

# DERs and Capacity Expansion

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ESIG System Expansion Modeling Workshop

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Powering forward.  
Together.





# Overview

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- SMUD's 2030 Zero Carbon Plan
- IRP Capacity Planning Tools, Data, Processes
- Incorporating DERs into Capacity Expansion
- Pricing Evolution and Implications in Resource Plan







### Repurpose natural gas generation

Replace 2 power plants with renewable and storage resources and retool remaining 3 to minimize emissions.



### Expand proven clean technology

Grow SMUD's renewable and battery storage by 3.5x. Support customer's resources via solar and battery storage.

~\$2 billion investment



### Pilot & scale new technology and business models

Increase education and demand flexibility, spread adoption of customer-owned virtual power plants & invest in grid-scale technology.



Pursue grants, partnerships and limit rate impacts



### Maximize community benefits

Stay affordable and reliable, improve air quality and overall community health while supporting under-resourced communities.

~\$2.5 billion investment

Goal:

Eliminate CO<sub>2</sub> from SMUD's power supply

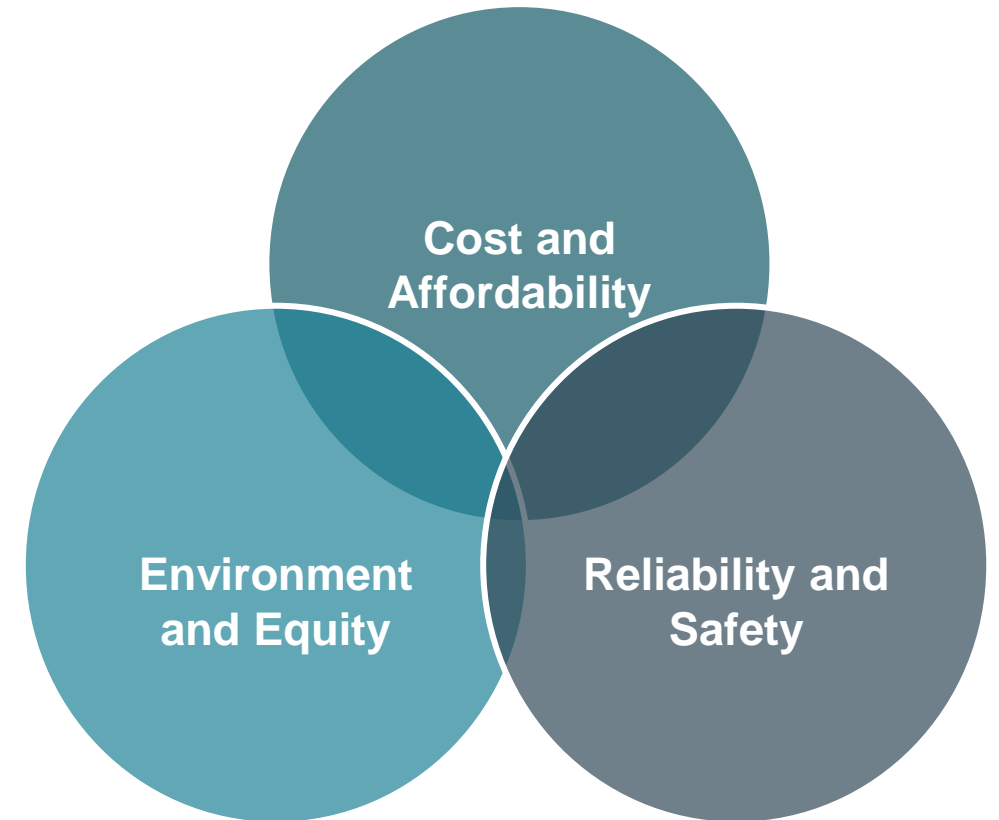
Zero carbon by 2030

Create thousands of new regional clean tech jobs

# IRP Background & Approach

- SMUD has maintained an Integrated Resource Planning process since the 1980s.
- SMUD IRP Updates Today:
  - **Internal Updates:** Annual updates, progress reporting and refinements as needed (ZCP Refresh)
  - **External Updates:** SB350 (2015) required POU's to begin filing IRPs publicly with the California Energy Commission (CEC) starting in 2019 (and at least every 5 years there after)
    - **1<sup>st</sup> Public IRP:** SMUD went through its first comprehensive IRP **public process** in 2018; filed with the CEC in April 2019.
      - Prior to this, SMUD's IRP updates were internal, with annual progress reports under SD9
    - **2<sup>nd</sup> Public IRP (2030 ZCP):** SMUD filed its second SB350 IRP filing with the CEC in September 2022
    - **3<sup>rd</sup> Public IRP (2030 ZCP Refresh):** We kick off a public process in ~2026 to develop and gain Board approval of our new IRP; need to file with the CEC by September 2027.

