



August 26, 2022

Arizona Corporation Commission
1200 W. Washington Street
Phoenix, AZ 85007

RE: Study of Community Solar Value Stack in Arizona - Community Solar (Docket No. E-00000A-22-0103), APS RES (Docket No. E-01345A-21-0240)

Madam Chair, Commissioners, Commission Staff, and Interested Stakeholders,

The signatories to this letter — a coalition of solar and storage industry partners, including developers, subscriber acquisition and management firms, and advocacy groups — appreciate the Commission and Staff conducting the working group meetings regarding the implementation of a community solar program in Arizona. We believe that a properly constructed community solar program will provide bill savings to electric utility customers, promote electric grid resiliency, and assist Arizona in its transition to clean energy. We are committed to docketing information that will assist in the Commission’s consideration of a proposal for implementation and we look forward to continued participation and discussion in the working group sessions.

Attached to this letter is a study completed by The Brattle Group that analyzes the value stack of community solar in Arizona. The Brattle Group is a leading consulting firm that specializes in answering complex economic, finance, and regulatory questions for corporations, law firms, and governments around the world.

The value stack of a community solar project represents the costs that would otherwise be borne by ratepayers but that are avoided due to the energy and grid services provided by a

community solar project. The community solar value stack consists of three value streams: (1) Avoided Generation, (2) Avoided Transmission and Distribution, and (3) Avoided Emissions.

The purpose of this value stack study is to provide the Commission and stakeholders with information to guide discussions on an appropriate bill credit rate and compensation mechanism for the community solar program in Arizona. Brattle will be prepared to present this material and answer questions at the working group session on August 30, 2022. We look forward to additional discussions regarding designing a final bill credit rate, tariff, and compensation mechanism for projects.

Respectfully,

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Community Solar Value Stack in Arizona

METHODOLOGY AND RESULTS

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AUGUST 30, 2022

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Agenda

1. Introduction
2. Value of Avoided Generation
3. Value of Avoided T&D
4. Value of Avoided GHG Emissions
5. Conclusion
6. Appendix

Introduction



Purpose of This Study

APS has a voluntary commitment to reach 100% clean energy by 2050 and will require support from competitive energy providers to meet this goal in the most efficient and cost-effective manner. Community solar is one of the solutions that will support this goal.

- In May 2022, the ACC ordered the creation of a Community Solar Working Group to establish the details of an APS community solar program
- The working group was tasked with capturing best practices from across the country and seeking input on mechanics, implementation, and operational details including:
 - Interconnection process
 - Ownership structures
 - **Compensation mechanisms** ← Focus of this study
 - Bill credit design
 - Technology and location

Study Objective: Develop a data-driven estimate of the value community solar projects provide to the APS grid to serve as the basis for compensation mechanisms for projects and rates for customers.

Background

ACC Decision 78583¹ proposes that community solar subscribers be compensated using a direct bill offset structure similar to that offered to rooftop solar customers.

- Text reads: “Direct bill offsets may be considered for subscribers to produce savings in a structure substantially similar to that offered to rooftop solar customers, eliminating the need for incentives. The value proposition for subscribers should be similar to those participating in onsite generation.”

Since 2017, rooftop solar in Arizona has been compensated using the Resource Comparison Proxy (RCP)

- The RCP rate is based on the assumption that rooftop solar offsets the need for utility-scale solar projects with additional adjustments for avoided transmission and distribution capacity costs and line losses¹
- In the most recent filing for the RCP rate² (effective 2022-2023), APS calculated an RCP rate range of \$48.30-\$54.00/MWh
- However, due to the 10% cap on annual RCP rate reduction, the actual rate is \$84.65/MWh

We follow a methodology that evaluates which resources may be avoided due to community solar projects by considering forward-looking avoidance of generic energy, capacity, and T&D requirements.

¹ [ACC Decision 78583](#) ² Sources and notes: [Docket No. E-01345A-16-0036](#), August 18, 2017, Appendix H; ³ [Docket No. E-01345A-22-0105](#), Jun 14, 2022, Commission Staff’s Memorandum on Revised RCP Rate

Approach

We estimate the value community solar projects provide to the APS grid based on the costs that would be borne by ratepayers but for the energy and grid services provided by a community solar project in APS' service territory.

