



Final Report of the Sacramento Municipal Utility District’s Technical Working Group on the Value of Solar + Storage

February 6, 2020

This Report summarizes the recommendations of SMUD’s Value of Solar + Storage Technical Working Group. [Gridworks](#) served as the Group’s facilitator and prepared this report.

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Introduction and Background

Between October 2019 and January 2020 SMUD convened a group of stakeholders interested in Net Energy Metering (NEM), a policy used to compensate customers who adopt behind-the-meter solar and solar + storage. The convening was named the “Technical Working Group on the Value of Solar and Solar + Storage” (TWG).

Participants in the TWG included representatives of SMUD customers, the solar industry, the storage industry, utility scale generators, low income customers, disadvantaged communities, UC Davis, environmental advocates, community leaders and SMUD. Participants were invited by SMUD to represent a range of viewpoints and deep expertise needed to ensure a 360-degree evaluation of NEM. A complete list of participants and contributors can be found in Appendix A.

[Gridworks](#) was retained by SMUD to facilitate meetings, create meeting minutes, and create this report reflecting the Group’s recommendations. The TWG reviewed and edited meeting minutes throughout its recommendations, as well as a draft of this Final Report. Throughout the process the facilitator maintained editorial independence in documenting recommendations of the group on how to conduct a Value of Solar and Solar + Storage study for SMUD.

Purpose and Goals

The purpose of the TWG was to make recommendations on how to conduct a value of solar and solar + storage¹ study to inform SMUD’s consideration of whether and how to change its current NEM policy. Recognizing there are a wide range of views on what should be included in a Value of Solar study, the TWG worked to achieve agreement on as many components for the study as possible. The initiative included 6 meetings held over 4 months, for 30 hours of meeting time.

The recommendations included here are intended to guide the work of an independent third-party consultant being hired by SMUD to determine the value of solar/storage. In

¹ For brevity, “Solar/Storage” is used generally to include solar (only) and solar + storage, except where more specificity is needed to distinguish between the configurations.



fulfilling this purpose the TWG serves as an advisory body (rather than decision-making).

At its first meeting, the TWG collaborated to identify the following goals for the Initiative.

- The Initiative will identify clear value of solar/storage categories and embrace innovative approaches to recognizing those values. This valuation will be done with an open process that will serve as an example beyond SMUD's territory.
- The Initiative will support equity for SMUD customers and promote affordable service for low income customers.
- The Initiative will balance the views and needs of the community and customers.
- The Initiative will pursue carbon reduction at the best value for SMUD customers.
- The Initiative will support a sustainable business model for SMUD.

These goals guided the process.

Scope and Timeline

The scope of the TWG included consideration of potential benefits provided by distributed solar/storage to non-solar/storage-participating SMUD customers and any costs which may be incurred to create those benefits. The TWG agreed to consider the following benefit categories: generation, environmental, societal, transmission, and distribution, each a part of a solar/storage "value stack." The specific benefits and costs the TWG considered are delineated below in Tables 1-5.

The scope of the TWG did not include policy questions related to NEM. Examples of policy questions which emerged but were tabled include:

- Should existing solar/storage systems be treated differently than new ones (i.e., grandfathering)?
- Is SMUD's Integrated Resource Plan well constructed and worthwhile?
- Should SMUD rates be used to secure identified benefits and recover associated costs?
- Should low income customers receive different treatment than other customers?



- The costs of interconnection born by SMUD customers and the potential cost savings which could be achieved through automation of interconnection. (Currently, SMUD does not charge NEM customers an interconnection fee).
- The merits of the various compensation mechanisms for the distributed generation (e.g., NEM, Virtual NEM, Net Billing, Feed in Tariffs)

Thus, the TWG sought to maintain a specific focus on guiding a forthcoming study which will be conducted by an independent third-party to determine the value of solar/storage to customers in SMUD’s territory. In turn, that information could support SMUD’s management and Board of Directors in determining the best approach to compensating customers with solar/storage. Policy related questions will be addressed in follow-on Community Working Groups.

Figure 1 from SMUD shows where the TWG’s work fits into the expected decision making process of SMUD staff and Board of Directors.