## SMUD's Main IRP Pillars



# IRP Modeling

## Capacity Expansion Modeling

Uses optimization techniques to identify a least-cost portfolio of resource investments to meet future reliability and clean energy objectives. SMUD has used RESOLVE, SERVM & PLEXOS as capacity expansion modeling tools.

## Reliability Study

Loss-of-load probability model that provides a detailed and statistically robust perspective on electric systems that rely on a combination of conventional, renewable, storage and demand-side resources. Procure capacity capable of meeting normal peak load conditions plus a 17.5% planning reserve margin (PRM). SMUD utilizes RECAP and SERVM as its main reliability analysis tools.

## Production Cost Modeling

Hourly simulation of the power system to develop an economic dispatch simulation. PLEXOS has been SMUD's PCM tool of choice for a number of years.

# Capacity Expansion Modeling

## Capacity Expansion Modeling Considerations

**SMUD's Zero Carbon Plan was created using RESOLVE**

A number of constraints were put in place to eliminate unrealistic results:

- New resource potential (realistic assumption on new resource type and magnitude available to SMUD)
- GHG constraint to limit thermal generation and spot market purchases
- Transmission line limits
- Demand side assumptions such as DR program, BTM battery dispatch assumptions
- RPS requirements

**The optimization results are typically refined through an iterative process:**

- Resource cost adjustments, system reliability modifications, etc.

