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Filer:	Gabriel Taylor
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Load Management Standards Economic Analysis

Gavin Situ, P.E., Existing Buildings Office, Efficiency Division

Date: April 12, 2021

Cost-Effectiveness

The standards shall be cost-effective when compared with the costs for new electrical capacity

PRC 25403.5 (Warren Alquist Act)

Problem Statement

Is Load Management Standard more cost effective than batteries?

Cost-Effectiveness: Levelized Cost of Storage Metric

Levelized Cost of Storage (LCOS)

- Measure lifetime costs divided by lifetime energy production
- Allows the **comparison** of different technologies of unequal life spans, project size, cost, return, and capacities—in this analysis, LMS vs. Battery

LCOS of LMS ($/MWh) < LCOS of Batteries ($/MWh)

Summary of Findings

With an investment of $14.2 million on LMS over 15 years, under a very conservative estimate:

- Residential behind the meter (BTM) battery owners will save $81 million in charging costs
- Peak hour load can be reduced by 1800GWh over 15 years, freeing up equal amount of electrical capacity
- LCOS of LMS -$37/MWh
- LCOS of LMS is smaller than LCOS of Battery ($80/MWh to $110/MWh)

LCOS

LCOS of LMS

$$\text{LCOS of LMS} = \frac{\text{Net Cost of LMS}(\$)}{\text{Energy Shifted}(\text{MWh})}$$

$$= \frac{\textbf{Cost of LMS} - \textbf{Res Battery Charge Optimization}}{\textbf{AC Peak Load Shift}}$$

LCOS of BATTERY

$80/MWh to $110/MWh (primary source: Lazard)

LCOS

$$LCOS\ of\ LMS = \frac{\boldsymbol{Cost\ of\ LMS}(\$)}{Energy\ \ Shifted(MWh)}$$

Numerator: what should be counted as cost of LMS

- The net present value of the cost of LMS over 15 years **Cost of LMS**
- minus the financial value of additional benefits, cost reduction, and cost avoidance that LMS can achieve while batteries can **not**

Focus on the reduction of charging cost for residential behind the meter (BTM) batteries optimized by LMS

Res Battery Charge Optimization

LCOS

$$LCOS\ of\ LMS = \frac{Cost\ of\ LMS(\$)}{\boldsymbol{Energy\ Shifted(MWh)}}$$

Denominator: The peak hour energy consumption (MWh) shift enabled by LMS

- Focus on one end use: Air Conditioning

AC Peak Load Shift

Cost of LMS

Assumptions and results

Item / Activity	Entity	Development & Implementation	Annual Maintenance	15-Year NPV†
Automation Server (MIDAS)	CEC	$30,000	$15,000	$210,000
Billing System	Utilities	$3,750,000	$75,000	$4,630,000
Rates Reporting	Utilities	$150,000	$75,000	$1,030,000
Customer Education	Utilities	$750,000	$375,000	$5,160,000
ASP Authorization	Utilities	$150,000	$75,000	$1,030,000
ASP Software Upgrades	ASPs	$300,000	$150,000	$2,060,000
Total		**$ 5,130,000**	**$ 765,000**	**$ 14,120,000**

Cost of LMS

Which Price to Value Electricity

Locational Marginal Price (LMP):

1. Best represents the time-dependent marginal cost of electricity consumption
2. Fundamental cost saving of load shift
3. LMP has carbon pricing component built-in
4. Total LMP saving is the aggregate saving, TOU rate is mechanism to divide the savings