Figure 1: SMUD’s NEM Evaluation Timeline - Illustration Only



Summary of Presentations and Discussions

The TWG benefitted from presentations provided by participants as well as outside experts. Over five meetings the following presentations were provided:

Meeting #1 (October 18, 2019)

- Jennifer Davidson (SMUD) provided a presentation initiating the TWG and expressing SMUD’s priorities. Slides from the presentation are available here:



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<https://www.smud.org/-/media/Documents/Rate-Information/NEM-2/10182019-J-Davidson-Welcome-Tech-Working-GroupFINAL.ashx>.

- Eric Poff (SMUD) provided a presentation titled “Valuation Technical Working Group -- Agenda Overview and Define Components.” Slides from the presentation are available here:

<https://www.smud.org/-/media/Documents/Rate-Information/NEM-2/10182019-E-Poff-Agenda-Overview-Tech-Working-GroupFINAL.ashx>.

Meeting #2 (November 7, 2019)

- Justin Scott (SMUD) provided an overview of SMUD’s NEM and Rate Structure. Slides from the presentation are available here:
<https://www.smud.org/-/media/Documents/Rate-Information/NEM-2/Overview-of-SMUDs-NEM-and-Rate-StructureFINAL.ashx>.
- Scott Martin (SMUD) provided an overview of SMUD’s Integrated Resource Plan. Slides from the presentation are available here:
https://www.smud.org/-/media/Documents/Rate-Information/NEM-2/IRP_Overview_NEM2_Workshop2_November7.ashx.
- James Frasher (SMUD) provided an overview of SMUD’s Energy Storage Roadmap. Slides from the presentation are available here:
https://www.smud.org/-/media/Documents/Rate-Information/NEM-2/Technical-Working-Group_Energy-Storage-Roadmap_FINAL.ashx.
- Dr. Karlynn Cory (National Renewable Energy Laboratory) provided a presentation titled “Value of Solar: Using Your Resources Wisely.” (Dr. Cory’s slides are available to TWG participants only at the presenter’s request.)

Meeting #3 (November 21, 2019)

- Rick Codina (SMUD Customer) provided a presentation, “The Value of Energy and Capacity from Rooftop Solar” available here:
<https://www.smud.org/-/media/Documents/Rate-Information/NEM-2/112119-Rick-Codina.ashx>.
- Scott Murtishaw (CalSSA) provided a presentation, “Energy and Capacity Value of Solar (& Storage) available here:
<https://www.smud.org/-/media/Documents/Rate-Information/NEM-2/112119-Scott-Murtishaw.ashx>.
- Jan Smutny-Jones (SMUD customer, Independent Energy Producers) provided a presentation, “Observations on the Value of Solar,” available here:



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<https://www.smud.org/-/media/Documents/Rate-Information/NEM-2/112119-Jan-Smutny-Jones.ashx>.

- Jon Olson (SMUD) provided a presentation, “Valuation of NEM Solar: A Wholesale Power Market Perspective,” available here:
<https://www.smud.org/-/media/Documents/Rate-Information/NEM-2/112119-John-Olson.ashx>.

Meeting #4 (December 12, 2019)

- Dr. Elena Krieger (Physicians, Scientist and Engineers for Healthy Energy) provided a presentation, “DER Non-energy Benefits” available here:
<https://www.smud.org/-/media/Documents/Rate-Information/NEM-2/121219-PSE-Healthy-Energy-Krieger-2019-SMUD.ashx>. Dr. Krieger’s analyses can also be interacted with at <https://www.psehealthyenergy.org/california-power-map/>.
- Luis Amezcua (Sierra Club) provided a presentation, “Environmental Benefits of Distributed Generation,” available here:
<https://www.smud.org/-/media/Documents/Rate-Information/NEM-2/121219-SMUD-presentation-on-environmental-benefits-of-DG-Sierra-Club.ashx>.
- Steve Campbell (Grid Alternatives) provided a presentation, “Societal Benefits Presentation to SMUD NEM Working Group,” available here:
https://www.smud.org/-/media/Documents/Rate-Information/NEM-2/121219-Societal-Benefits-Presentation-to-SMUD-NEM-Working-Group_v4.ashx.
- Al Rich (ACR Solar) and Lee Miller (SMUD Customer) provided a presentation, “Rooftop Solar Creates Jobs in Sacramento,” available here:
<https://www.smud.org/-/media/Documents/Rate-Information/NEM-2/121219-ACR-Solar--L-Miller-Economic.ashx>.
- Patrick Durham, Rene Toledo, and Eric Rivero-Montes (SMUD) provided a presentation, “Valuation of NEM Solar: Environmental Considerations,” available here:
https://www.smud.org/-/media/Documents/Rate-Information/NEM-2/121219-NEM---Environmental-Presentation_2019-12-12_Final.ashx.