- The community solar value stack consists of 3 value streams:
 - 1. Avoided Generation:** The value of reduced energy and capacity requirements due to community solar generation
 - 2. Avoided Transmission and Distribution:** The value of reduced T&D system capacity needs resulting from location of community solar closer to load than utility-scale generation
 - 3. Avoided Emissions:** The value of reduced GHG emissions from generation plants that would operate if not for community solar generation
- We present an estimated range of the levelized value of each value stream over a 20-year timeframe for a community solar project going into service in 2023
- Other states, such as NY and MN, take similar value-based approaches to compensate community solar projects¹

¹ New York State Public Service Commission, [The Value Stack](#), 2022; Minnesota Department of Commerce, Division of Energy Resources, [Minnesota Value of Solar: Methodology](#), 2014

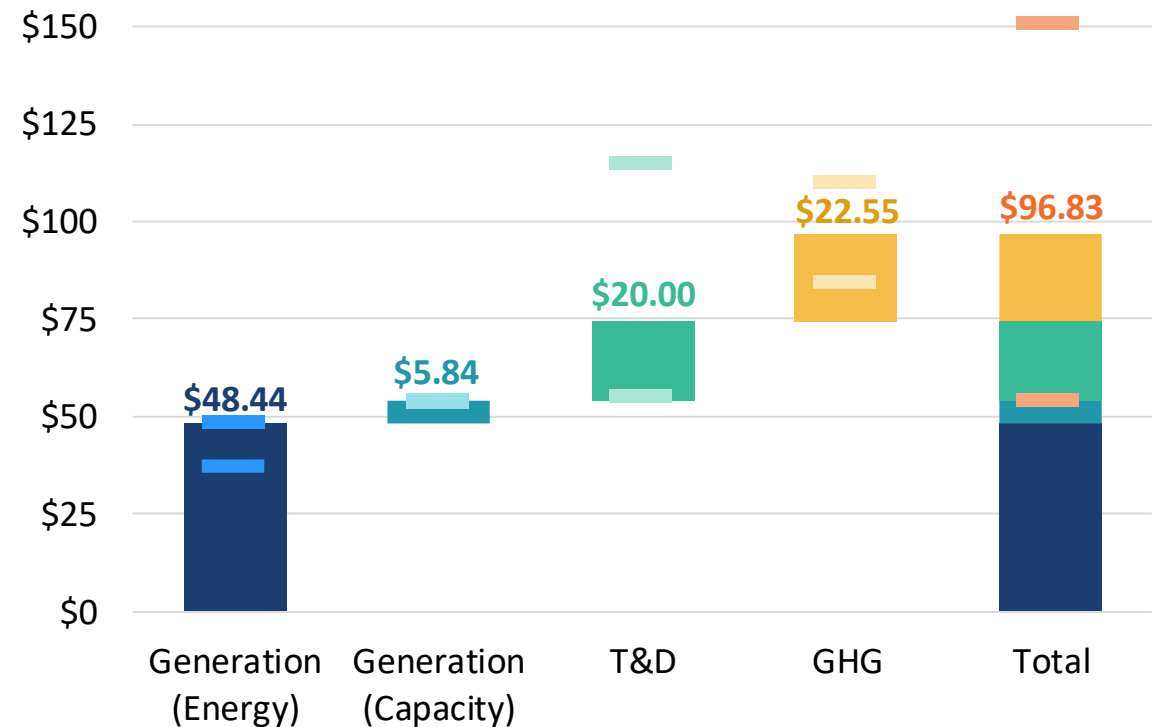
Summary of Value Stack Results

Based on our analysis of avoided generation, T&D, and GHG emissions, we estimate community solar value in the APS region ranges from \$54.45/MWh to \$150.92/MWh.

Within this range, we recommend a value of **\$96.83/MWh** based on selection of a reasonable combination of methodologies and data sources.

- **Generation Value:**
 - Avoided energy costs range from \$37.49-\$48.44/MWh with recommended value of **\$48.44/MWh**
 - Avoided capacity costs range from \$5.44-\$5.84/MWh with recommended value of **\$5.84/MWh**
- **T&D Value:** Avoided T&D capacity costs range from \$1.14-\$60.86/MWh with recommended value of **\$20.00/MWh**
- **Emissions Value:** Avoided GHG emissions costs range from \$10.38-\$35.78/MWh with recommended value of **\$22.55/MWh**

Community Solar Value Stack (\$/MWh)



Value of Avoided Generation



Avoided Energy and Capacity Cost Estimation Approach

We quantify the value of generation avoided due to community solar using energy price forwards at Palo Verde hub and NREL's modeling of energy and capacity prices in the APS balancing area.