Res Battery Charge Optimization

LMS
+
Battery Management Apps

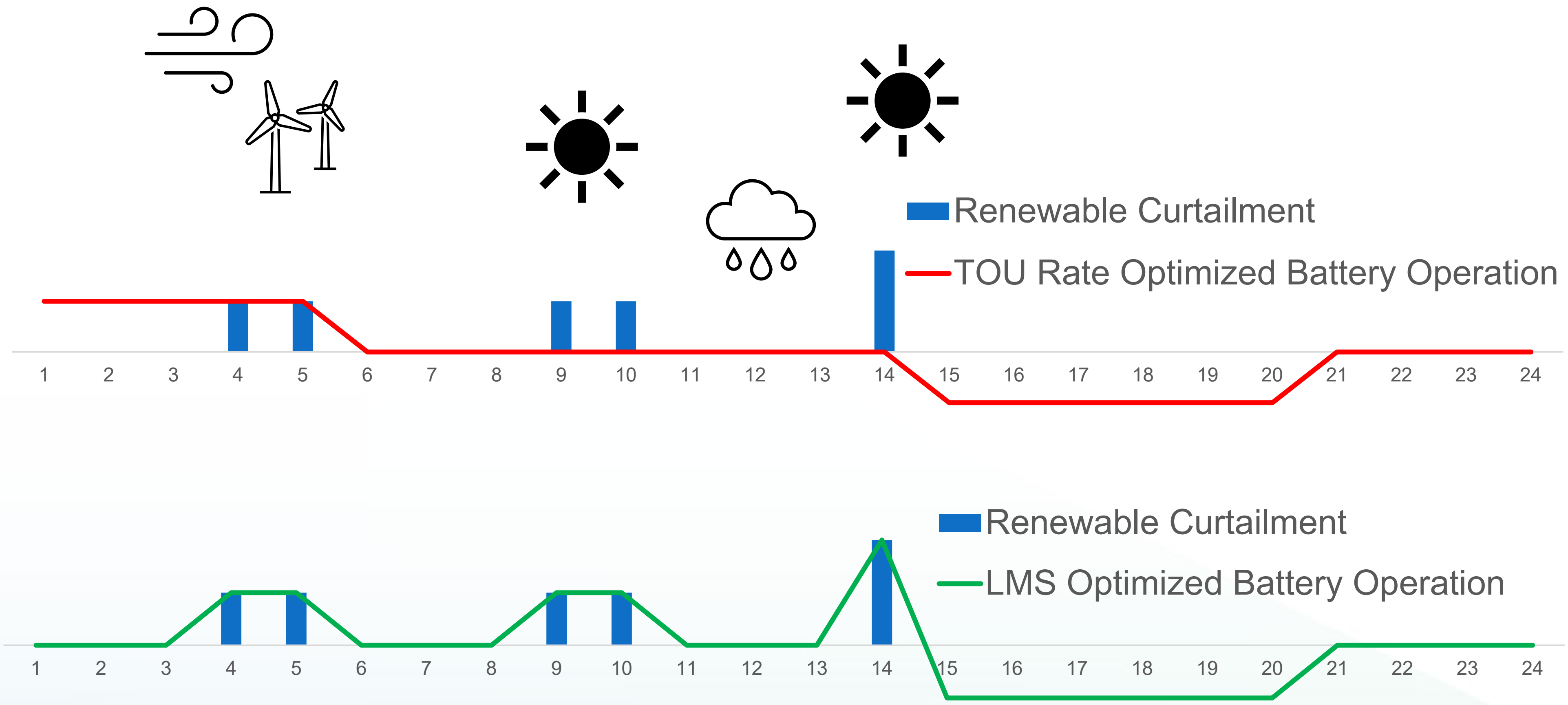
Operation Before

1. Discharge during peak hour
2. The charging is **complicated:**
   - Current TOU rates incentivize charging at night
   - Federal tax incentive requires charging by renewables, but the incentive quickly declines to 10% 2020 onward, and enforcement unclear
   - SGIP requires participants charging when GHG signal is low

