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Energy+Environmental Economics

Modeling Tools to Maximize Solar + Storage Benefits

Comments Review and Case Study

Public Workshop

12/12/2019

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Agenda

- **Project Overview and Schedule**
- **Case study**
  - SGIP
  - EV Managed Charging
  - Microgrid for PSPS
- **Model Updates for Final Release**
- **Recommendations and Next Steps**

About E3

- Founded in 1989, E3 is an industry leading consultancy in North America
- E3 operates at the nexus of energy, environment, and economics
- Our team employs a unique combination of economic analysis, modeling acumen, and deep institutional insight to solve complex problems for a diverse client base

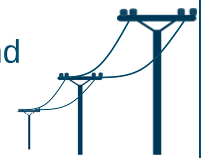
E3 Practice Areas

E3 has five defined working groups that create continual innovation from cutting edge projects and constant cross-fertilization of best practices across the groups

DERs & Rates

Analyzes distributed energy resources, emphasizing their costs and benefits now and in the future

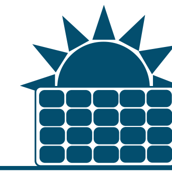
Supports rate design and distribution system planning



Clean Energy

Provides market and policy analysis on clean energy technologies and climate change issues

Includes comprehensive and long-term GHG analysis



Asset Valuation

Determines asset values from multiple perspectives

Uses proprietary in-house models and in-depth knowledge of public policy, regulation and market institutions

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Planning

Develops and deploys proprietary tools to aid resource planners

Informs longer-term system planning and forecasting

Market Analysis

Models wholesale energy markets both in isolation and as part of broader, more regional markets

Key insights to inform system operators and market participants

Project Overview: EPC-17-004

+ Project Purpose

- Develop the Solar + Storage Tool that assesses the cost effectiveness of PV, storage, and other DER technologies for customers and ratepayers under different tariff and program designs
  - Simulate the operation of dispatchable DERs based on an optimization algorithm
  - Estimate value with a focus on location of the resource (Local Net Benefits Analysis (LNBA))

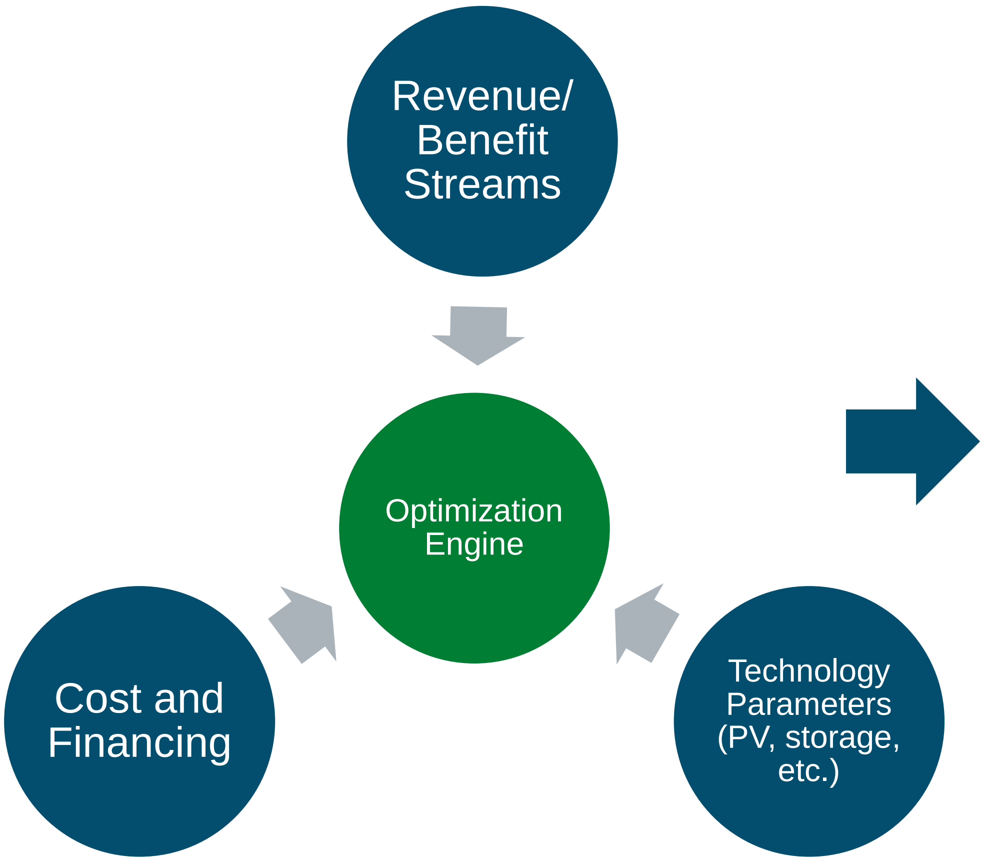
- Apply the tool to evaluate solar + storage systems being researched in other EPIC projects (GFO-16-309)
  - Results will be shared in today's workshop

Project Schedule

+ **The tool is available for download in this website:**
  - https://www.energy.ca.gov/research/mod_tool_max_solar_storage/
  - User guide is also available, which contains a quick-start guide along with full instructions and methodology documentation
  - Pre-loaded example cases
  - No installation required
+ **Three workshops**
  - June 2019: **Tool and use cases overview**
  - August 2019: **Case study results and tool demonstration**
  - Today: **Final project presentation and wrap-up**

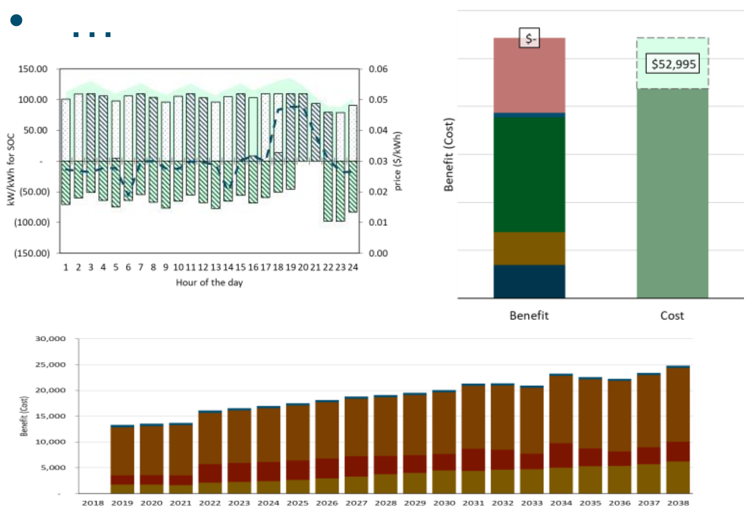
The Solar + Storage Tool

+ A DER valuation tool with an optimization engine for dispatch



Results:

