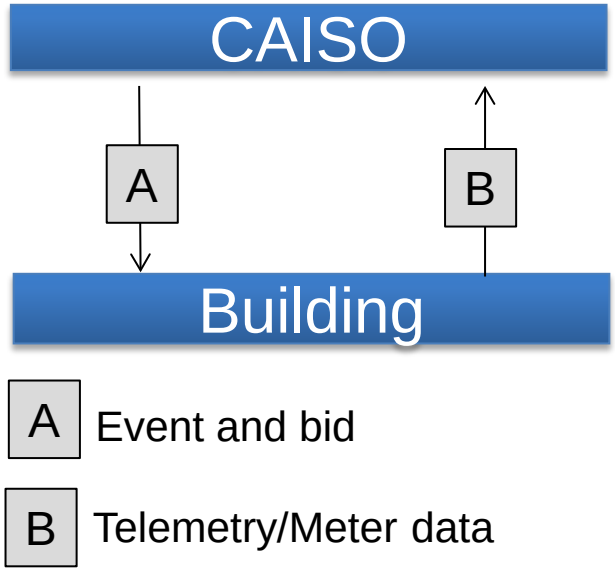
- Using day-ahead DR strategies for non-spinning reserves.
- Measuring response time and signal latencies

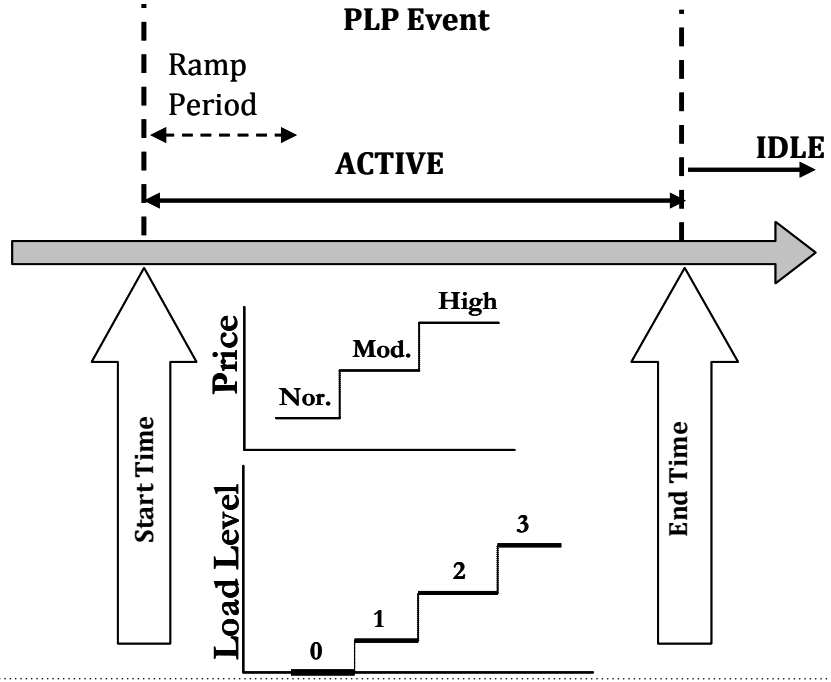
Participating Load - Architecture



Participating Load Pilot– Extent/Transactions/Parties

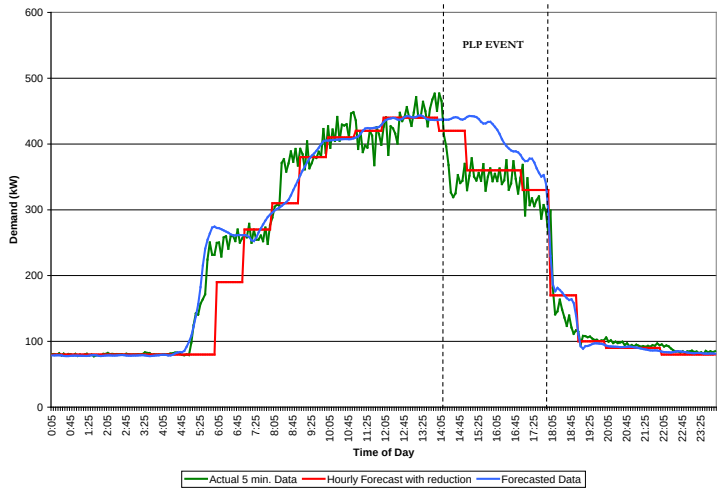
- Designed to be used from end-to-end (CAISO to end-use)
- Multiple sites





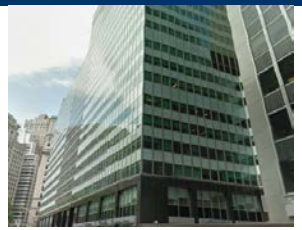
Participating Load Pilot – Cont.