Meeting #5 (January 9, 2020)

- Maria Veloso Koenig and James Frasher (SMUD) provided a presentation, “Valuation of NEM Solar: Transmission and Distribution Grid Perspective” available here:



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<https://www.smud.org/-/media/Documents/Rate-Information/NEM-2/SMUD-NEM-20-TD-Presentation-01092020.ashx>.

- Damon Franz (Tesla) provided a presentation, “Transmission and Distribution Value” available here:

<https://www.smud.org/-/media/Documents/Rate-Information/NEM-2/TeslaSMUD-Avoided-TDJan09FINAL-D-Franz--Tesla.ashx>.

- Paul de Martini (Pacific Energy Institute) provided a presentation, “T&D Value of Solar + Storage” available here:

<https://www.smud.org/-/media/Documents/Rate-Information/NEM-2/DeMartini-SMUD-TD-Value-of-DER-Jan-2020.ashx>

Meeting #6 (January 30, 2020)

- Lee Miller (SMUD Customer) provided a presentation, “Distributed Solar Across Income Levels” available here:

<https://www.smud.org/-/media/Documents/Rate-Information/NEM-2/Distributed-Solar-Across-Income-Levels---Lee-Miller-Presentation.ashx>

Summaries of these presentations, as well as insights which emerged as the TWG discussed them, are recorded in the group’s meeting minutes, available at:

<https://www.smud.org/nem2>.

Recommendations

The TWG arrived at the following recommendations. Recommendations are organized into two groups: overarching and value specific.

Overarching Recommendations

The TWG makes the following overarching recommendations:

- A. The Value of Solar/Storage analysis of benefits and costs should be specific to SMUD territory.
- B. The Value of Solar/Storage analysis should consider three resource configurations: 1) solar (only), 2) solar+storage responding to Time of Day rates, and 3) solar+storage responding to SMUD dispatch signals maximizing value for all customers.



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- C. The Value of Solar/Storage depends on the accuracy of forecasted supply and demand. The evaluation should rely on state of the art forecasting methods.
- D. The Value of Solar/Storage should be based on expected future values in the SMUD system (as opposed to historical trailing value).
- E. The Value of Solar/Storage should be updated regularly with the Integrated Resource Plan. Updates should reflect the impact of increasing electrification and new technology.
- F. The Value of Solar/Storage study will include a Cost Impact Analysis of SMUD's current NEM rate with respect to NEM and non-NEM customers. This analysis will include an annual and cumulative cost impact value using existing solar customer count and IRP solar adoption projections over 10 years starting in 2020 assuming no changes to NEM. In performing the its analysis, the TWG recommends the consultant consider the Value Components and guidance included below in Tables 1-5. Upon completion, the consultant should compare the estimated Value of Solar/Storage to the price currently paid for distributed generation under NEM to inform SMUD's decision-making on future solar/storage compensation.

Value Specific Recommendations

Tables 1-5 include a summary of the TWG's value specific recommendations categorized by generation, environmental, societal, transmission, and distribution. Combined, the tables identify 23 potential value components, each a potential benefit or cost that may be attributable to distributed solar/storage in SMUD's territory. The TWG assigned each value component to a category and gave each a unique ID for ease of reference.

Inclusion of the recommendation in the table implies the TWG reached "General Agreement"² that the consultant performing SMUD's Value of Solar/Storage study should consider the value element. Following each table, various related suggestions, caveats and dissents put forward by TWG participants are identified. Unless otherwise

² No counting mechanism was used to determine exactly how many participants supported or opposed each element; the determination of whether General Agreement was achieved was determined by the facilitator using their best judgement.



noted, these perspectives are offered by individual participants and did not reach broad agreement by the group.