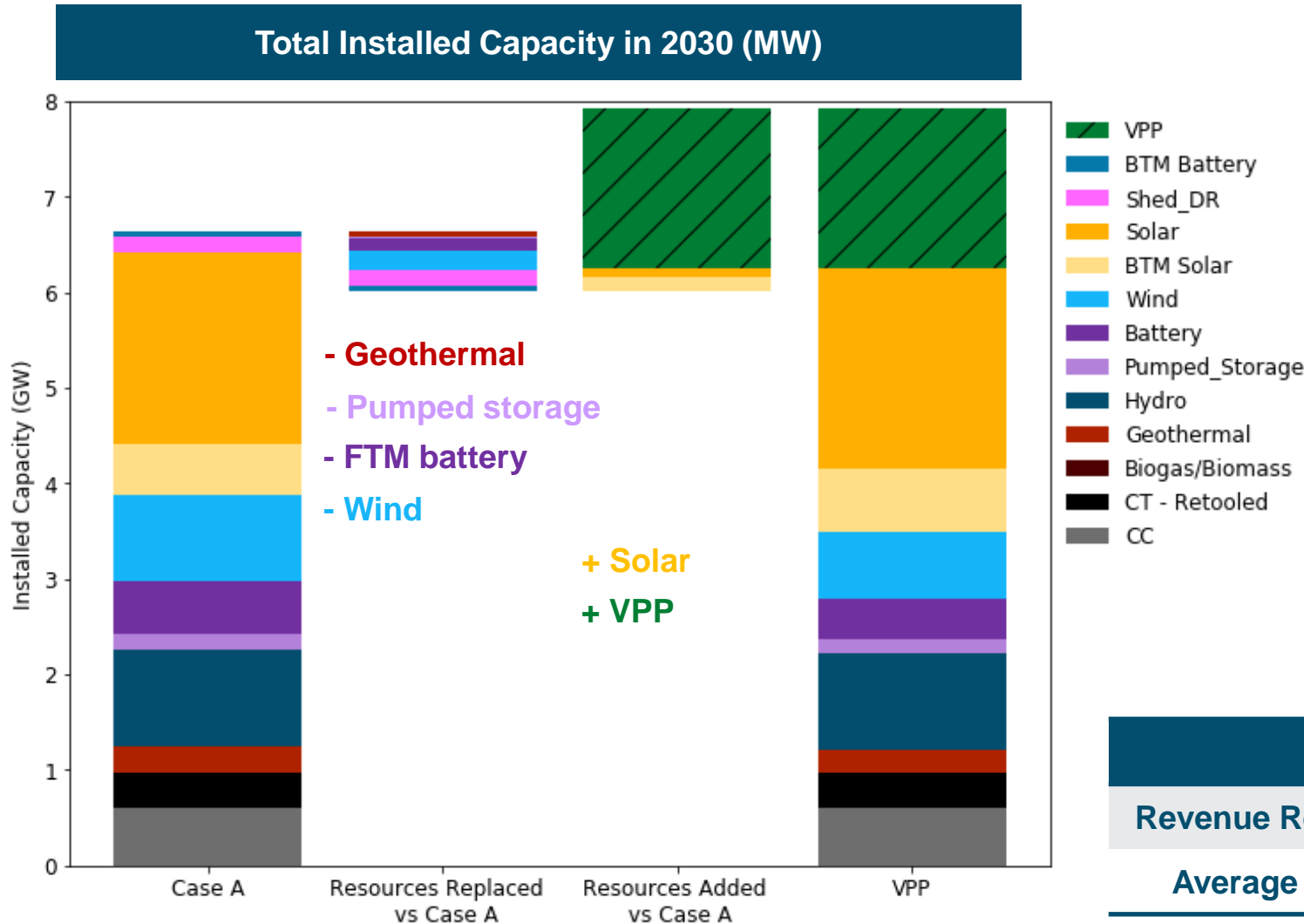
**• Model Inputs:**

- load, distributed generation forecasts, electrification adoption, committed resource schedules and pricing (renewables/storage/new tech, etc.), generic resource pricing, market price forecasts (electricity, gas, carbon etc.), system updates, existing thermal fleet changes, hydro generation expectation, DR program growth, etc. Integrated Distributed Resource Planning considerations

# Evolving DER Considerations for Capacity Expansion



# VPP's in SMUD's Zero Carbon Plan – E3 Analysis Summary (2021)



+ ~ 1.7 GW of VPP resources are selected by 2030

- Geothermal, wind, and some pumped hydro and FTM batteries are replaced by VPP resources
- VPP provides additional diurnal flexibility which helps integrate solar resources

+ The VPP saves \$1.9B in system costs by avoiding expensive resource builds

- Average rate is reduced by 0.9 ¢/kWh when VPP resources are available

+ The VPP resource provides energy and capacity benefits

- Ancillary services provision was explored through a sensitivity

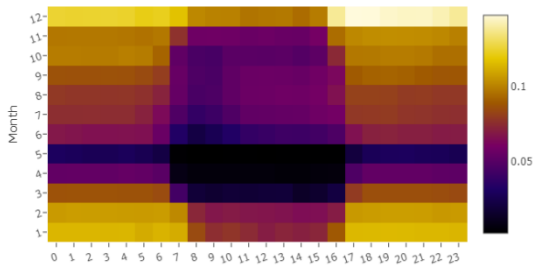
	Base Case	With VPP	Savings
Revenue Req (PV)	\$34.5 B	\$32.6 B	\$1.9 B
Average Rate	17.4 ¢/kWh	16.5 ¢/kWh	0.9 ¢/kWh