- Transactions: kW reduction in load for market price
- Transacting Parties: CAISO and HVAC system, fully automated.
- Temporal Variability: Event driven. 4 second measurement and hourly settlement granularity
- Interoperability: OpenADR 1.0
- Value Assignment: DR is a price taker, value is CAISO market determined.
- Alignment of Objectives: Customer like short duration events. Opt-out available
- Stability Assurance: CAISO monitors and controls it.



Kiliccote, Sila, M. A. Piette, G. Ghatikar, E. Koch, D. Hennage, J. Hernandez, A. Chiu, O. Sezgen and J. Goodin. Open Automated Demand Response Communications in Demand Response for Wholesale Ancillary Services. Grid Interop. November 2009. LBNL-29-45E

Mandatory Hourly Pricing (MHP) in NY



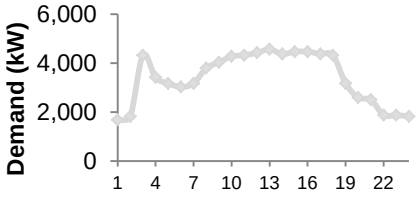
Metropolitan Transportation Authority

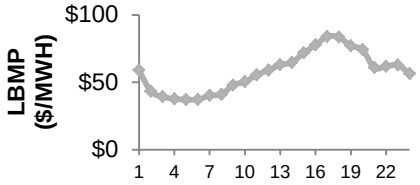
One World Financial Center

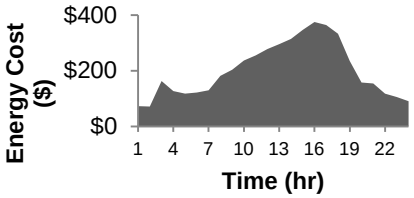
Paramount

New York University – Fairchild Building

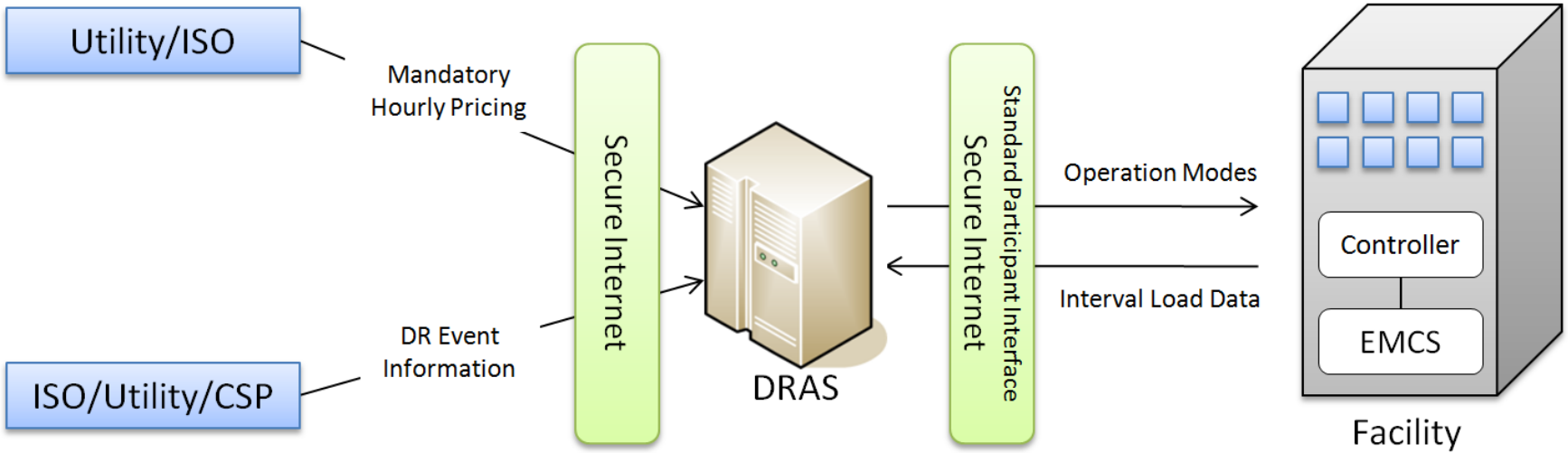
- Purpose: demonstrate OpenADR to support hourly price responsive demand for large customers in NYC
- Partners: LBNL, Honeywell, with review from NYISO & ConEd
- Methods: Optimal DR strategies
  - Energy Cost Minimization
  - Peak Demand Minimization