The applicability and implementation of each recommendation may depend on whether it is being applied to one or more of the TWG’s envisioned resource configurations: 1) solar (only), 2) solar + storage responding to Time of Day rates, and 3) solar + storage responding to SMUD dispatch signals maximizing value for all customers. Unless otherwise noted, the TWG defers to the consultant to exercise judgement on which recommendations apply to each resource configuration.

Generation Category

Table 1: Summary of SMUD Technical Working Group Recommendations Generation Category			
ID#	Value Component	Benefit/Cost	Description
1	Energy	Benefit	Avoided purchase of energy that would otherwise be needed, including SMUD’s obligations to comply with California’s RPS and carbon emissions cap-and-trade system
2		Cost	Integration costs
3		Cost	Higher marginal cost of emissions due to intermittent resources
4	Generation	Benefit	Provides Resource Adequacy
5	Capacity	Cost	Increases need for intra-hour flexibility
6	Financial Risk	Benefit	Reduces Fuel Price Risk
7		Neutral	Increases energy price volatility
9		Neutral	Assigned criteria pollutant Emission Reduction Credits are sunk cost (no financial impact)
10	Variable Operating	Benefit	Decreased thermal power plant operations will decrease variable operating costs (i.e., water,



	Cost		waste, etc.)
10a		Cost	Increased power plant standby/station power costs and higher operations and maintenance (O&M) costs due to cycling

With regards to the generation category of value specific recommendations, the following suggestions, caveats and dissents are put forward by TWG participants:

- Recommendation 1, Energy:
 - The TWG agreed the energy value of solar/storage is reflected in hourly wholesale energy prices SMUD would otherwise have purchased that energy.
 - The TWG acknowledged utility scale solar energy may be the marginal resource displaced by rooftop solar energy at an increasing number of hours going forward. This can be accounted for through a forecast of hourly marginal resources.
 - Rick Codina and SMUD suggest the consultant should perform production cost modeling with and without solar/storage to determine energy value.³
 - Jan Smutny-Jones offers references to the California Legislative Analyst Office and Lazard's to support valuation of energy to help inform the consultant's research.⁴

- Recommendation 2, Integration Costs:
 - The TWG suggests CAISO Regulation Up and Regulation Down prices may be an appropriate proxy for these costs.
 - CalSSA and Sunrun observe these costs have been de minimis in past Value of Solar studies.

- Recommendation 4, Resource Adequacy:
 - A method for allocating the share of a solar/storage resource that is reliably available when generation demand peaks should be used.

³ Rick Codina offers the following explanation of his presentation and recommendations: <https://gridworks.org/wp-content/uploads/2020/02/NotesOnNEM-2Presentation-1.docx>

⁴ Resources available at <https://gridworks.org/wp-content/uploads/2020/02/lazards-levelized-cost-of-energy-version-130-vf-1.pdf>



- CESA suggests the work of the California Public Utilities Commission on how to count solar + storage resources toward Resource Adequacy obligations should be considered.⁵
- Recommendation 5, Increased Need for Intra-hour Flexibility:
 - The TWG concludes this cost would be applicable to Solar (only). Applicability to solar + storage depends on whether the retail rates or operator dispatch signals the resource is responding to reflect grid needs.
- Recommendation 10 and 10a, Variable Operating Costs:
 - Sunrun suggests variable operating costs identified by SMUD should be considered, but notes they may be mitigated through timely storage application and operation.

Environmental Category

Table 2: Summary of SMUD Technical Working Group Recommendations Environmental Category			
ID#	Value Component	Benefit/Cost	Description
11	Criteria Emission Reductions	Benefit	Overall decreased emissions contribute to societal benefits
11a	Carbon Emission Reductions	Benefit	Benefits of reducing carbon emissions beyond those achieved in support of SMUD’s compliance with California cap and trade system (Recommendation #1)
12	Land and Water Use	Benefit	Use of the built environment, water use reductions

With regards to the environmental category of value specific recommendations, the following suggestions, caveats and dissents are put forward by TWG participants:

- Recommendation 11, Criteria Emission Reductions:

⁵ The CPUC’s Resource Adequacy proceeding is accessible through <https://www.cpuc.ca.gov/RA/>.