- NPV and annual benefits and costs
- Cost tests
- DER optimal dispatch
- …

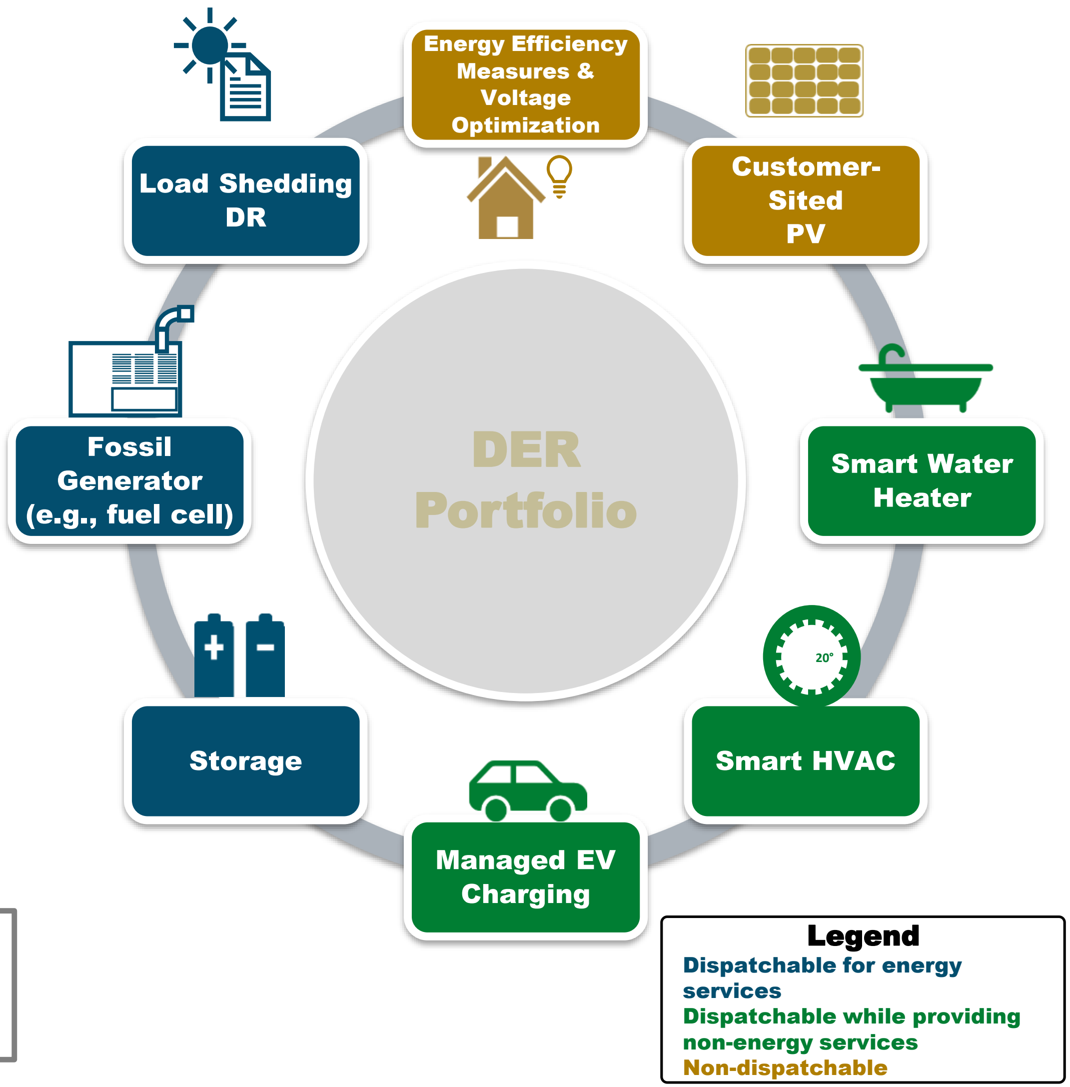


DER Shapes

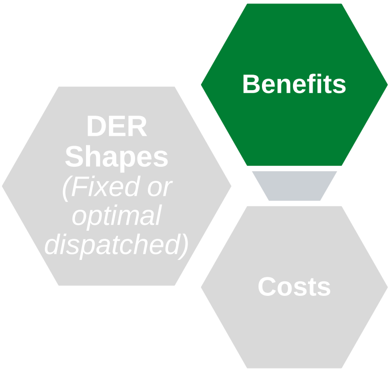
+ **Dispatchable**
  - Objective function: minimizing net costs
  - Subject to technology, market, and incentive (e.g. ITC) constraints
  - Co-optimization across multiple technologies with perfect foresight
  - Price taker
+ **Partial Dispatchable**
  - Dispatch with the consideration of customer comfort level
  - Co-optimize with both dispatchable and partial dispatchable technologies
+ **Fixed shapes**
  - User input based on the specific project or customer
  - Default PV shapes pre-loaded for each climate zone

Other highlights

- Temperature-based day mapping
- Flexible Optimization Window (Daily, Monthly, Annual) and Intervals (Hourly, 15mins, 5mins)



Benefits



+ A wide range of benefit streams can be modeled

- The model is able to calculate and co-optimized against them – it is critical for value stacking

+ Benefit combinations

- Commonly used benefit combination for each use case is pre-defined
- Users can also mix and match and pick their own benefit streams

+ Other highlights

- Flexible rate and utility program design
  - E.g. multi-tiered TOU demand charge, daily demand charge, real time rate, asymmetric energy charges, volumetric payment for demand response, etc.
- Project-specific T&D Deferral Values (LNBA Style)

Customer sided

- Demand charge management
- TOU energy charge management
- Utility Program Revenue (e.g. DR program)
- Back-up power

Distribution System

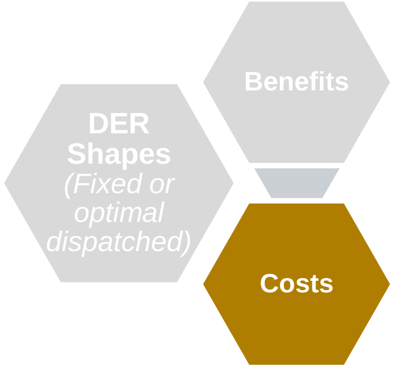
- Project specific T&D deferral
- Interconnection costs reduction
- Reliability
- System avoided costs or Bulk system revenues

Bulk System

- Resource adequacy program
- Wholesale energy market
- Ancillary services revenue
- Project specific transmission deferral
- Renewable firming services

Costs

- **A Pro Forma is integrated into the model to calculate the all-in project costs, including:**
  - Capital costs
  - Operating and maintenances costs
  - Financing costs
  - Incentives
    - Self-Generation Incentive Program (SGIP)
    - Investment Tax Credit (ITC)
  - Taxes
- **Two financing options:**
  - Self-financing with the ability to specify a debt and equity ratio
  - Third-Party Leasing
- **Users can also overwrite with their own cost estimate**



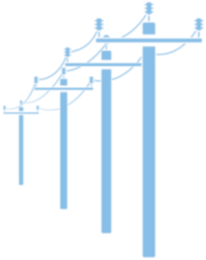
Comparison with HOMER – BTM Cases

+ **Two BTM use cases consistent with HOMER**
  - 1,000 kW and 10 kW PV with 250kW/550kWh storage
  - 48 hours optimization window

	HOMER (1000 kW PV)	Solar + Storage (1000 kW PV)		HOMER (10 kW PV)	Solar + Storage (10 kW PV)	
Rate	SCE TOU-8-D-2-50kV-NEM2	captured most of the rate components		SCE TOU-8-D-2-50kV-NEM2	captured most of the rate components	
PV	1000 kW	1000 kW		10 kW	10 kW	
ES	250 kW/550 kWh	250 kW/550 kWh		250 kW/550 kWh	250 kW/550 kWh	
Current Elecitricity Cost	$520,452	$493,480	**95%**	$520,452	$493,480	**95%**
Year-1 Energy Cost	$276,844	$248,668	**90%**	$276,844	$248,668	**90%**
Year-1 Demand Charge Cost	$243,608	$244,812	**100%**	$243,608	$244,812	**100%**
Year-1 Energy Savings	$132,869	$112,524	**85%**	$2,707	$850	**31%**
Year-1 Demand Charge Savings	$104,484	$109,552	**105%**	$26,697	$26,320	**99%**
Total Year-1 Savings	$237,353	$222,077	**94%**	$29,404	$27,170	**92%**

Model Applications

- Costs & benefits behind-the-meter solar + storage
- Targeted DER portfolios for local distribution deferral
- Value of Vehicle Grid Integration (VGI)
- Benefits of dynamic rates
- Costs & benefits of microgrids
- Utility-scale solar + storage



Energy+Environmental Economics

Case Study
SGIP 2018 Impact Evaluation

SGIP Program Background

- **The Self-Generation Incentive Program (SGIP) provides financial incentives for the installation of new qualifying technologies that are installed to meet all or a portion of the electric energy needs of a facility.**
  - “The purpose of the SGIP is to contribute to Greenhouse Gas (GHG) emission reductions, demand reductions and reduced customer electricity purchases, resulting in the electric system reliability through improved transmission and distribution system utilization; as well as market transformation for distributed energy resource (DER) technologies.”[1]
- **Of the $567 million total SGIP incentive budget, $448 million (79%) is allocated to energy storage**
- **Itron and E3 conducted an 2018 Impact Evaluation of energy storage to understand whether the SGIP program is achieving these goals**
  - Itron performs analysis of actual impacts of SGIP storage operations
  - E3 utilize the Solar + Storage tool to quantify potential benefits under optimal dispatch with perfect foresight

[1] https://www.selfgenca.com/documents/handbook/2017

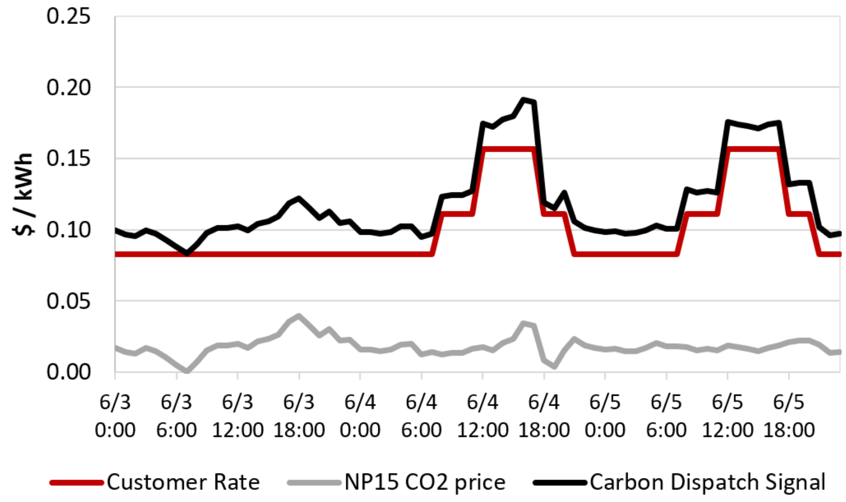
2018 Impact Evaluation Approach

- **Energy storage customers were dispatched using three approaches:**

System Cost	Customer	Carbon
• Minimize utility avoided costs	• Minimize customer electricity bills	• Minimize customer electricity bills **and** carbon costs

- **A sample of 441 SGIP energy storage customers were modelled**
  - Sample results were used to estimate impacts for the entire SGIP population
- **Key inputs varied across customers**
  - Load
  - PV output
  - Storage parameters
  - Electric rate

Example Carbon Dispatch Price Signal



Note: this use case does require sophisticated post-processing!

Timing of Optimal Dispatch

- Timing of charging/discharging varies significantly by dispatch approach
- System cost dispatch results in much higher depth of charge / discharge due to more dynamic price signal