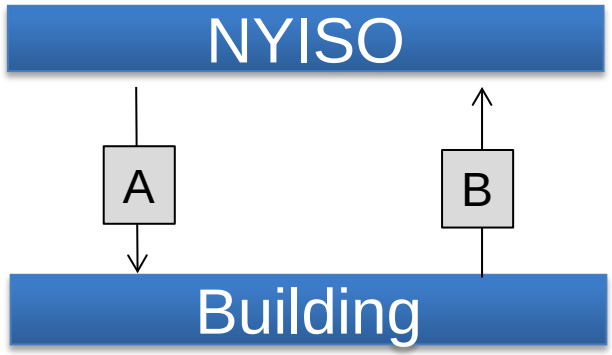


Mandatory Hourly Pricing in NY- Architecture



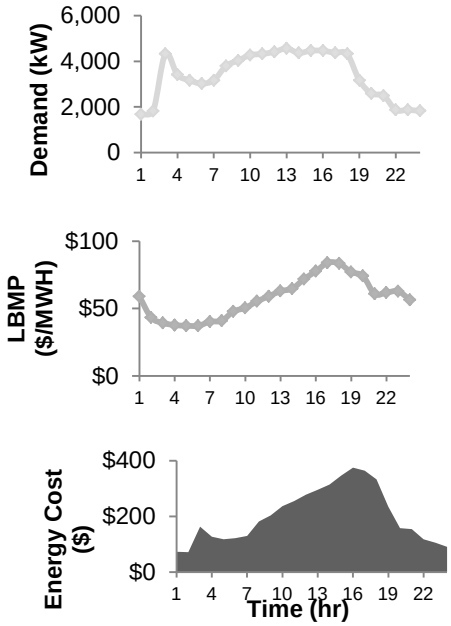
MHP in NY– Extent/Transactions/Parties

- Designed to be used from end-to-end (NYISO/LBMP to end-use)
- Multiple sites



A Day-ahead hourly prices

B Telemetry/Meter data



Participating Load– Cont.

- Transactions: kW reduction in load for market price
- Transacting Parties: Utility and HVAC system, fully automated.
- Temporal Variability: Hourly price driven. Hourly settlement granularity
- Interoperability: OpenADR 1.0
- Value Assignment: value of electricity reduced is loacational marginal prices
- Alignment of Objectives: Customers choose price thresholds for low power mode action
- Stability Assurance: NYISO monitors and controls it.

Set Demand & Cost Reduction Targets for the Month

- r = reduction rate (i.e., 1%, 2%, etc.)
  TDC = {1-r} * $\text{Max}_{1\le k\le N}\{DC_kP_k\}$
  TEC = {1-r} * $\sum\{EC_kP_k\Delta t\}$
  P = load (kW)
  t = time interval (i.e., 1 hr, 30 min, etc.)

Demand Limiting

- Sort P_k according to $\{DC_kP_k\}$.
  If TDC < {1-r} * $\text{Max}_{1\le k\le N}\{DC_kP_k\}$,
  for each k, apply *High Mode* to P_k if $\{DC_kP_k\}$ > TDC
  until TDC > {1-r} * $\text{Max}_{1\le k\le N}\{DC_kP_k\}$
  *Constraint: # *High Mode* ≤ 2 per Day

Price Response – Level I

- Sort Pk according to EC (=LBMP).
  If TEC < {1-r} * $\sum\{EC_kP_k\Delta t\}$,
  for each k, apply *Moderate Mode* to P_k
  until TEC > {1-r} * $\sum\{EC_kP_k\Delta t\}$
  *Constraint: # *Moderate Mode* ≤ 3 per Day

