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Lessons from the California Demand Response Potential Studies and Flexible Demand Appliances

SB 49 Workshop

Mary Ann Piette

Demand Response Research Center
Energy Technologies Area
Lawrence Berkeley National Laboratory
Dec 14, 2020

Research sponsored by the Calif PUC and the DOE Building Technologies Offices
Agenda

◆ Introduction to Demand Response Potential Studies
  □ Phase 1 and 2 – Shape, Shift, Shed and Shimmy (2016-2018)
  □ Phase 3 – Shift – included electrification (2019-2020)
  □ Phase 4- will include residential appliances (2020-2022)
◆ Cost Data for Connected Devices
◆ Summary and Future Directions
Growing Challenge
Curtailment Increases Every Year

CAISO Daily Average Curtailment

Season
- Winter
- Spring
- Summer
- Fall

Average Curtailled Renewable Energy (GWh / Day)

> 5 GWh/day in spring 2019
Memorial Day 2019 curtailment reached 40 GWh
DR Potential Study Objectives

◆ Evaluate potential for DR to meet California’s resource planning needs and operational requirements

◆ Provide analysis to support DR policy based on a bottom-up model
  - “Order Instituting Rulemaking to Enhance the Role of Demand Response in Meeting the State’s Resource Planning Needs and Operational Requirements” (13-09-011)

◆ Identify opportunities for DR products and programs to assist in meeting long-term clean energy goals

◆ Evaluate opportunities for electrification and load shifting
DR Service Types Providing Grid Needs

Shed Service: Peak Shed DR

Shift Service: Shifting load from hr to hr to alleviate curtailment/overgeneration

Shimmy Service: Load Following & Regulation DR
End-use disaggregation & forecasting

Phase 3 end-uses modeled

<table>
<thead>
<tr>
<th>Sector</th>
<th>End use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>Plug loads</td>
</tr>
<tr>
<td></td>
<td>Pool pumps</td>
</tr>
<tr>
<td></td>
<td>Space cooling</td>
</tr>
<tr>
<td></td>
<td><strong>Space heating</strong>*</td>
</tr>
<tr>
<td></td>
<td><strong>Water heating</strong>*</td>
</tr>
<tr>
<td></td>
<td>EV charging</td>
</tr>
<tr>
<td></td>
<td>Other</td>
</tr>
<tr>
<td>Commercial</td>
<td>HVAC</td>
</tr>
<tr>
<td></td>
<td>Lighting</td>
</tr>
<tr>
<td></td>
<td>Refrigeration</td>
</tr>
<tr>
<td></td>
<td>EV charging</td>
</tr>
<tr>
<td></td>
<td>Other</td>
</tr>
<tr>
<td>Industrial</td>
<td>Process</td>
</tr>
<tr>
<td></td>
<td>Pumping</td>
</tr>
<tr>
<td></td>
<td>Other</td>
</tr>
</tbody>
</table>

Additions for Phase 4
- Residential appliances
- Commercial space heating
- Commercial water heating

*Electrification estimates new in Phase 3

Source: CPUC Working Group on Load Shift January 31, 2019
DR Site Enablement Cost Categories

- **Fixed** initial **communication and hardware costs** for controllability “per site” for given end-use or customer premise. Costs included are telemetry, communication resource interface, and installation costs. Reported in $ per site.

- **Variable** initial **costs for control technology** for controllability “per kW” (e.g., HVAC and retail lighting controls). Reported as $ per kW enabled for DR services.

- **Fixed** initial **end-use control technology and communication costs** for achieving controllability “per end-use”. Costs are specific to Electric Vehicles and the Residential sector end-uses and are reported as $ per end-use enabled for DR services.
Residential DR Site Enablement Costs

Further work needed to collect and compare these costs for various appliances
Forthcoming Report - Grid Interactive Efficient Buildings Technologies

Data Report

Presented to: Berkeley Laboratory
Prepared by: Guidehouse Inc.

September 30, 2020

Will include costs for smart, connected technologies.
### Example of Data from Guidehouse - Residential Central AC/Smart Thermostats

<table>
<thead>
<tr>
<th>DATA</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Current Standard</strong></td>
<td>36</td>
<td>36</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td><strong>Typical SEER</strong></td>
<td>15.0-16.0</td>
<td>15.2-16.0</td>
<td>15.2-16.0</td>
<td>15.2-16.0</td>
</tr>
<tr>
<td><strong>South: 18 North: 24</strong></td>
<td>8-10</td>
<td>8-10</td>
<td>8-10</td>
<td>8-10</td>
</tr>
<tr>
<td><strong>Retail Equipment Cost (2020$)</strong></td>
<td>2,771</td>
<td>3,007</td>
<td>3,007</td>
<td>3,007</td>
</tr>
<tr>
<td><strong>Total Installed Cost (2020$)</strong></td>
<td>4,344</td>
<td>4,597</td>
<td>4,597</td>
<td>4,597</td>
</tr>
<tr>
<td><strong>Annual Maintenance Cost (2020$)</strong></td>
<td>21</td>
<td>21</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td><strong>Reported Energy Savings</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Typical Capacity (kBTU/hr)**

- 36
- 36
- 36
- 36
- 36
- 36
- 36
- 36

**SEER**

- South: 14.0
- North: 13.0
- South: 18
- North: 24
- 15.0-16.0
- 15.2-16.0
- 15.2-16.0
- 15.2-16.0
- 15.2-16.0
- 15.2-16.0

**Average Life (yrs.)**

- South: 18
- North: 24
- 8-10
- 8-10
- 8-10
- 8-10
- 8-10
- 8-10

**Retail Equipment Cost (2020$)**

- 2,771
- 2,845
- 3,007
- 3,007
- 3,007
- 3,007
- 3,007
- 67

**Total Installed Cost (2020$)**

- 4,344
- 4,597
- 4,597
- 4,597
- 4,597
- 4,597
- 4,597
- 167*

**Annual Maintenance Cost (2020$)**

- 21
- 133
- 133
- 133

**Reported Energy Savings**

- 7%
- 7%
- 7%
- 7%
- 7%
- 7%
- 7%
- 10%
- 10%
- 10%
- 10%
- 10%
- 10%
Phase 2 Shed Technology $200/kW Price Referent
2025 Medium Case

PG&E total: 3.0 GW
SCE total: 2.9 GW
SDG&E total: 0.24 GW

Total Medium Scenario: 6.1 GW
Participating vs. Shift Potential - SB49 Should Increase Customer Participation Rates

Technology cost and performance levels constrain how much shiftable load is accessible.

DR-Path includes a customer participation model based on historical participation, which curtails participation. New engagement models may help.

These GWh-yr are available each day
Sometimes twice a day
Residential Appliances

- **Phase 4 study will include**
  - Refrigerator
  - Freezer
  - Washer and Dryer
  - Dishwasher
  - Domestic Hot Water

- **Data from CEC 2019 load shape study by ADM Associates**
  - Residential end use load shapes
  - Modeled across 12 climate zones in CA
  - Data normalized by sector, building type and end use

Sample load shape for refrigeration end use
Summary and Future Directions

- Flexible loads are critical to support California’s clean energy policies.
- New efforts to model flexible appliances will quantify the value of load shedding and shifting.
- New sources of data are becoming available to understand the costs and benefit of load flexible technologies.

References

https://buildings.lbl.gov/potential-studies

(Covers DR Potential Studies - Phases 1, 2 and 3)


Demand Response Advanced Controls Framework and Assessment of Enabling Technology Costs

Thank you!