Nonresidential Customers - System Dispatch Approach

Hour Beginning \ Month	1	2	3	4	5	6	7	8	9	10	11	12
0	-0.139	-0.162	-0.175	-0.203	-0.290	-0.114	-0.186	-0.220	-0.080	-0.133	-0.075	-0.063
1	-0.304	-0.193	-0.375	-0.524	-0.579	-0.322	-0.298	-0.266	-0.334	-0.495	-0.252	-0.222
2	-0.438	-0.503	-0.508	-0.586	-0.570	-0.396	-0.502	-0.499	-0.347	-0.510	-0.523	-0.386
3	-0.456	-0.467	-0.154	-0.059	-0.061	-0.030	-0.282	-0.206	-0.046	-0.080	-0.353	-0.289
4	-0.072	-0.043	0.019	0.222	0.345	0.176	-0.029	-0.023	0.013	0.038	-0.027	-0.034
5	0.017	0.066	0.342	0.612	0.646	0.456	0.095	0.259	0.310	0.375	0.201	0.019
6	0.350	0.582	0.561	0.286	0.182	0.099	-0.023	0.079	0.124	0.475	0.531	0.317
7	0.484	0.454	0.152	-0.063	-0.250	-0.636	-0.236	-0.395	-0.092	-0.018	0.173	0.349
8	0.026	0.036	0.016	-0.211	-0.365	-0.509	-0.166	-0.327	-0.496	-0.134	-0.089	0.026
9	-0.099	-0.036	-0.126	-0.190	-0.354	-0.320	-0.071	-0.113	-0.411	-0.414	-0.309	-0.041
10	-0.128	-0.217	-0.286	-0.323	-0.206	-0.098	-0.026	-0.064	-0.176	-0.477	-0.335	-0.084
11	-0.234	-0.245	-0.435	-0.405	-0.261	-0.164	-0.012	-0.056	-0.064	-0.328	-0.267	-0.205
12	-0.490	-0.510	-0.441	-0.239	-0.206	-0.078	-0.035	-0.004	-0.012	-0.106	-0.380	-0.508
13	-0.334	-0.449	-0.388	-0.288	-0.185	-0.078	-0.012	0.017	-0.003	-0.081	-0.157	-0.371
14	-0.157	-0.348	-0.209	-0.214	-0.245	-0.074	0.021	0.033	0.003	-0.068	-0.053	-0.156
15	-0.012	-0.068	-0.149	-0.132	-0.109	-0.077	0.052	0.064	0.038	-0.007	0.022	0.004
16	0.048	0.017	0.025	-0.038	-0.064	0.052	0.113	0.099	0.070	0.119	0.146	0.049
17	0.527	0.218	0.130	0.076	0.069	0.084	0.369	0.466	0.413	0.615	0.635	0.525
18	0.530	0.642	0.677	0.595	0.380	0.632	0.558	0.545	0.536	0.490	0.359	0.383
19	0.099	0.249	0.404	0.541	0.708	0.472	0.154	0.128	0.104	0.104	0.075	0.104
20	0.085	0.120	0.112	0.085	0.202	0.085	0.024	0.033	0.050	0.061	0.057	0.065
21	0.043	0.057	0.056	0.055	0.066	0.042	-0.005	0.004	0.009	0.029	0.029	0.030
22	0.008	0.005	-0.033	-0.007	0.029	-0.003	-0.043	-0.007	-0.056	-0.051	0.010	0.004
23	-0.033	-0.063	-0.140	-0.047	-0.030	0.005	-0.066	-0.034	-0.039	-0.045	-0.050	-0.079

Nonresidential Customers - Bill Dispatch Approach

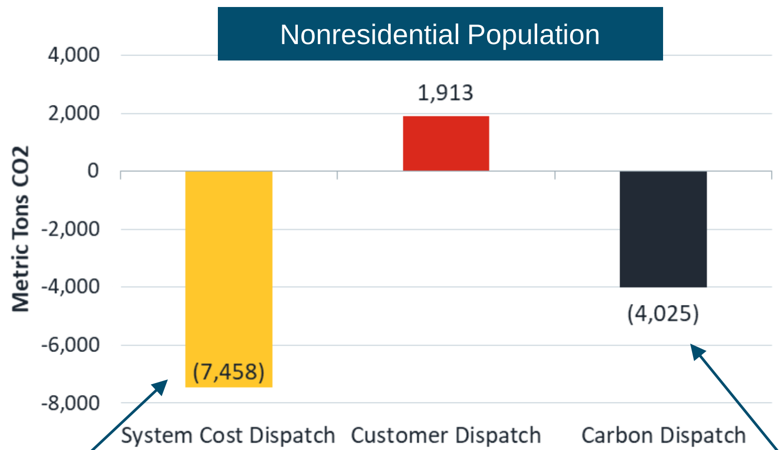
Hour Beginning \ Month	1	2	3	4	5	6	7	8	9	10	11	12
0	-0.043	-0.051	-0.052	-0.053	-0.066	-0.151	-0.147	-0.176	-0.152	-0.124	-0.067	-0.065
1	-0.027	-0.032	-0.038	-0.038	-0.047	-0.094	-0.081	-0.089	-0.084	-0.075	-0.046	-0.049
2	-0.027	-0.027	-0.034	-0.034	-0.046	-0.071	-0.063	-0.070	-0.064	-0.059	-0.050	-0.051
3	-0.040	-0.039	-0.044	-0.042	-0.054	-0.074	-0.066	-0.080	-0.074	-0.072	-0.072	-0.074
4	-0.064	-0.062	-0.053	-0.045	-0.069	-0.104	-0.086	-0.119	-0.110	-0.111	-0.104	-0.102
5	-0.102	-0.094	-0.049	-0.038	-0.093	-0.153	-0.134	-0.182	-0.157	-0.149	-0.144	-0.145
6	-0.029	-0.023	-0.012	-0.015	-0.042	-0.084	-0.079	-0.096	-0.081	-0.060	-0.049	-0.048
7	-0.070	-0.073	-0.072	-0.077	-0.101	-0.173	-0.162	-0.180	-0.147	-0.129	-0.109	-0.087
8	0.096	0.082	0.090	0.088	0.058	-0.001	0.010	0.004	0.004	0.094	0.166	0.166
9	0.012	0.004	0.015	0.022	0.025	0.001	0.008	0.005	0.004	0.036	0.037	0.043
10	0.004	0.004	-0.005	-0.001	0.017	-0.001	0.007	0.003	0.002	0.030	0.028	0.034
11	0.003	0.003	-0.002	0.000	0.007	-0.012	0.002	-0.005	-0.002	0.031	0.025	0.027
12	0.005	0.006	-0.005	-0.006	0.104	0.262	0.245	0.281	0.248	0.136	0.025	0.024
13	-0.001	0.001	-0.029	-0.040	0.022	0.080	0.069	0.090	0.071	0.047	0.017	0.017
14	0.003	0.002	0.007	0.005	0.013	0.065	0.053	0.072	0.059	0.033	0.021	0.015
15	-0.002	-0.002	0.000	-0.001	0.007	0.048	0.036	0.052	0.041	0.017	0.015	0.008
16	0.053	0.047	0.050	0.056	0.074	0.131	0.118	0.149	0.121	0.099	0.078	0.063
17	0.036	0.031	0.025	0.021	0.100	0.261	0.234	0.271	0.242	0.132	0.052	0.052
18	0.024	0.023	0.024	0.025	0.014	-0.006	-0.008	-0.014	0.004	0.030	0.028	0.029
19	0.015	0.016	0.019	0.024	0.018	0.009	0.003	-0.004	0.000	0.015	0.021	0.023
20	0.043	0.042	0.049	0.039	0.037	0.060	0.061	0.059	0.056	0.088	0.066	0.064
21	-0.029	-0.024	-0.028	-0.024	-0.092	-0.087	-0.085	-0.101	-0.080	-0.115	-0.062	-0.063
22	-0.012	-0.010	-0.014	-0.015	-0.043	-0.045	-0.046	-0.051	-0.046	-0.057	-0.031	-0.030
23	-0.012	-0.013	-0.016	-0.019	-0.032	-0.124	-0.127	-0.156	-0.137	-0.043	-0.031	-0.029

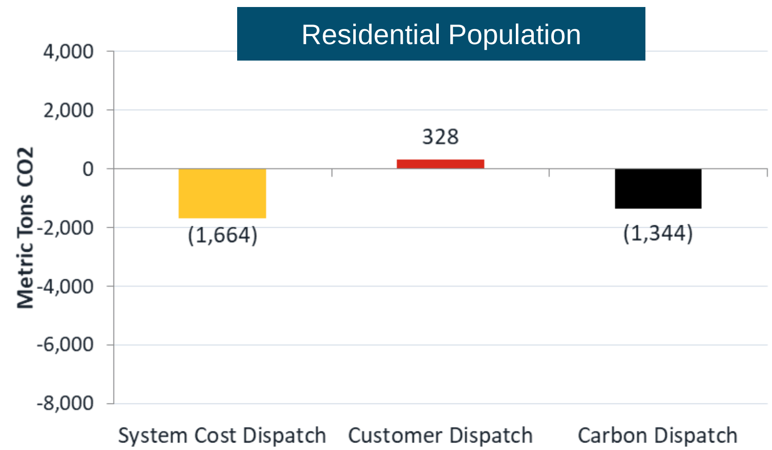
Shading represents maximum hourly net discharge /charge (kW / kW-rebated capacity)

Minimum	-0.70	-0.19	0.00	0.34	0.73	Maximum

Population GHG Impacts – Optimal Dispatch

- Under the Customer Bill Dispatch approach we see an emissions increase for both nonresidential and residential customers
- Adding a carbon price to customer rates reduced emissions significantly
- The System Cost dispatch approach achieves the highest emission reduction – very dynamic signal well correlated with marginal emissions





Actual dispatch: **+1,517** Tonnes CO_2

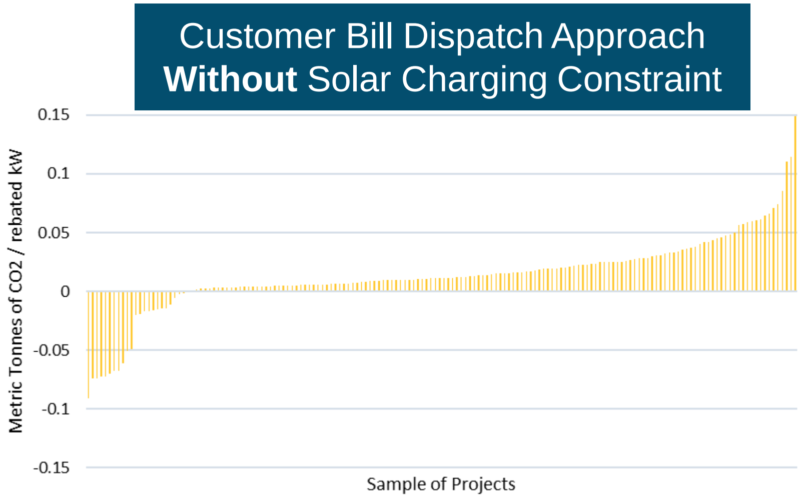
Actual dispatch: **-69** Tonnes CO_2

Potential GHG Reductions

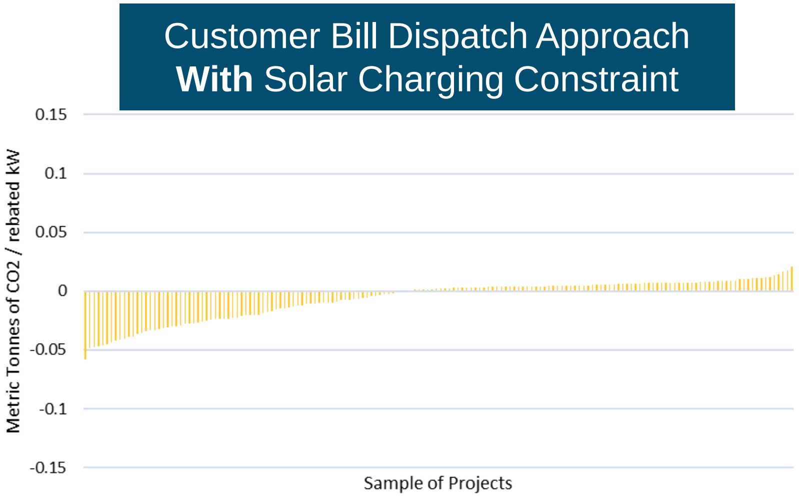
Potential GHG Reductions with no bill impact