Price Response – Level II

- If TEC < {1-r} * $\sum\{EC_kP_k\Delta t\}$,
  for each k, apply *High Mode* to P_k
  until TEC > {1-r} * $\sum\{EC_kP_k\Delta t\}$
  *Constraint: # *High Mode* ≤ 2 per Day

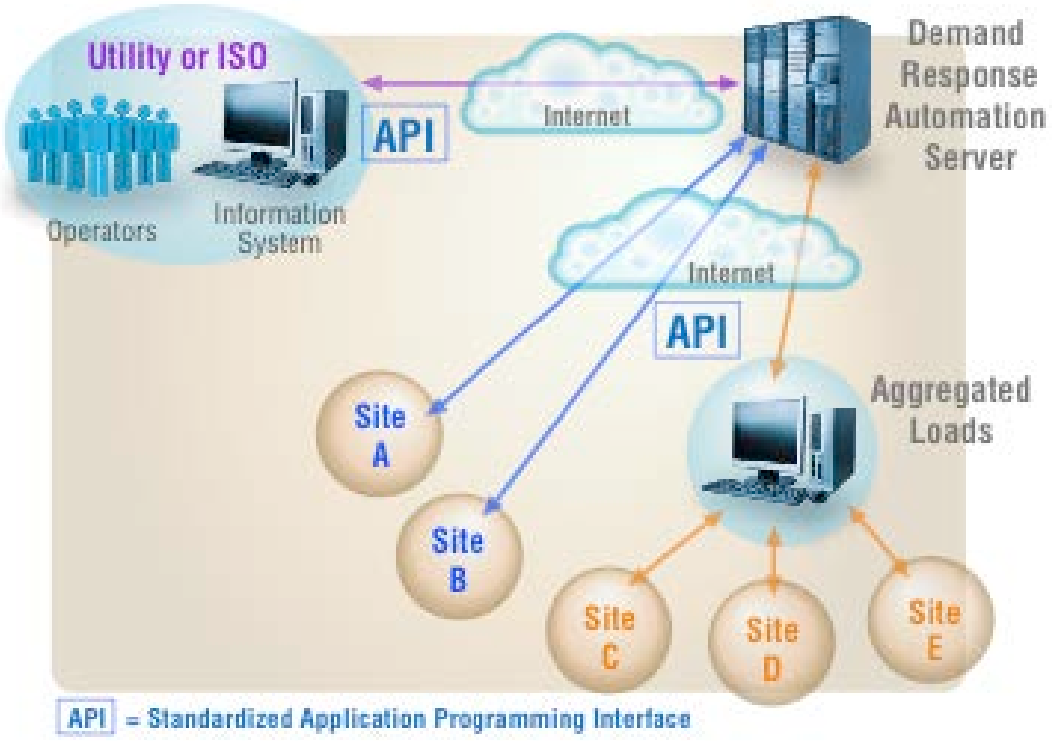
Automated Demand Bidding Program (AutoDBP)

- Offered to PG&E and SCE customers
- 100s of sites

Objectives:

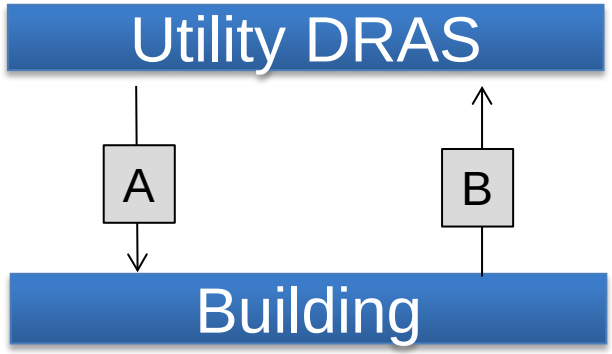
- Flexible, voluntary program with no penalties

Automated Demand Bidding Program- Architecture



AutoDBP– Extent/Transactions/Parties

- Designed to be used from end-to-end (utility to end-use)
- Multiple sites



A Event and bid

B Bid, Ack, Telemetry/Meter data

• **PG&E may issue day-ahead event under 1 or more conditions:**
• CAISO day-ahead load forecast exceeds 43 GW;
• CASIO issues an Alert or higher level notice;
• Forecasted temp for Load Zone exceeds temp threshold for Load Zone; or
• PG&E forecasts that generation resources or electric system capacity may not be adequate.