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- The TWG agreed the magnitude of criteria emission reductions depend on how well the solar/storage displaces the conventional alternative. Key factors impacting this question include:
 - Which marginal generator is displaced? Is the solar/storage meeting needs or dispatching to the grid in a time and place the results in displacement of a conventional generator or not?
 - Did the distributed resource result in more ramping of conventional generators?
 - Are the financial incentives to discharge storage aligned with the period of greatest emission intensity for the alternative power supply (e.g., peak demand)?
 - What is the population density near the displaced power plants?
 - Does storage get charged by onsite solar or by grid power? If so, what is the emission intensity of the grid power used?
 - Is the emitting generator a cogeneration plant that creates steam for an industrial process?
- Recommendation 11a, Carbon Emission Reductions:
 - Reducing carbon emissions creates a benefit beyond the captured value of allowances in California's cap-and-trade system, included under Recommendation #1.
 - Sacramento 350 suggested the consultant should count the Social Cost of Carbon, which would reflect the full environmental costs of carbon emissions, as a benefit of solar/storage. Sacramento 350 offered references to support the consultant.⁶
 - Tesla suggested the consultant could estimate the value of solar/storage using a Marginal Cost of Emissions method, which would reflect the costs SMUD would otherwise incur to reduce carbon emissions beyond its obligations under California's cap-and-trade system.
 - Professor Dave Rapson observes that the California's cap-and-trade system will impact whether rooftop solar/storage

⁶ Kopp & Mignone 2012 <http://dx.doi.org/10.5018/economics-ejournal.ja.2012-15>; Nordhaus 2018 <http://cowles.yale.edu/sites/default/files/files/pub/d20/d2084.pdf>; Scovronick et al. 2019 https://journals.lww.com/epidem/Fulltext/2019/09000/Human_Health_and_the_Social_Cost_of_Carbon_A.6.aspx; Xu et al. 2019 <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6818759/>



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reduce carbon emissions, regardless of price paid. Rapson explains, “since emissions from grid-scale electricity generation are under the “cap” (AB32), rooftop generation can produce head-room for other polluting sources by reducing net demand for (grid-scale) electricity. Because of this, rooftop solar will only produce additional abatement when the cap is “non-binding” (i.e. emissions are either below the cap or the permit price is at the price ceiling). The signal for whether this is the case comes from the permit price -- when the permit price is at the price floor or the price ceiling, the cap is non-binding and rooftop solar will contribute incremental abatement. At any intermediate price, the cap is “binding” (i.e. emissions equal the cap and would be higher without it), and rooftop solar does not offer net incremental abatement.” Therefore, the quantity of solar/storage actually reducing carbon emissions should be analyzed and value for reducing carbon emissions should be limited to the generation which occurs when the cap is not binding. A similar argument applies to the 100% renewables mandate, in which more rooftop solar in SMUD territory will slow down and eventually displace investment in renewables elsewhere in California.

- Patrick Mealoy suggests performing a sensitivity analysis on the price of allowances under the cap-and-trade system, testing a range of prices from the administratively set floor price, to the Marginal Cost of Emissions, and the Social Cost of Carbon.
- Recommendation 12, Land and Water Use:
 - While supportive of the value created through these benefits, the Working Group has not fully agreed on whether recovery of the costs of creating these benefits should be accomplished through SMUD rates.
 - The Sierra Club offers references which include methods for quantifying the value of avoided land and water use.⁷

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https://gridworks.org/wp-content/uploads/2020/02/1137-Distributed-Generation-White-Paper_03_low-1.pdf



- Jan Smutny-Jones observes that the environmental costs associated with land use of large scale solar is internalized in the wholesale energy price.

Societal Category

Table 3: Summary of SMUD Technical Working Group Recommendations Societal Category			
ID#	Value Component	Benefit/Cost	Description
13	Equity	Benefit	Reduced energy burden for low income customers who have solar/storage
14	Resilience	Benefit	Customer can meet critical needs during outage if the system is configured to function during grid outages.