Residential Solar Only Charging Analysis

+ **Objective was to reconcile difference between emission savings for residential customers under real dispatch and simulated dispatch (customer bill approach)**
+ **When residential customers are required to charge entirely from Solar the population switches from being net emitter to net reducer of system emissions.**



Population GHG estimate: **+328** Tonnes CO_2

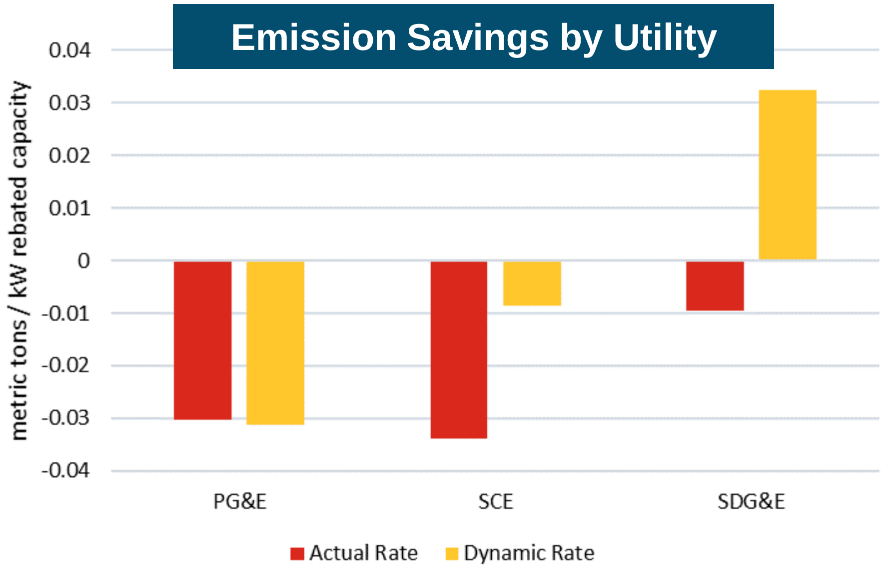


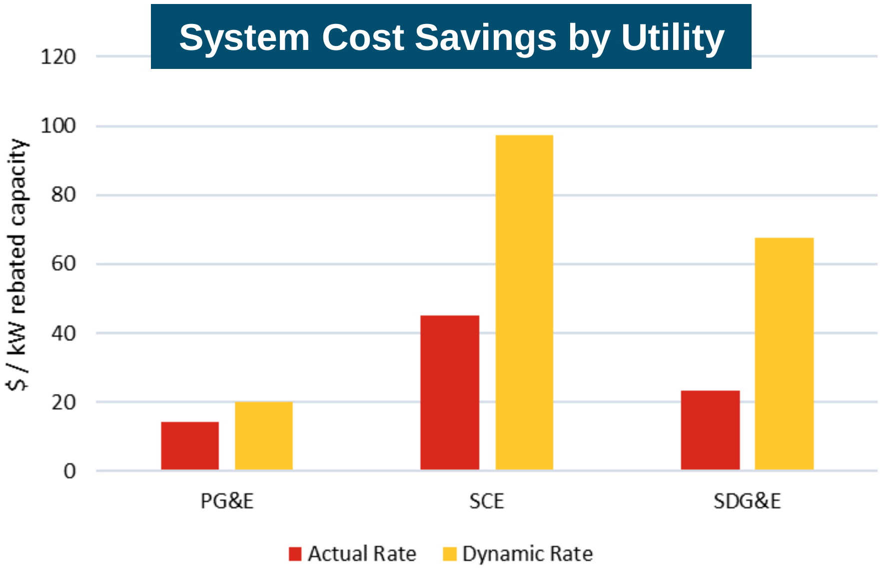
Population GHG estimate: **-72** Tonnes CO_2

Dynamic Rates Analysis

- Sensitivity for Nonresidential customers only
- More dynamic rates generally lead to improved system cost and emission savings
- The more dynamic the rate, the bigger the improvement

Utility	Dynamic Rate Used
PG&E	The Peak Day Pricing (PDP) option for A-6, A-10, E-19, and E-20
SCE	The Real-Time-Pricing (RTP) option for TOU-GS-2, TOU-GS-3, and TOU-8
SDG&E	The Grid Integration Rate (GIR)





Energy+Environmental Economics

Case Study
Vehicle Grid Integration (VGI)

Electric vehicles can deliver value to the grid and capture new revenue streams

+ **EVs are parked most of the time during which their batteries can provide flexibility services to the grid.**
+ **The Solar + Storage Tool can be used to simulate various VGI scenarios**

EV Modeling Inputs

1 **Driver Characteristics**
- Vehicle miles travelled
- Driving trips
- Charging infrastructure access
- Limitations on V1G/V2G

2 **Battery Characteristics**
- Battery capacity (kWh)
- Battery power (kW)
- Charge efficiency
- Battery lifetime
- Minimum state of charge
- Parasitic losses

3 **EV Charging Equipment**
- Power (kW)

4 **Market Prices**
- Energy prices
- Capacity prices/demand response pricing
- Ancillary service prices

5 **Non-Market Prices**
- T&D capacity value/pricing
- Increased RPS cost

6 **Financial Inputs**
- Discount rate
- Incremental vehicle cost/battery cost
- EV depreciation schedule
- Tax credits

→ **Solar + Storage Tool**

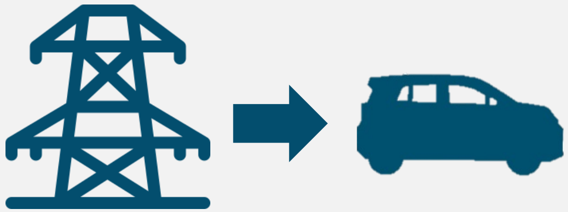
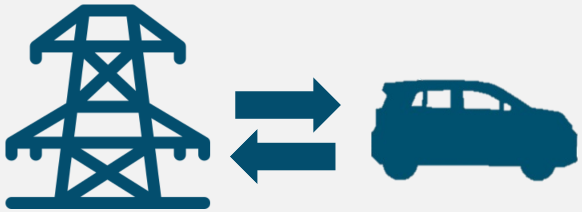
Derivative Outputs

1 **Value**
- $/year per EV
- NPV of value

2 **Detailed operations of battery**
- Number of cycles per year
- Daily dispatch operations

