Price-Based Grid Coordination

A **Simple** and **Universal** Mechanism for Grid/Customer DER Co-optimization

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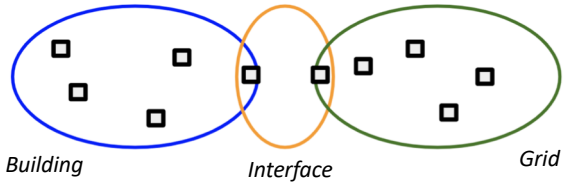
Context

- Customers and grid need to coordinate about energy to balance supply and demand
- Customer/grid interface should be as simple as possible
  - Isolate complexities of building and grid from each other
  - Simplest adequate solution is usually the best
- Need universal mechanism; for all
  - Building types
  - Application contexts
  - Countries

$/kWh

Internals of building and grid are hidden from the other

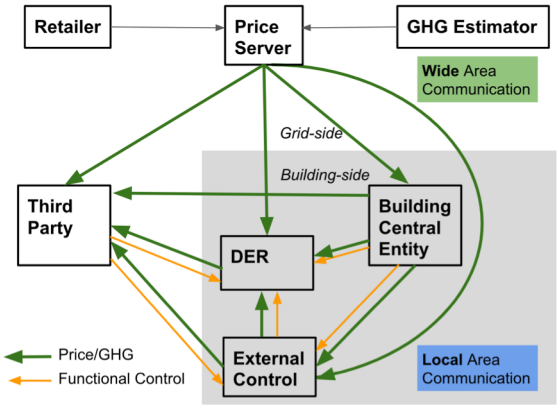


All other grid coordination mechanisms are more expensive and lower performing { Direct Load Control, TOU, CPP/VPP, Aggregators, 2-way Transactive, …

What is PBGC?

- System architecture: *Who* talks to *Whom* about *What*
- Data model for structure of information exchanged
- Identification of key communication technologies
- Enables multiple paths and locations of intelligence to translate prices to functional control
- Facilitates "local prices" for GHG optimization and other purposes

PBGC System Architecture



Key Concepts

Retailer	Organization that the customer pays for electricity service
Price Server	Device that broadcasts prices over multiple communication paths
GHG Estimator	Organization that estimates marginal greenhouse gas emission rates
Third Party	Organization outside the customer site (cloud-based) tha provides functional control commands to the DER, taking price into account
DER	Distributed energy resource within a customer site; flexible loads, thermal or electric storage, dispatchable generation, and EV charging
Building	Device that takes in price information and distributes prices
Central Entity (BCE)	and/or functional controls to multiple DER
External Control	Hardware device serving and directly connected to a single DER
Prices	Static metadata - retailer ID, tariff ID, etc. Time series data - Prices (import and export), Marginal greenhouse gas emissions, Emergency Alerts
Functional Control Signal	Device operation commands such as for setpoints, on/off level control, etc.

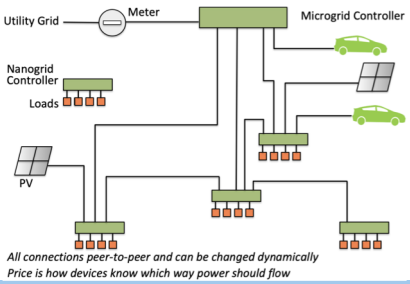
Dynamic Capacity Management

- Customers subscribe to capacity that non-bursty loads never exceed
- EVs (e.g.) modulate to keep entire site under that limit
- Reservations for additional capacity can be requested – may have fee

Highly Dynamic Prices

- At least hourly
  - Periods no less than 5 minutes
- Set no farther in advance than the day before
- Different every day
- Can be guaranteed or forecast

'Real-Time Price' implies narrow calculation from wholesale price



All connections peer-to-peer and can be changed dynamically
Price is how devices know which way power should flow

Local Power Distribution "Networked Electricity"

- Apply appropriate lessons from success of Internet technology
- Self-organizing microgrids composed of modular microgrids
- Any application context – ANY
- Exchanges all based on price, quantity, capacity

OpenADR 3.0

- **Universal** standard for DR communication
- **Simple**, modern (REST / JSON)
- Suitable for WAN and LAN contexts and integration into **any** device

Local Prices / Building Gateways

- Availability of electricity in customer site can diverge from that on grid
  - Differential import/export, adding GHG emissions, capacity constraints, microgrid operation
- Price is a unit of measurement, like *kg* or *m*; they do not have to be used in cash exchange
- Flexible loads optimize to price – don't need to know/care if it is local
- Many reasons to separate WAN and LAN technologies

Related Activities

- The California Energy Commission has Load Management Standards, Flexible Demand Appliance Standards, and the MIDAS price distribution system
- The California Public Utilities Commission has the CalFuse proposal to require electricity rates to be simple, dynamic, and grid responsive
- Lawrence Berkeley National Laboratory hosts the California Load Flexibility Research and Development Hub (CalFlexHub) which is advancing PBGC
- California large utilities are conducting pricing pilots

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CalFlexHub

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