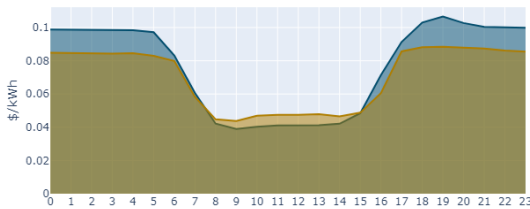
# Novel Modeling Approach

	Step 1: SMUD's Avoided Cost Streams	Step 2: Calculate Resource Cost	Step 3: Technology Characteristics	Step 4: Capacity Expansion Modeling
<b>Approach</b>	SMUD AC streams and tailor to Case A Results	Make the customer whole and include only VPP incremental costs	Maximize flexibility without customer disturbance	Model with SMUD's 2030 carbon goal defined by Case A + Additional EE
<b>General</b>	<ul style="list-style-type: none"> <li>Energy: E3's market price forecasts</li> <li>CO2 &amp; System Capacity: SMUD Case A</li> <li>Dist Capacity: 2021-25, planned capital investments. 2026+, Rate Costing study</li> <li>AS: Savings based on SMUD's reserve requirements through NWPP</li> </ul>	Resource Cost: <ul style="list-style-type: none"> <li>SMUD VPP Admin Costs</li> <li>+ Customer Incentives</li> <li>+ VPP Tech Cost</li> <li>- Additional Distribution Benefits</li> </ul>	<ul style="list-style-type: none"> <li>Need for communications &amp; telemetry equipment for Solar + Storage and EVs.</li> <li>Unique NQC and ELCC values for each resource</li> <li>Smoothed shapes with underlying diverse tech and behavior representation</li> </ul>	New RESOLVE functionality for Demand Response resources
<b>Details</b>	Bulk Sub 9 – BULKHUR Weighted average distribution deferral value of all DPAs	<ul style="list-style-type: none"> <li>SMUD VPP Admin: <i>Provided</i></li> <li>Incentive: <math>\frac{\Delta \text{Customer Benefit under VPP}}{\text{Tech Capacity}}</math></li> <li>VPP Tech Cost: <i>Tech Upgrade Costs + Telemetry Costs</i></li> <li>Distribution Benefits: <i>Avoided Cost Streams Distribution Deferral and Avoided T&amp;D Losses</i></li> </ul>	<ul style="list-style-type: none"> <li>Solar + Storage: Fully Flexible</li> <li>EVs: E3's EVGrid Analysis</li> <li>HVAC: LBNL CA DR Potential</li> <li>HPWHs: NRDC &amp; Ecotope HPWH Load Shifting</li> </ul>	Additional distribution level value streams included in RESOLVE capacity expansion modeling: Distribution deferral and avoided T&D losses

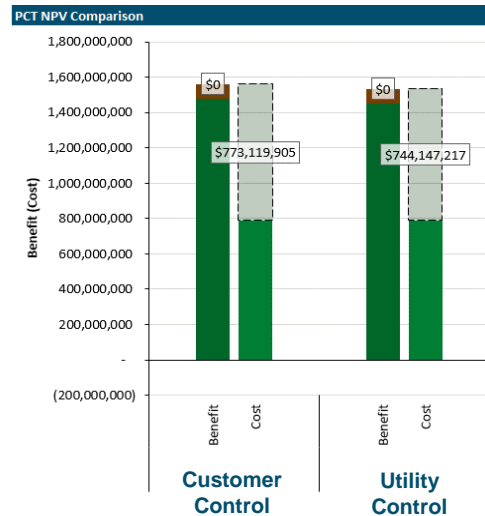
## Energy Values



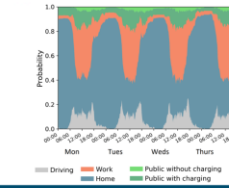
## AC Streams



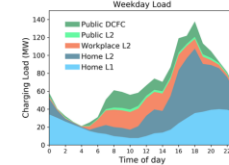
## Participant Cost



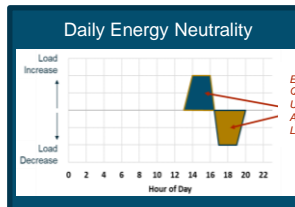
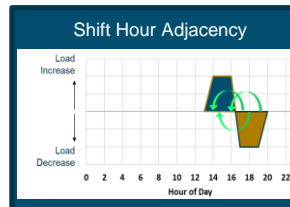
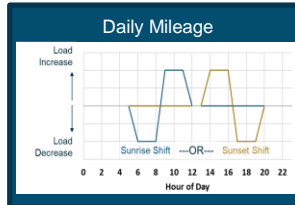
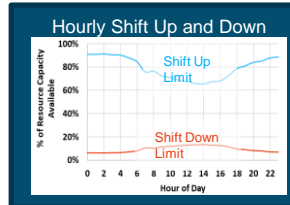
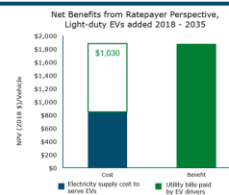
## 1. Driving Profiles