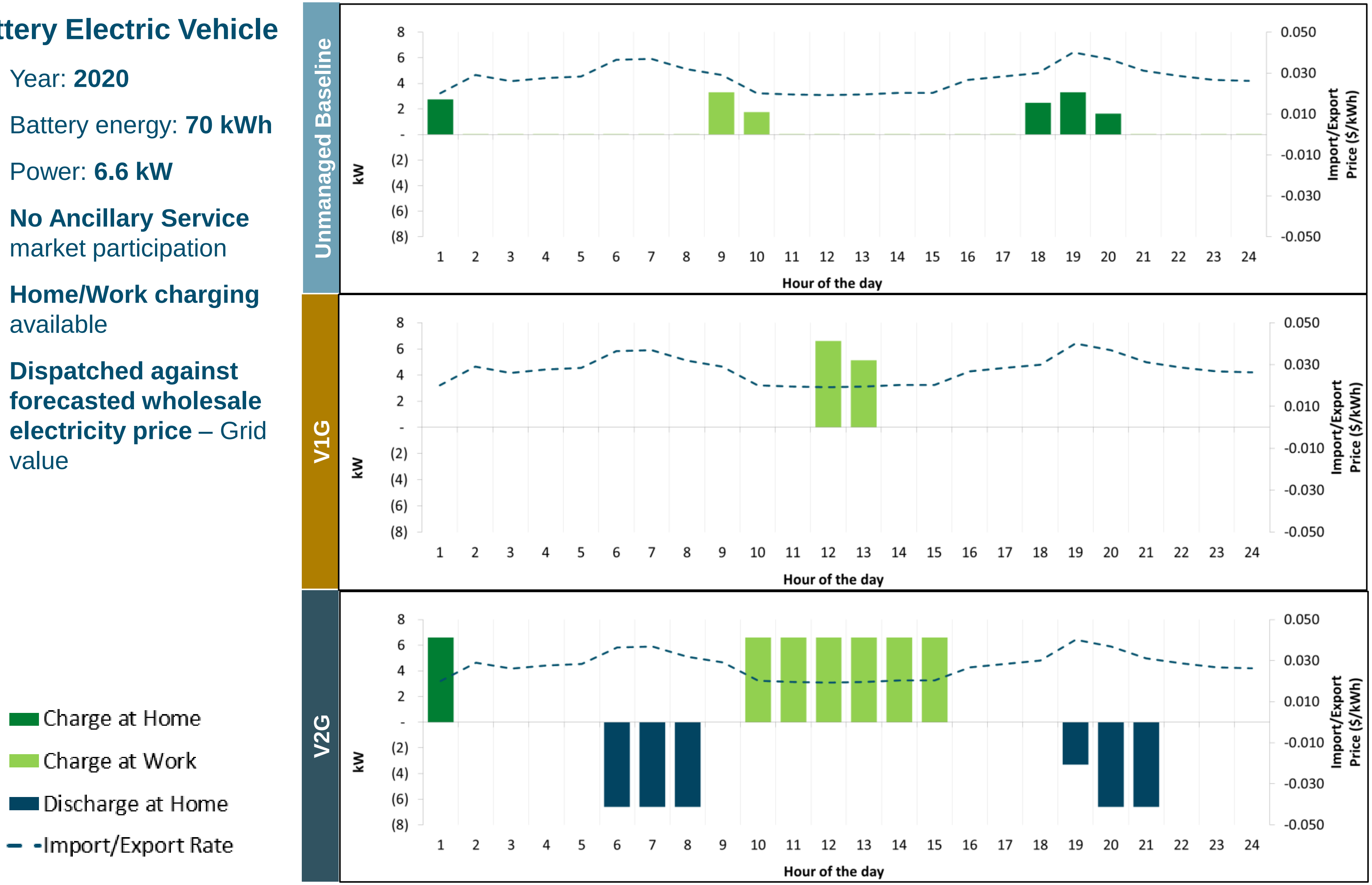
Case Study – Methodology

- Battery Electric Vehicle (BEV): 70 kWh, 6.6 kW
- Objective: evaluate the value of VGI compared to EV charging baselines

Cases	Description	Price Signal	Diagram
Unmanaged Charging Baseline	Charge whenever a vehicle plugs in	No signal	
TOU Baseline	Charge against the TOU price blocks	Simulated TOU price blocks from wholesale electricity prices	
Managed Charging (V1G)	Manage when the EV charges from the grid and how fast	Wholesale electricity prices	
Vehicle-to-Grid (V2G)	Manage charging and discharging	Wholesale electricity prices	

Daily Dispatch Operation (Unmanaged Baseline, V1G, V2G)

+ **Battery Electric Vehicle**
  - Year: **2020**
  - Battery energy: **70 kWh**
  - Power: **6.6 kW**
  - **No Ancillary Service** market participation
  - **Home/Work charging** available
  - **Dispatched against forecasted wholesale electricity price** – Grid value

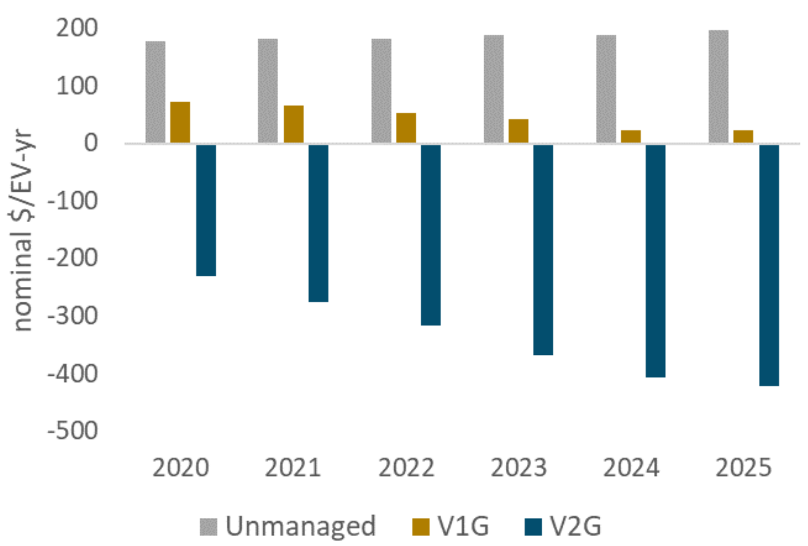


Grid Value of VGI – Unmanaged baseline

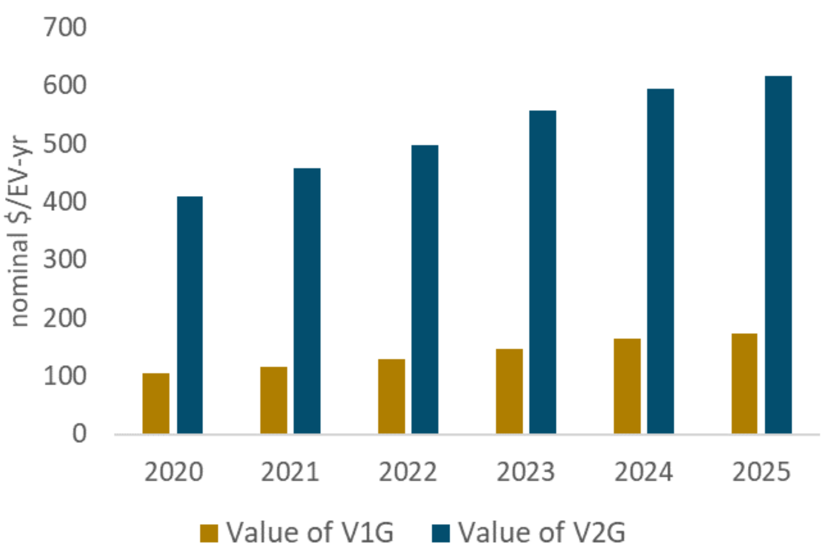
VGI value = VGI charging cost – Unmanaged Charging cost

- **Under V2G, vehicles can generate revenue (negative cost) potentially allowing much greater value than V1G**
  - In the V2G scenario vehicles can take advantage of high price hours by discharging to the grid, earning revenue
  - Under V1G vehicles are constrained by their SOC on arrival a
- **VGI value increases over time as prices become more volatile.**

Charging Cost



V1G/V2G Value (Unmanaged Baseline)

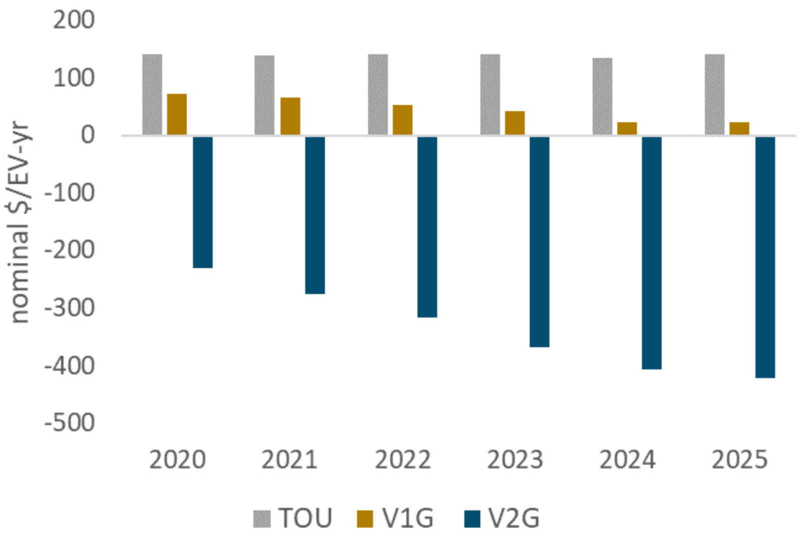


Grid Value of VGI – TOU Baseline

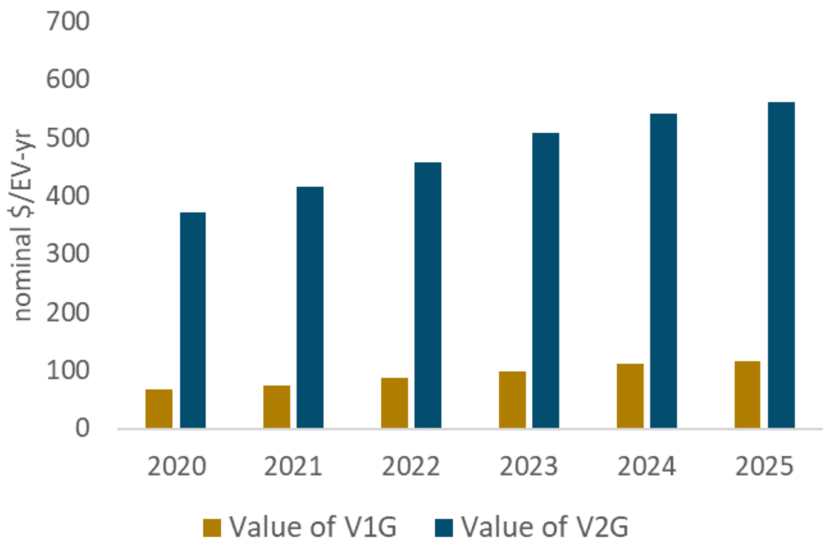
VGI value = VGI charging cost – TOU Charging cost

- **Charging can easily be timed to TOU tariff peaks without VGI technology**
- **When using TOU charging as the baseline, the additional value VGI provides is lower since TOU charging already provides some grid benefit relative to unmanaged charging**

Charging Cost



V1G/V2G Value (TOU Baseline)