Operation After

1. Discharge during peak hour
2. Smart and optimized charging whenever curtailment would otherwise occur

Res Battery Charge Optimization



Net benefits

1. Reduce charging cost
2. Reduce renewable curtailment
3. No additional load shift benefit

Res Battery Charge Optimization

Assumption, Approach, and Data Source

1. Use CEC's 2020-2030 demand forecast and calculate implied total capacity of Res BTM Battery in 2025

   Result: 758MWh daily charging capacity in 2025

2. Same 2025 forecast data also suggests that this capacity happens to be able to with reduce renewable curtailment to near zero, **IF** they all charge using renewables
3. Assume, Res BTM battery moves away from **indiscriminate** night charging, and maximize charging by curtailed renewables, up to the total capacity of Res BTM Battery
4. Calculate annual total curtailment charging. Results: 198,000 MWh

Res Battery Charge Optimization

5. Every MWh charged with curtailed renewables is valued at **$0 LMP**
6. Every MWh previously charged by non-curtailed energy at night is valued at average 2019 night time LMP
7. Calculate 2019 average night time LMP based on publicly available CAISO 2019 LMP data Result: 34.3$/MWh
8. Calculate annual cost saving

$$\begin{aligned} Cost\ Saving &= Annual\ total\ curtailment\ charge * \Delta LMP \\ &= 198{,}000 MWh * 34.3\ \$/MWh \\ &= \$6.8\ million \end{aligned}$$

9. To be conservative, we disregard the future increase of battery capacity. Net present value of 15 years of annual cost saving: **$~81 million**

Res Battery Charge Optimization

AC Peak Load Shift

LMS
+
Advanced Thermostat

Operation Before
Unmanaged use, high coincidence with peak hour

Operation After
Intelligent precooling during off peak as desired; Shed during peak

AC Peak Load Shift

Net benefits

1. Peak cooling load reduced to almost zero
2. Intelligent pre-cooling utilizes near zero cost renewables

AC Peak Load Shift

$$C_{AC} = E_{AC,Peak} rmp$$

- C_{AC} : **AC Peak Load Shift**, achieved by advanced thermostat with LMS feeding price information
- $E_{AC,Peak}$: Statewide peak Hour cooling load by location. data source: CEC Energy Assessment Division
- r: Reduction of peak hour cooling load. $r = 90\%$ (based on multiple studies and modeling)

AC Peak Load Shift

$$C_{AC} = E_{AC,Peak} rmp$$

- m: **Current** market share of advanced thermostat. $m = 13.8\%$

  Advanced thermostats currently have 13.8% market share in CA (Source: Ecobee/Statista)

  Same per capita advanced thermostat ownership across CA

- p: Participation rate by advanced thermostats. $p = 26\%$ (Source: Ecobee)

  Advanced thermostat owner in Hot Summer Area has 50% participation rate

  Advanced owner in Mild Summer Area has 20% participation rate

- $mp = 13.8\% \times 26\% = 3.6\%$, very low and conservative percentage of overall population participating

AC Peak Load Shift

Results

1. Annual peak period energy consumption shifted: 120 GWh
2. 15-year energy consumption shifted: **1800 GWh** AC Peak Load Shift
3. Summer months average daily peak period cooling load reduction: 200 MW

LCOS

$$\text{LCOS of LMS} = \frac{\text{Cost of LMS(\$)}}{\text{Energy Shifted(MWh)}}$$

$$= \frac{\textbf{Cost of LMS} - \textbf{Res Battery Charge Optimization}}{\textbf{AC Peak Load Shift}}$$

$$= \frac{\$14 \text{ Million } - \$81 \text{ million}}{1800\ GWh}$$

$$= -\$37/WMh$$

$$< \$80/WMh(Battery\ LCOS)$$

Brief Discussion about Heat Pump Water Heater

1. Heat Pump Water Heater (HPWH) is expected to play a big role in decarbonization and load management soon
2. Current installation of HPWH is low - communicating HPWH even lower
3. Using current installation numbers (consistent with AC analysis), 15-year total energy consumption shifted is estimated to be approximately 100 GWh
4. Not considered for now due to its relatively small magnitude (less than 5% of AC shift)
5. Not included in the draft staff report

Q&A

Result Summary

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