## 2. Charging Profiles



## 3. Cost Benefit Analysis

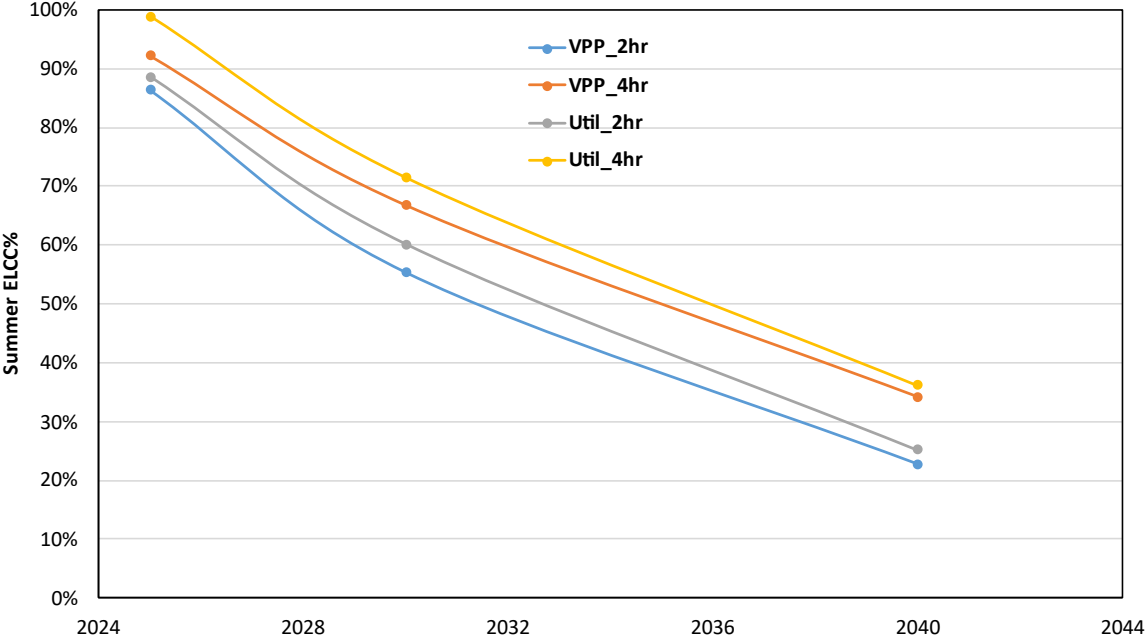


# 2024 ELCC Modeling of 2 Hour vs. 4 Hour VPP vs. Utility Scale Resource

Resource	Annual/Summer ELCC %		
	2025	2030	2040
VPP_2hr	86.35%	55.34%	22.77%
VPP_4hr	92.22%	66.80%	34.23%
Util_2hr	88.59%	60.15%	25.17%
Util_4hr	98.82%	71.44%	36.16%

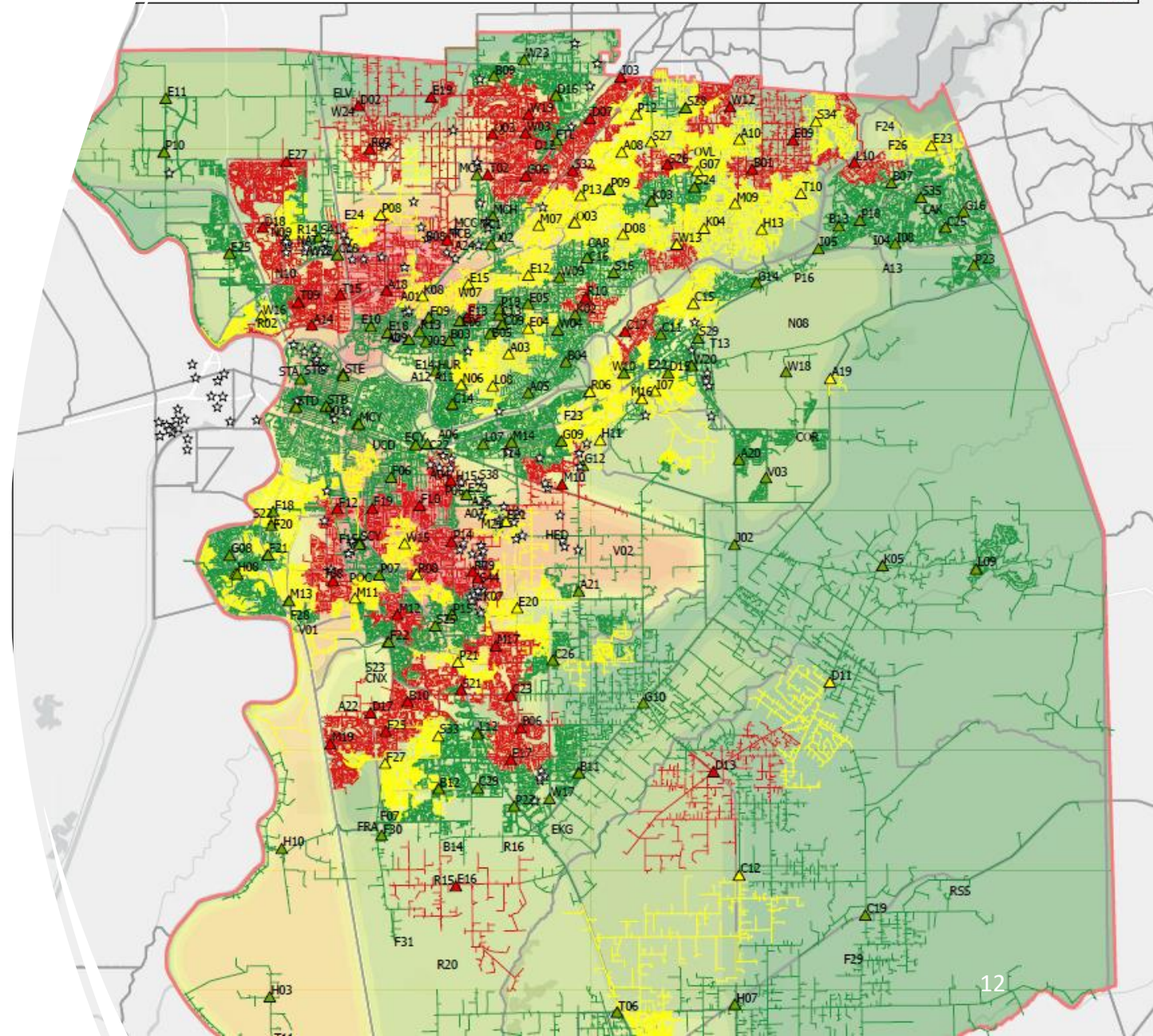
Utility scale Forced Outage Rate key differentiator – more uncertainty for VPP resource