With regards to the societal category of value specific recommendations, the following suggestions, caveats and dissents are put forward by TWG participants:

- Recommendation 13, Equity:
 - SMUD suggests solar + storage may be a more costly way of providing these benefits relative to alternatives.
- Recommendation 14, Resilience:
 - The TWG agrees the value of resilience in SMUD’s territory appears lower than in neighboring territories where wildfire risk mitigation strategies are leading to power shutoffs.
 - Paul de Martini observes the methods for determining resilience value are probably not adequate for this application. De Martini offered a reference to guide the consultant.⁸
 - The TWG acknowledges:
 - The installed system must be configured to deliver energy independently of the grid.

⁸ https://gridworks.org/wp-content/uploads/2020/02/Regulating-for-Resilience_USDOE_Zetterberg_11.20.19-1.pptx



- The benefits which accrue to the participating customer should be distinguished for both participating and non-participating customers.
- Lee Miller and Al Rich suggested several additional societal benefits be considered, including local economic growth and the value of engaging customers in their energy use. Both suggestions are detailed in their presentation, “Rooftop Solar Creates Jobs in Sacramento.”⁹ These suggestions were not generally agreed to by the TWG. Competing and supportive perspectives included:
 - John Briggs suggests job creation is not unique to the generation of electricity by solar/storage. Building and maintaining thermal plants and nuclear plants also create jobs. Moreover, the growth of the renewable energy industry seems to result in job/economic replacement—a shift of jobs from fossil fuel based electricity production to renewable electricity production.
 - Director Benjamin Finkelor suggests jobs and associated companies that deploy solar/storage are also likely well-suited to deploy electrification solutions. These solutions are inherently distributed, requiring companies and jobs to be put to work on renovating buildings and equipment for residential and commercial customers. Most likely solar/storage installers will provide more value to SMUD and its customers by switching their business models from installing just solar/storage to installing Solar/Storage that responds to SMUD dispatch AND (and perhaps more importantly) electrification and electric vehicle charging infrastructure.
 - Sunrun offered the consultant a reference on the relative benefit to local economies of distributes and utility scale solar.¹⁰

⁹ <https://www.smud.org/-/media/Documents/Rate-Information/NEM-2/121219-ACR-Solar--L-Miller-Economic.ashx>

¹⁰ https://gridworks.org/wp-content/uploads/2020/02/Crossborder-Energy_Power-to-the-Customer-1-2-1.pdf



Transmission Category

Table 4: Summary of SMUD Technical Working Group Recommendations Transmission Category			
ID#	Value Component	Benefit/Cost	Description
18	Transmission Capacity	Benefit	Reduces day time demand and may reduce traditional upgrades
19	Transmission Line Losses	Benefit	Local generation reduces losses on transmission grid

With regards to the transmission category of value specific recommendations, the following suggestions, caveats and dissents are put forward by TWG participants:

- Recommendation 18, Transmission Capacity:
 - As it did with Resource Adequacy, the TWG Working Group agreed that a methodology for allocating capacity from solar+storage resources should reflect reliably available capacity when transmission demand peaks.
 - Tesla offers the National Economic Research Associates method for determining Transmission and Distribution value.¹¹
 - Jan Smutny-Jones and Rick Codina dispute rooftop solar helps meet transmission system peak without storage.
 - Paul de Martini observes that determining transmission benefits may require a full study of power flow on the transmission grid with and without the distributed resources. Such a study is not practically implemented by a third party consultant.

- Recommendation 19, Transmission Line Losses:
 - The TWG Working Group agrees avoided line losses at the transmission level is a benefit, but doubts whether this benefit would be large enough to prioritize.