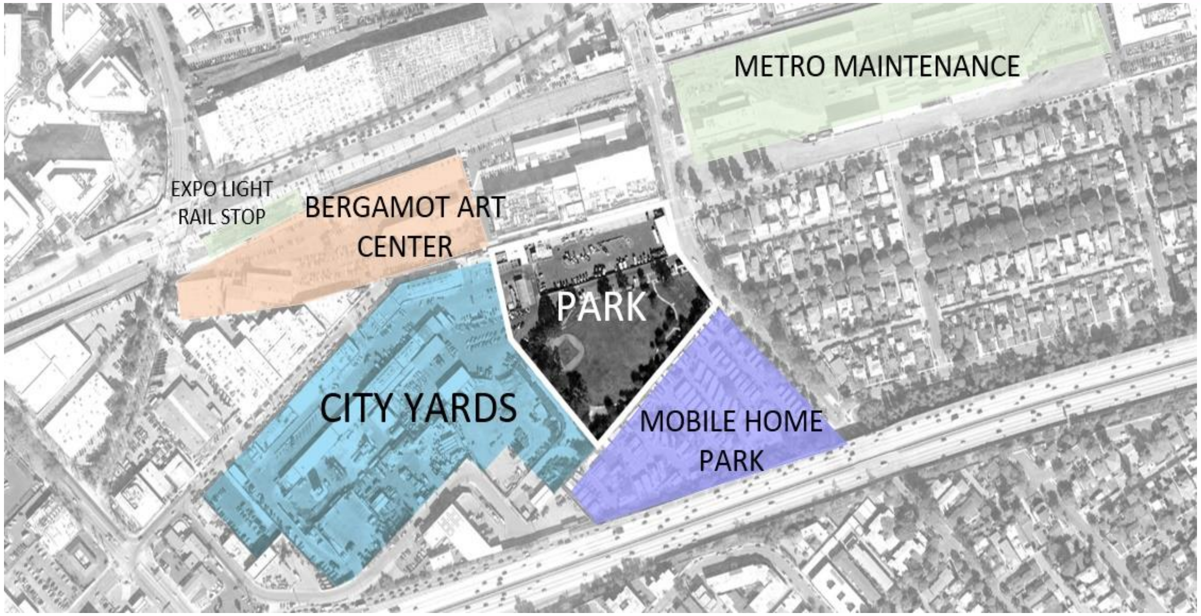


Note: the value of VGI compared to TOU Baseline is smaller than the value compared to Unmanaged Baseline because the charging cost under TOU Baseline is lower.

Energy+Environmental Economics

Case Study
Microgrid for PSPS

Santa Monica Advanced Energy District



- **Microgrid feasibility study for the redeveloped City Yards facility**
  - Other scenarios included Metro Maintenance and Bergamot Art Center facilities
- **The microgrid had to achieve the following goals:**
  - Approach zero net energy use during normal operation
  - Operate during utility company power outages – "Island mode"
- **Cost tests used to calculate net benefits under various scenarios**

Methodology

- **Microgrid technologies included:**
  - PV, Storage, Fuel Cell, and VGI
- **Microgrid sizing influenced by:**
  - Area / number of facilities covered
  - Load at each facility to be covered
  - Duration of “island mode” events
- **Base case scenario for Design load:**
  - 1.2MW PV, 7.2MWh Storage
- **E3 Avoided Costs used**
- **SCE and Clean Power Alliance rates were tested**
- **Island mode assumptions:**
  - Value of Lost Load (VoLL) taken from the Interruption Cost Estimate calculator - residential $5.82 / hr, small C&I: $288.71 / hr, medium C&I: $147.27 / hr
  - Outage frequency and duration calculated using SAIFI and SAIDI reliability calculations

Load Scenarios for City Yards Facility

Load Scenario	Max Annual Load (kw)	Load Notes
Design (EE)	344	City Yards load after energy efficiency measures
CNG Modification	278	Design load after CNG operation modification
Necessary Loads	247	CNG modification load without fire tower, solid waste admin, and streets conference road loads
Reduced Maintenance	200	Necessary loads with 50% reduction to City Yards load
No Maintenance	154	Necessary loads without City Yards load
No CNG / Maintenance	74.6	No maintenance load without CNG load
Critical Loads	41.7	Critical loads only

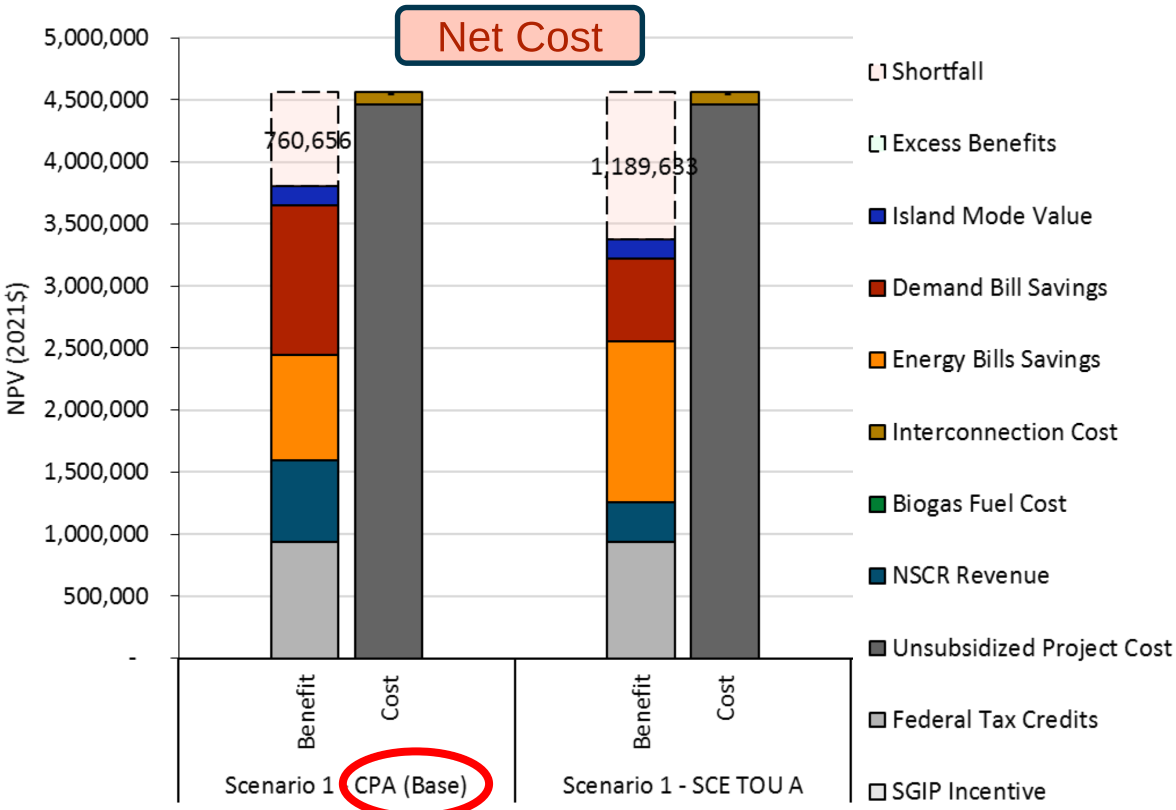
[1] https://www.sce.com/nrc/reliability/reports/SantaMonica.pdf

Cost to Santa Monica City

Participant Cost Test

The PCT assesses if a project is cost effective from the perspective of the end consumer

- **Low cost effectiveness for SMCY due to large size of the microgrid relative to load**
- **Bill savings largest under the CPA rate**
  - NSCR much higher
  - Easier to reduce demand charges



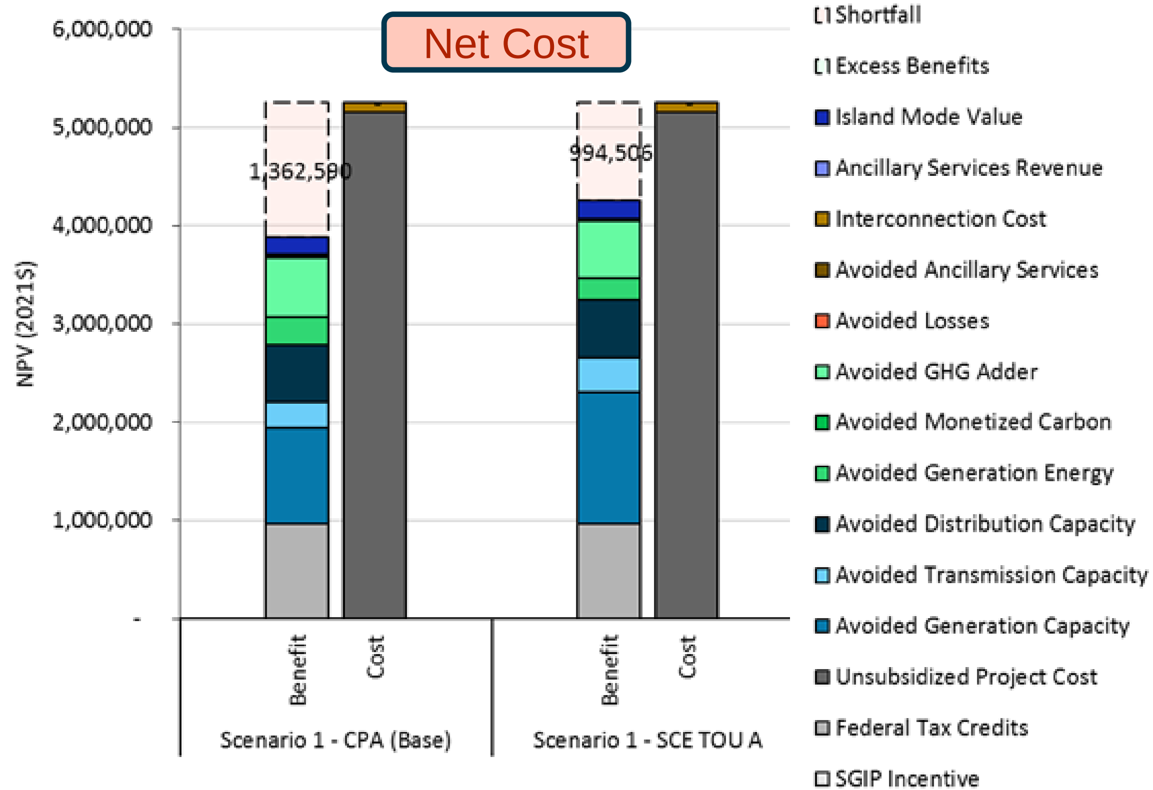
CPA: Clean Power Alliance
Los Angeles Community Choice Aggregator