Significant storage buildout to 2040 responsible for declining ELCC values



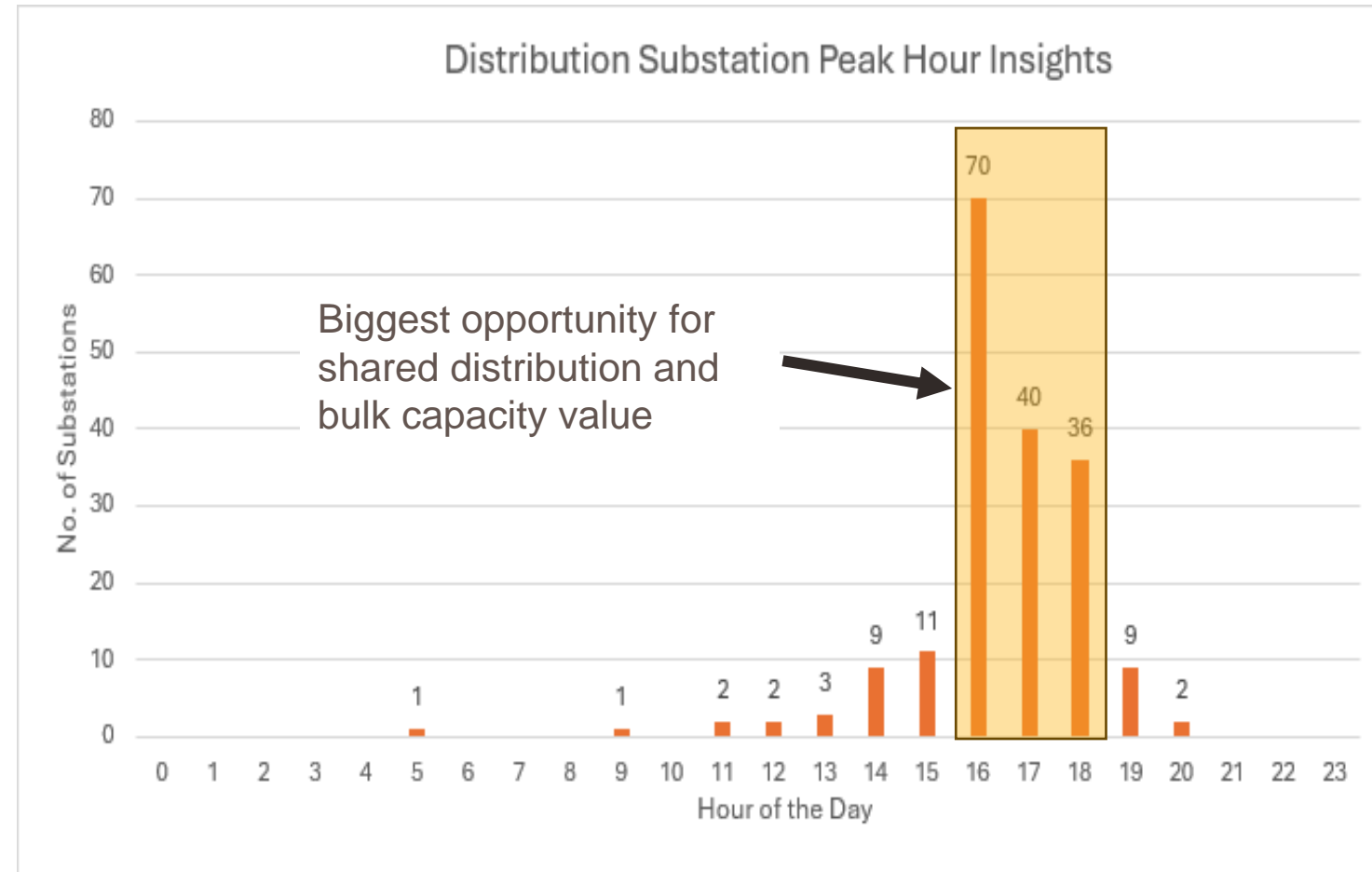
# 2024/25 – Integrated Distribution Resource Plan Update