¹¹ <https://www.smud.org/-/media/Documents/Rate-Information/NEM-2/TeslaSMUD-Avoided-TDJan09FINAL-D-Franz--Tesla.ashx>



Distribution Category

Table 5: Summary of SMUD Technical Working Group Recommendations Distribution Category			
ID#	Value Component	Benefit/Cost	Description
20	Distribution Capacity	Benefit	Reduces daytime demand and may reduce traditional distribution upgrades
21	Distribution Line Losses	Benefit	Local generation reduces losses on distribution grid
22		Cost	Excess generation increases losses at a local level
23	Grid Modernization	Cost	The costs of tools and infrastructure used by the utility to support DER at the distribution level
25	Voltage/Power Quality	Benefit	Local power quality can be maintained with appropriate smart inverter settings
26		Costs	Distribution system equipment wear & tear (voltage regulators and capacitors)

With regards to the distribution category of value specific recommendations, the following suggestions, caveats and dissents are put forward by TWG participants:

- Recommendation 20, Distribution Capacity:
 - As it did with Resource Adequacy and Transmission Capacity, the TWG agreed a methodology for allocating the share of a solar/storage resource that is reliably available when distribution demand peaks should be considered.
- Recommendation 21 and 22, Distribution Line Losses:
 - The TWG agreed line losses at the distribution level is a benefit, but doubts whether this could be quantified and would be large enough to



prioritize.

- Recommendation 23, Grid Modernization:
 - The TWG observes such costs would need to be incremental to what would have been needed otherwise and that, unless the costs is wholly due to solar/storage, only a share of the costs (rather than the full costs) may warrant recognition.

- Recommendation 25 and 26, Voltage and Power Quality:
 - The TWG agreed these benefits and costs warrant consideration and acknowledged whether they materialize depends on whether smart inverter volt var functions are enabled.

Prioritizing the Technical Working Group’s Recommendations

Recognizing that the value of solar study that will be performed using the TWG recommendations as an input will be time constrained, the TWG ranked its priorities. To determine its priorities, fourteen working group participants responded anonymously to an electronic survey. Each participant was asked to rank order 26 potential recommendations from highest priority to lowest priority. (Please note the items highlighted in yellow were recommendations that did not reach general agreement in the TWG, but were included in the prioritization exercise). If a recommendation was ranked as a top priority from one participant, that recommendation received 26 points, two participants 52 points, and so on. A recommendation which was prioritized as the top priority for all participants would have received a score of 364 (14 participants x 26 points).

Table 6 shows the results of the prioritization exercise. Five recommendations are marked with an asterisk; explanations follow those recommendations follow the table.

Table 6: Results of the SMUD Technical Working Group Prioritization Exercise					
ID	Value Component	Description	Rank	Points (Out	Score



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				of 364)	
1	Energy	Avoided purchase of energy that would otherwise be needed, including SMUD's obligations to comply with California's RPS and carbon emissions cap and trade system	1	351	96%
4	Generation Capacity	Provides Resource Adequacy	2	287	79%
2	Energy	Integration Cost	3	276	76%
8*		Decreased GHG allowances required per decreased thermal power plant generation	4	234	64%
5	Generation Capacity	Increases need for intra-hour flexibility	5	250	69%
6	Financial Risk	Reduces Fuel Price Risk	6	246	68%
3	Energy	Higher marginal cost of emissions due to intermittent resources	7	236	65%
11	Criteria Emission Reductions	Overall decreased emissions contribute to societal benefits	8	234	64%
10	Variable Operating Cost	Decreased thermal power plant operations will decrease variable operating costs (i.e., water, waste, etc.)	9	215	59%
13	Equity	Reduced energy burden for low income customers who have solar/storage	10	205	56%
12	Land and Water Use	Use of the built environment, water use reductions	11	204	56%
18	Transmission Capacity	Reduces day time demand and may reduce traditional upgrades	12	200	55%
7	Financial Risk	Increases energy price volatility	13	199	55%
14	Resilience	Customer can meet critical needs during outage	14	194	53%