Cost to California State

Total Resource Cost Test

The TRC assesses the monetized costs and benefits to <u>California State</u>

- **Avoided capacity accounts for most of the benefit**
- **Lower benefit under the CPA rate**
  - SCE rate has more focus on energy charges – better alignment of rate signal with system avoided costs

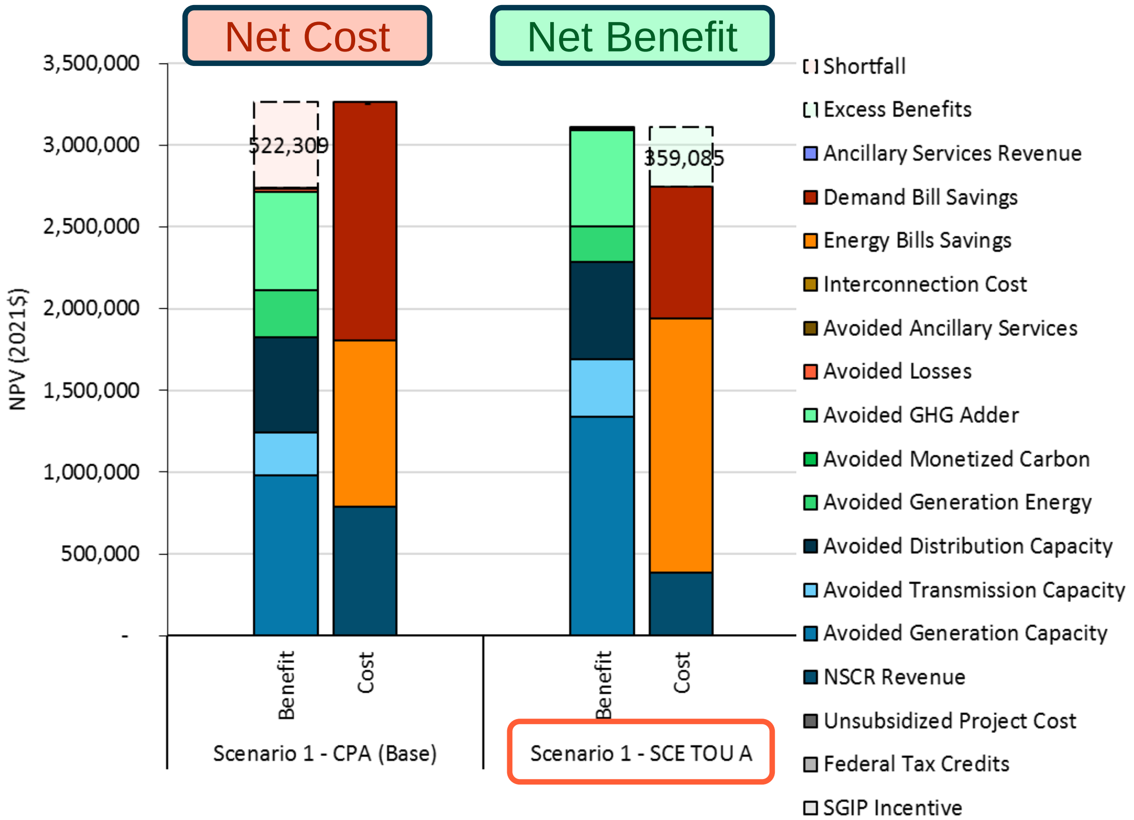


Cost to non-participating ratepayers

Ratepayer Impact Measure

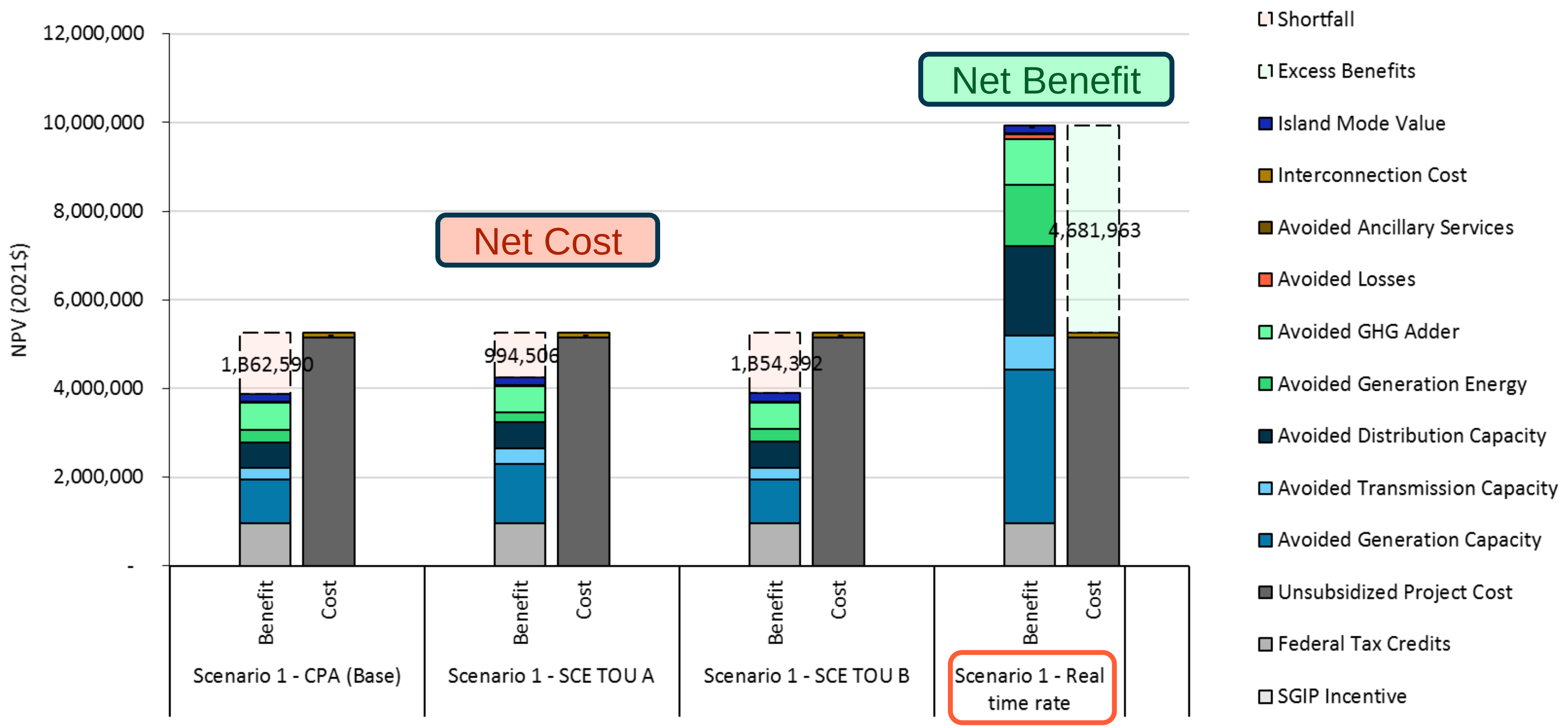
The RIM quantifies the impact of the microgrid on the non-participating ratepayers

- **SCE rate compensates participant less – benefits to utility outweigh reductions in rate revenue**



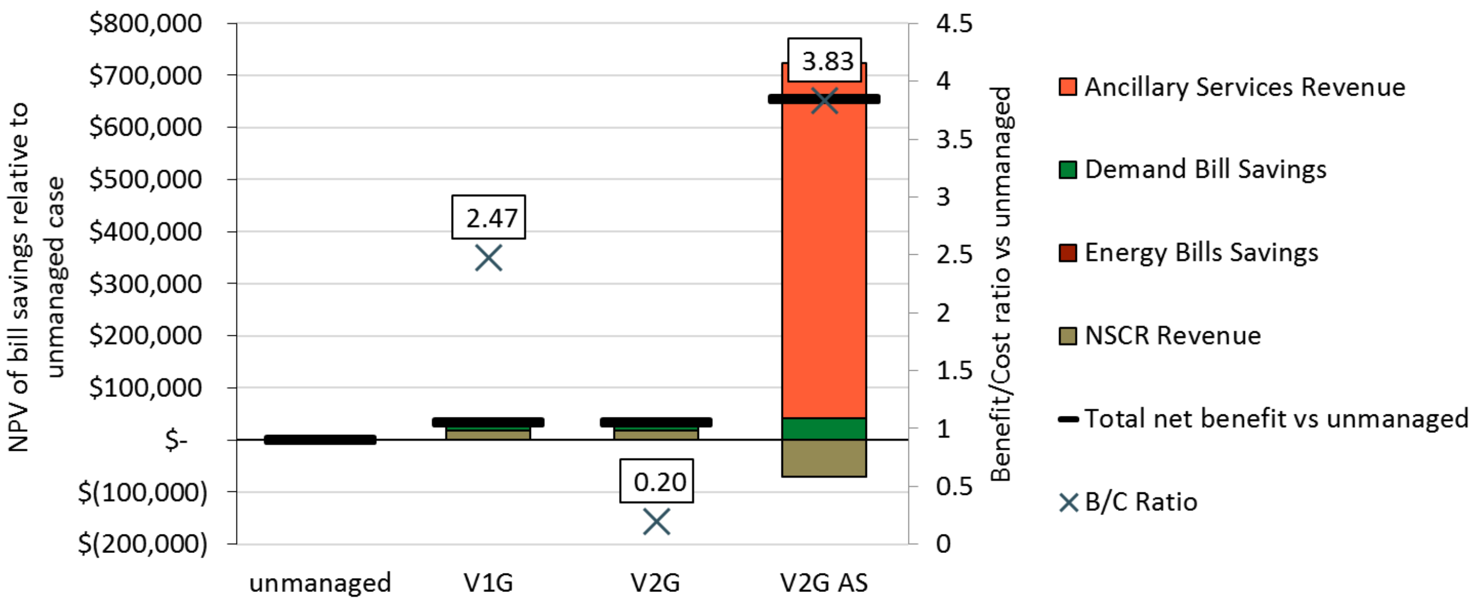
Rate design considerations

+ **More dynamic rates can unlock far greater value from the microgrid**



VGI Technology - Customer Bill Savings

- **Including load from charging an EV fleet nearly doubles annual energy consumption**
- **Adding managed charging technology (V1G) is cost effective with a 2.47 B/C ratio**
  - Managed charging helps to reduce the demand charge and reduce usage of energy storage
- **V2G doesn't provide additional bill savings compared to V1G**
  - The electricity bill is very low for SMCY and there is no room for additional demand charge reduction (discuss later)
- **But if EVs could participate in ancillary services market, much higher revenues can be generated**