- Focus on Transportation Electrification Growth, associated grid impacts, flexibility and DER mitigations / valuation
- Element of shared use analysis between distribution and bulk system use cases
- Plan informs scale of challenge ahead for distribution investments, clarify opportunity and value for load flexibility and storage solutions to mitigate
- Launching this month with E3/Integral Analytics team



# Looking ahead to Incorporating DERs in Capacity Expansion In SMUD 2026 IRP

- Capturing avoided distribution upgrade value will be a key focus
- Falling cost of batteries creating a big opportunity to locate batteries on distribution system to provide local and bulk capacity
- Quantifying potential to displace bulk storage key to minimizing costs
- Will require new approaches to thinking about uncertainty in hours, year that upgrades would be required, confidence of avoidance



# Pricing Considerations in Capacity Expansion



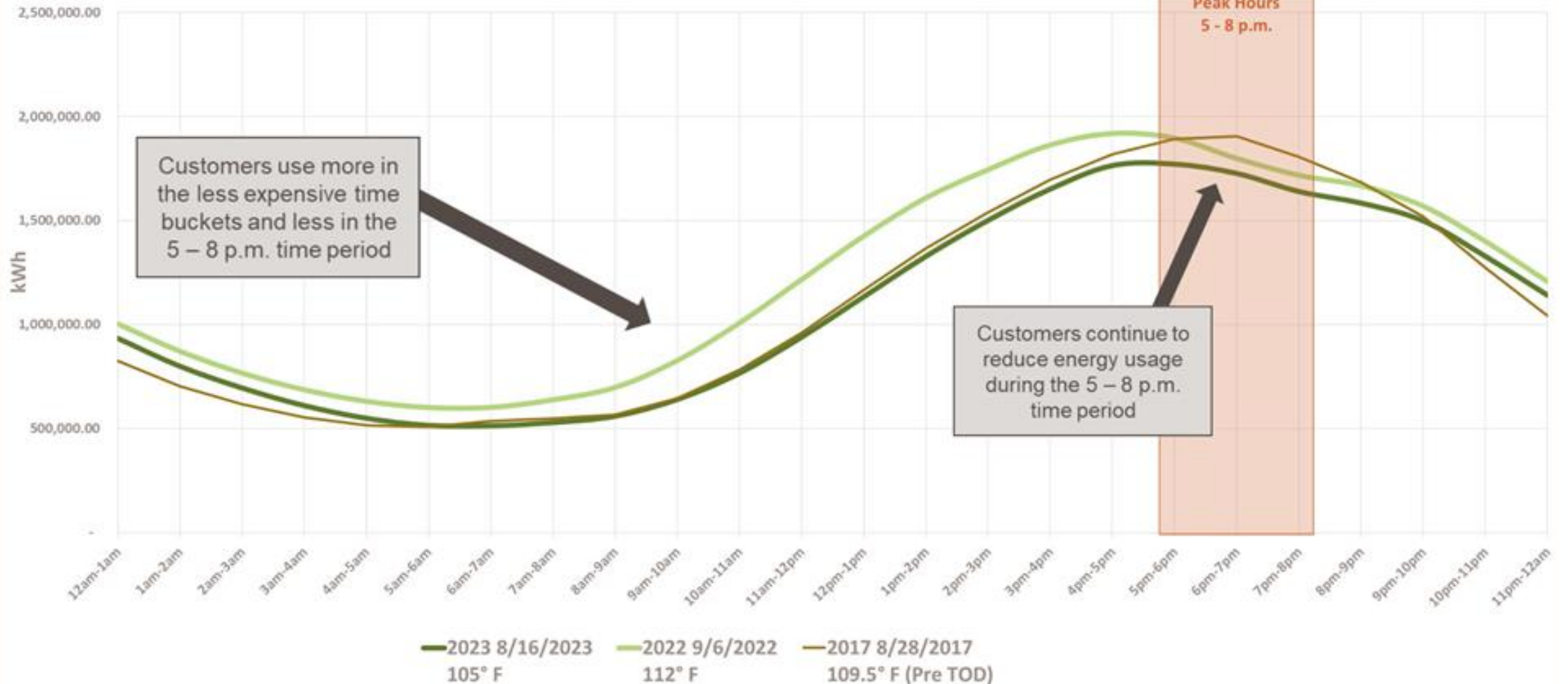
## Default Time of Day Rates (2019)

