Distributed energy resource services and pricing: A Caltech perspective (Adam Wierman)
Goal:
under generation ⇔ demand response
over generation ⇔ storage
time variability ⇔ balancing energy

The Pricing Predicament
What new wholesale DR/DER services should be offered?
... how should they be incorporated into the market?
... and how should they be priced?
**Wholesale market prices**

<table>
<thead>
<tr>
<th>Capacity</th>
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<tbody>
<tr>
<td>Seasonal Cap-zones</td>
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**Goal:** Extracting costs & incentivize “good behavior”

**Retail Energy Rates**

- Tiered
- Time-of-use
- Coincident-peak-pricing
- Real-time-pricing
- Net-metering

**Consumers**

- Utility Owned Assets
- Industrial
- Commercial
- Generation
- Electric Storage
- Transportation
- Thermal Storage
- Residential
**Wholesale market prices**

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  - Seasonal
  - Cap-zones

- **Energy**
  - Day-ahead
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Wholesale market prices

- Capacity: Seasonal, Cap-zones
- Energy: Day-ahead, Real-time, Locational
- Reserves: Day-ahead, Real-time, Zonal
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Wholesale DR/DER services

- Balancing energy
- Ramping
- Capacity (Seasonal)
- Ancillary Services (reserves, regulation)

DR/DER Services

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**Goal:** Provide dispatchable energy services

**DR/DER Rates**

- Real-time-pricing
- Pay-for-performance
- Fixed incentive
- Coincident-peak-pricing
- Contract-based
- Credits for service

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**Goal:** Extracting costs & incentivize “good behavior”

Wholesale DR/DER services

- **Balancing energy**
- **Ramping**
- **Capacity (Seasonal)**
- **Ancillary Services**
  - Energy (DA/RT/Locational)
  - (reserves, regulation)

**Goal:** Provide dispatchable energy services

Separation of services

Retail Energy Rates

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**DR/DER Rates**

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Forecasts
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(A few) Key Challenges

1) Consumer-side challenges

2) Social challenges

3) Utility-side challenges

4) Economic challenges
(A few) Key Challenges

1) Consumer-side challenges
   → Participation must be seamless (& profitable) for the consumer
   → Wide-spread participation requires aggregators/intermediaries

2) Social challenges
   → Avoid “energy poverty” & the “utility death spiral”
   → Direct control vs. voluntary participation

3) Utility-side challenges
   → Scalability & decentralized control

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...they have significant flexibility
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500 kW-100 MW each
Usage is growing fast

Load can be delayed and/or moved geographically

- 10% of consumption can be shed in 20min
- 5% of consumption can be shed in 2 min

[LBNL 2-year case study]

Backup generators & storage are typically on-site
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...big overhead to prepare for active participation
...sophisticated programs viewed as too “risky”
...not convinced of profitability of programs

Our research fights these stereotypes
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**Our view:** Data centers are a great test case for any new market architecture
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- Increased transmission & distribution infrastructure
- Increased electricity rates
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The goal: Understand how significant this feedback is and understand what tariff/DR structures mitigate this feedback?
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Traditional electricity markets: Danger of market manipulation is extreme

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The goal: Develop new measures for market power that are appropriate DER/DR & incorporate the transmission system
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