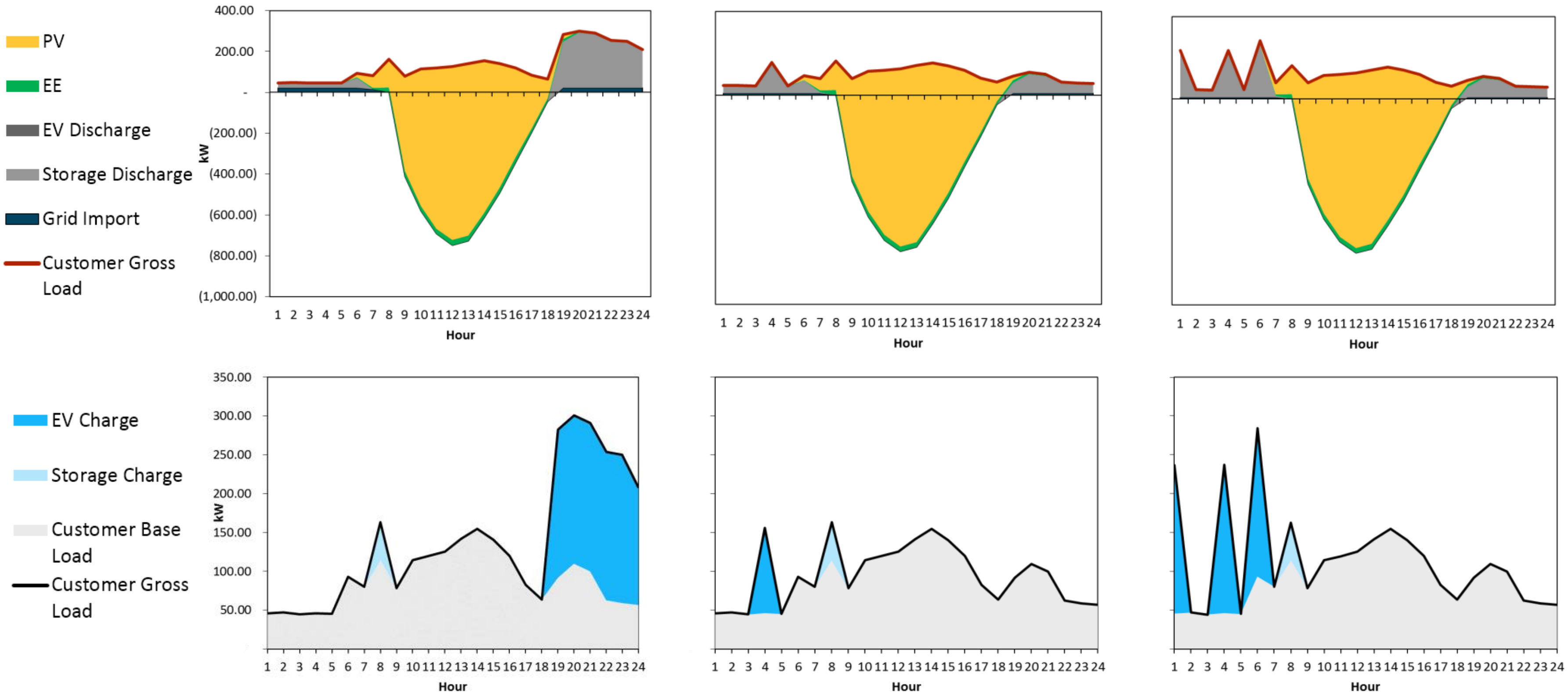
VGI Technology - Dispatch Behavior

SMCY electricity supply / demand balance – Monday April 17th

Unmanaged Charging	Managed Charging	V2G

Supply

Demand



		Unmanaged Charging	Managed Charging	V2G
Annual Storage charge / discharge cycles		82	60	60
Annual EV charge / discharge cycles		20	20	20

PSPS Break-Even VoLL

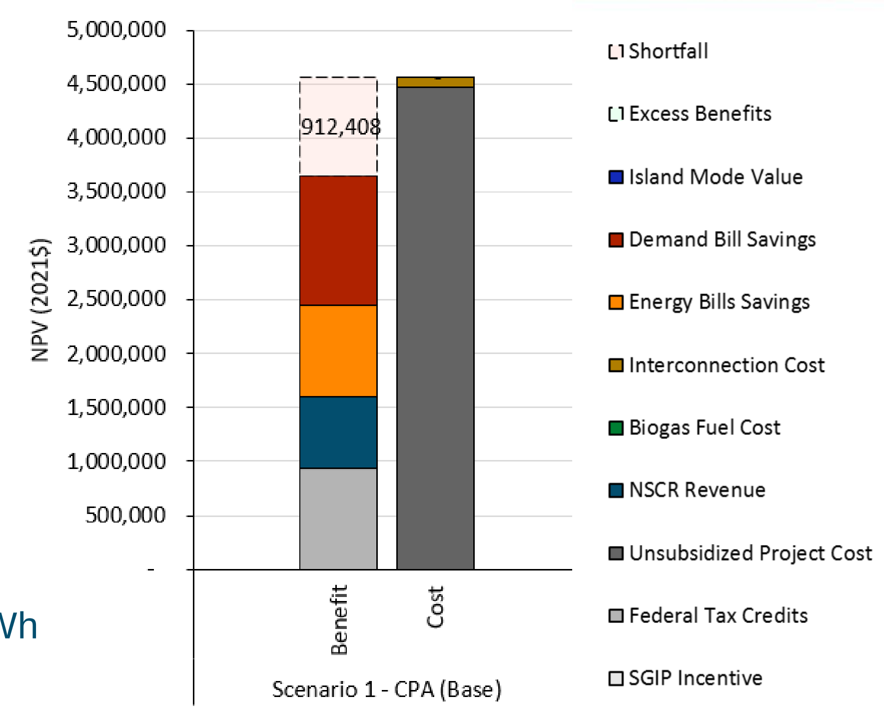
- **Shortfall with no VoLL: $912,408**
- **SMCY annual load:** 882,724 kWh
- **Based on SAIDI and SAIFI outage assumptions:**

$$Avg\ Outage\ Probability = \frac{SAIDI \times SAIFI}{8760\ hours \times 60\ mins/hour}$$

SAIDI = 62.4 mins / event
SAIFI = 0.85 events / year

NPV of load covered during lifetime outage events: 875 kWh

Break-even VoLL = 1,042.77 $ / kWh



- **Based on a Public Safety Power Shutoff Protocol (PSPS) outages:**

Assuming total annual outage duration: 72 hours / year

NPV of load covered during lifetime outage events: 71,265 kWh*

Break-even VoLL = 12.80 $ / kWh

[1] Assuming outage events and duration remain constant over 25-year lifetime

Energy+Environmental Economics

Model Updates for Final Release

Model Update – What's New

UI

- Inputs Generator UI are now separated into two individual UIs for better user experience (timeseries vs others)
- ancillary service settings can now be viewed and edited in UIs

Model

- executable files are now consolidated which effectively reduces the model size
- storage can now be operated under CAISO REM rules as one of the storage technology specification inputs

Data

- more example cases are now available along with the model package for better use case demonstration

Model Update – Improvements

UI

- **UI response speed and size**
- consistency of chart color patterns in Dashboard
- more meaningful results in Dashboard

Model

- portfolio selection calculation methodology
- EV unmanaged charging calculation methodology
- general model improvements, including code conventions, results decimal place, warning messages, output process, and Python package requirements

Data

- default large_user: VoLL updated to 85 $/kWh
- default FTM cost test definition
- default real-time rates
- default storage parameters
- default avoided cost settings

Model Update – Bug Fixes

UI

- Screening Tool: total distribution avoided costs can now show up when detailed T&D feature is TRUE
- Screening Tool: distribution network can now show up consistently
- Simplified UI: PAC cost test charts are now in the correct places
- General UI bug fixes including chart regrouping function, color pattern mismatch, a few dropdown list errors, user instructions, DER technology size calculation, and number format.

Model

- remove redundant CAIDI calculation
- remove typos in pro forma module, frequency check module
- export_snapshot feature can now work smoothly when it tries to save load modifier data
- fix the criteria of showing driving profile conflict warning message
- fix the way annual run results and hourly timeseries results are aggregated
- fix storage mileage calculation

Data

- convert default data to 2019$
- default financial scenario: "Battery alone qualified for ITC" updated to FALSE
- default NP15/SP15 avoided generation capacity cost (see User Guide)
- default ancillary service setting: spin special requirement updated to FALSE
- zero out customer reliability value for FTM customers, and storage mileage cost
- fix example Rector data in distribution location, fixed day-type mismatch in some default utility rate inputs

Recommendations

Recommendations and Next Steps

- **To provide a more user-friendly and robust DER evaluation tool for California, we recommend adding in or at least considering the following features in future studies:**
- **Further development of simplified user interface**
- **CAISO Market Rules**
  - Modeling the detailed CAISO rules can be helpful for developers in their daily operation and project acquisition process.
- **Imperfect Foresight**
  - Dispatch simulation with imperfect foresight can provide a more realistic estimation of revenues.
- **Electrification**
  - More features can be added to further analyze the cost-effectiveness of the electrification. For example, natural gas bill calculations and building stock-rollover.
- **Customer Adoption Projection**
- **Microgrid Sizing**