AutoDBP– Cont.

- Transactions: Auto-bid (kW) Auto-shed kW reduction in load fixed price ($0.50/kWh)
- Transacting Parties: Utility and end uses, fully automated.
- Temporal Variability: Event driven. Hourly settlement granularity
- Interoperability: OpenADR 2.0b
- Value Assignment: fixed pre-set value for DR
- Alignment of Objectives: Flexible duration, voluntary participation, opt-out available
- Stability Assurance: utility monitors and controls it through scheduling events.

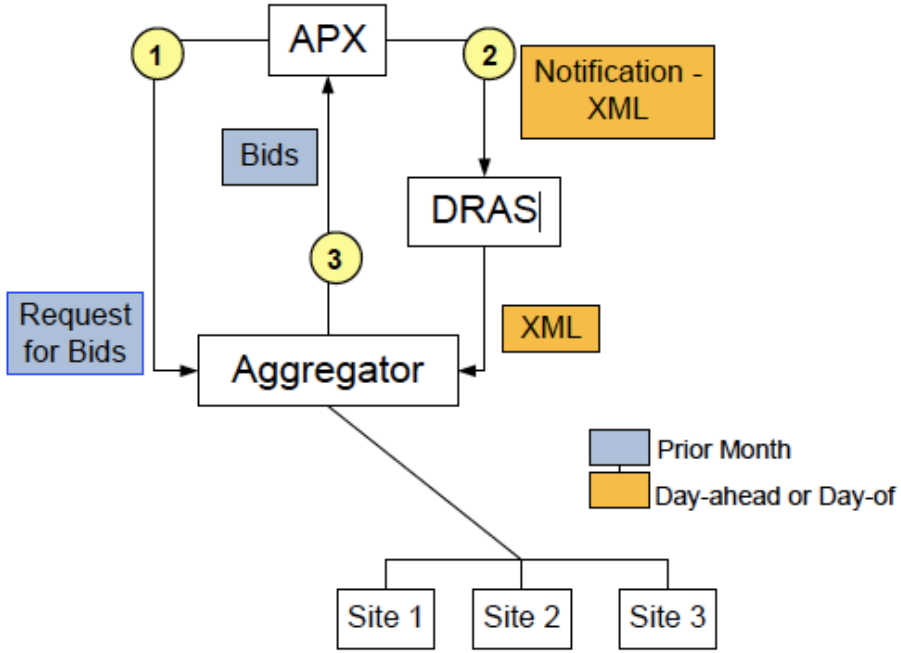
Automated Capacity Bidding Program (AutoCBP)

- Offered to PG&E and SCE customers
- 100s of sites

Objectives:

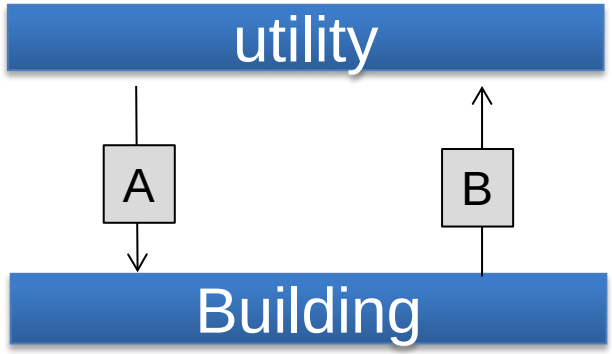
- Flexiblilty,
- Allows aggregation
- Customers are available to provide DR as a capacity resource

Automated Capacity Bidding Program (AutoCBP)



AutoCBP – Extent/Transactions/Parties

- Designed to be used from end-to-end (utility to end-use)
- Multiple aggregated sites or self aggregated participants



A Event and bid

B Bid, Ack, Telemetry/Meter data

AutoCBP – Cont.

- Transactions:
  - Auto-bid (kW) Auto-shed kW reduction in load fixed price
  - Capacity and energy payments
- Transacting Parties: Utility and end uses, fully automated.
- Temporal Variability: Event driven. Hourly settlement granularity
- Interoperability: OpenADR 2.0b
- Value Assignment: fixed pre-set value for DR
- Alignment of Objectives: Flexible duration, voluntary participation
- Stability Assurance: utility monitors and controls it through scheduling events.

Thank you.

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