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- SMUD defaulted all residential customers onto a ToD rate in 2019
- ~3:1 on peak to offpeak ratio, 3 hour peak window (5-8PM) – was initially 4-7PM but solar growth pushed out in time
- 97% of customers have remained on the rate
- Customers saved 130 MW of demand during hot days (4% of SMUD Peak, 10% of residential demand)
- Offpeak rates (non 5-8 during non-summer – 61% of hours) supportive of electrification 11.8 cents per kWh

# TOD Rates Continue to Reduce Residential Peak

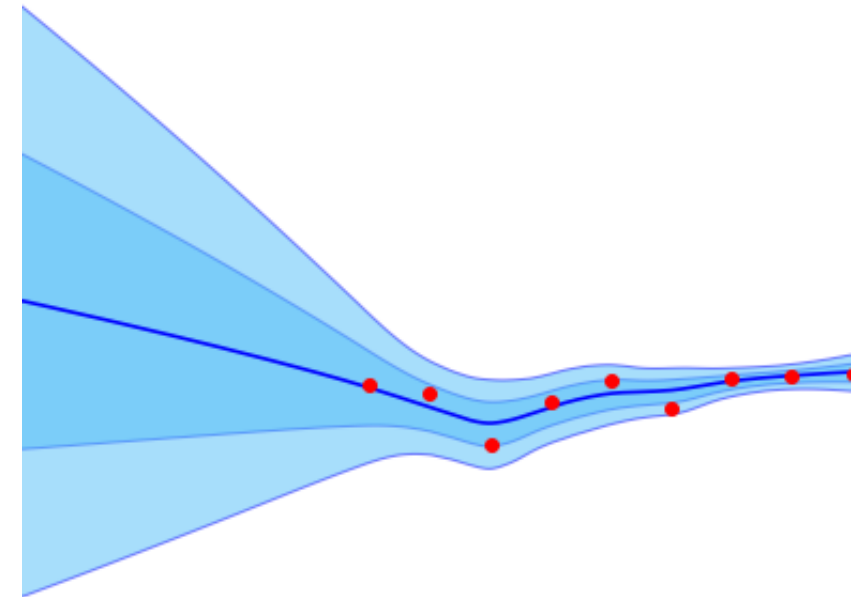
## Residential Peak Day kWh



# Additional Pricing Considerations

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- 2019 also began transition of commercial TOU rates to incorporate low daytime price due to solar growth
- Residential rates still do not reflect low daytime value but expect this to be a future feature
  - Have so far not incorporated due to concerns over complexity to customers
- EV rates (12am – 6am discount) are expected to need to change to avoid driving additional storage needs (e.g. 2023 Stanford Study)
- Dynamic rates being promoted to create better load responsiveness but significant uncertainty for planners around adoption, retention, and thus value



Thank you!



18 Bulk Substation "Station G"