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19	Transmission Line Losses	Local generation reduces losses on transmission grid	15	180	49%
20	Distribution Capacity	Reduces daytime demand and may reduce traditional distribution upgrades	16	164	45%
21	Distribution Line Losses	Local generation reduces losses on distribution grid	17	141	39%
9	Financial Risk	Assigned criteria pollutant ERCs are sunk cost (no financial impact)	18	141	39%
17*	Emotional/Political	Engaging customers with their bill through NEM changes the way they use energy	19	136	37%
11	Carbon Emission a* Reductions	Benefits of reducing carbon emissions beyond those achieved in support of SMUD's compliance with California cap and trade system (Recommendation #1)	20	132	36%
25	Voltage/Power Quality	Local power quality can be maintained with appropriate smart inverter settings	21	129	35%
16*	Local Economy	Jobs and local economic growth resulting from rooftop solar	22	127	35%
24*	Reliability	Restoring service or preventing outages in an emergency	23	125	34%
26	Voltage/Power Quality	Distribution system equipment wear & tear (voltage regulators and capacitors)	24	101	28%
23	Grid Modernization	The costs of tools and infrastructure used by the utility to support DER at the distribution level	25	97	27%
22	Distribution Line Losses	Excess generation increases losses at a local level	26	93	26%



Explanations:

- At the suggestion of the TWG, this final report combines Recommendation #8, decreased GHG allowances required per decreased thermal power plant generation, and Recommendation #1. However, the two were separate at the time this prioritization poll was conducted. This likely impacted the results of the prioritization.
- Recommendations 16 and 17 were omitted from the Summary Tables of this final report because they both did not achieve general agreement by the group and they received relatively low prioritization scores.
- Recommendation 24 was omitted at the request of the TWG.
- Recommendation 11a, recognizing the benefits of reducing carbon emissions beyond those achieved in support of SMUD's compliance with California cap and trade system (Recommendation #1), emerged from discussion immediately preceding the prioritization exercise and was not clearly identified and accessible to the participants during the prioritization exercise. Therefore, this scoring result may not be reflective of the TWG's priorities.

Because of this uncertainty, and because recognition of the benefits of carbon emission reductions was a key priority advanced by some participants in the TWG, Gridworks endorses the suggestion advanced by Mr. Maeloy: *the consultant should perform a sensitivity analysis on the price of carbon emission allowances under the cap-and-trade system, testing a range of prices from the administratively set floor price, to the Marginal Cost of Emissions, and the Social Cost of Carbon.* This relatively simple addition to the analysis will provide the public and SMUD's Board of Directors a range of results reflecting a diversity of perspectives on the important question of how to recognize the cost of carbon in determining the Value of Solar/Storage.

The results of this ranking are not intended to be binding on the consultant, but rather a general expression of the TWG to guide the consultant's navigation of prioritization and trade-offs.

Conclusion

SMUD's Technical Working Group concluded its work on January 30, 2019, beginning the next phase: execution of the SMUD Value of Solar/Storage study by a third-party,



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independent consultant. SMUD intends to share the results of the study with the TWG at its conclusions, including providing a briefing and notification about future steps for those interested.

SMUD and Gridworks wish to thank the participants and presenters for the considerable effort made, perspective shared, and the spirit of compromise that prevailed.



Appendix A: Participants and Contributors in the Technical Working Group

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- Alex J. Morris, California Energy Storage Alliance (CESA)
- Alex Jackson, Natural Resource Defense Council (NRDC)
- Alcides Hernandez, Sacramento Municipal Utility District (SMUD)
- Ben Davis, California Solar & Storage Association (CalSSA)
- Ben Finkelor, University of California (UC) - Davis
- Damon Franz, Tesla
- Dan Noran, Canadian Solar
- Dave Rapson, University of California (UC) - Davis
- David Wright, 350 Sacramento
- Eric Poff, Sacramento Municipal Utility District (SMUD)
- Jan Smutny-Jones, Independent Energy Producers Association (IEP)
- John Briggs, Customer
- Joshua Brister, Sunrun
- James Frasher, Sacramento Municipal Utility District (SMUD)
- Justin Scott, Sacramento Municipal Utility District (SMUD)
- Kim Bates, Sacramento Municipal Utility District (SMUD)
- Lauren Randall, Sunrun
- Lee Miller, Customer
- Matthew Tisdale, Gridworks - Facilitator
- Obadiah Bartholomy, Sacramento Municipal Utility District (SMUD)
- Olof Bystrom, Sacramento Municipal Utility District (SMUD)
- Patrick Mealoy, Customer
- Rick Codina, Customer
- Rachel Bird, Borrego Solar
- Steve Campbell, GRID Alternatives
- Stephanie Bray, United Way
- Scott Murtishaw, California Solar & Storage Association (CalSSA)