- Forward peak and off-peak energy prices are available through 2028 at Palo Verde¹ hub, representing the market's expectation of future prices; we use historical 2021 hourly price patterns to develop hourly value of solar based on the Palo Verde prices
- NREL's Standard Scenarios that simulate the US power sector through 2050 are updated annually and provide hourly prices, emissions, and other operational data based on capacity expansion modeling at the balancing area level
- We use the results for the AZPS balancing area from two of **NREL's scenarios**:
 - **No New Policy Scenario** – A scenario with no assumptions on policy mandates imposing a carbon emission limit on the power sector.
 - **95% Clean by 2050 Scenario** – A scenario with policy-driven 95% reduction in US power sector carbon emissions by 2050; this scenario is more applicable to the APS context as APS has a commitment to reach 100% clean generation by 2050.
- As NREL's Standard Scenarios were last updated in 2021, they do not capture the recent increases in energy prices; our recommended case adjusts for this lag by using Palo Verde hub forward prices through 2028 and NREL's 95% Clean by 2050 case prices from 2029 to 2043
- In each case, we calculate generation-weighted avoided costs based on a representative hourly community solar generation profile provided by Cypress Creek²

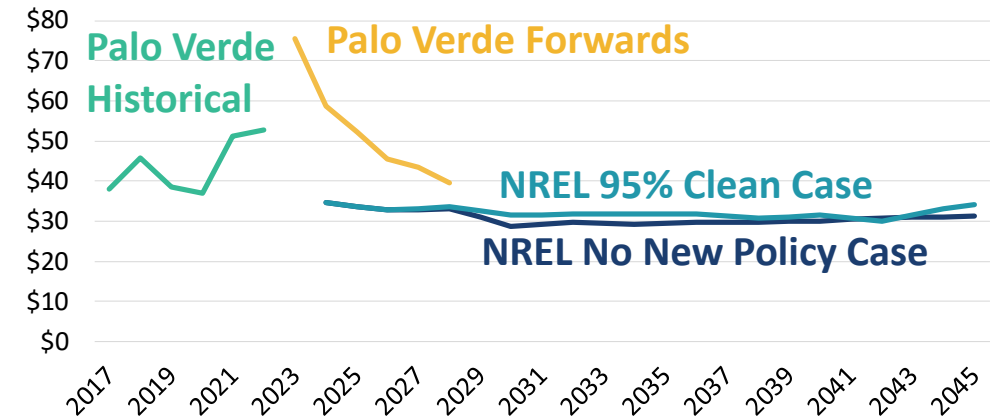
¹ Palo Verde hub prices were also used by APS in its 2020 IRP to represent wholesale market prices in Arizona; ² Generation profile shown in appendix

Forward-Looking Energy and Capacity Prices

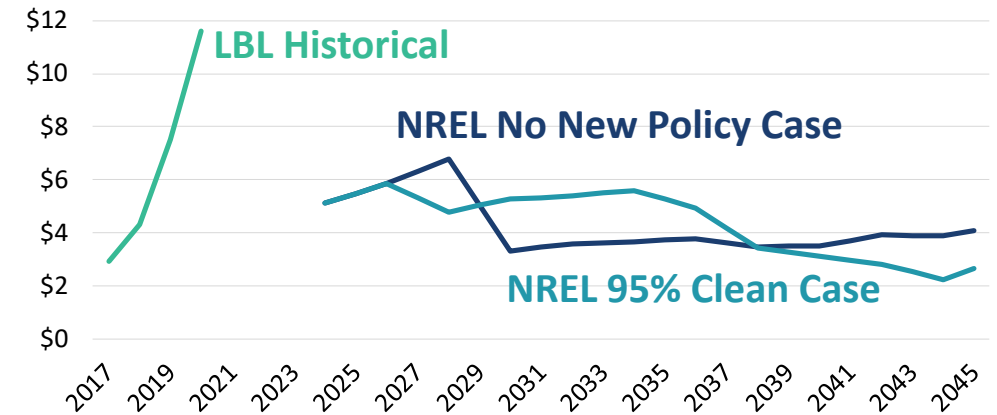
We use projected energy and capacity prices to quantify the value of community solar generation over the 20-year period from 2023-2042.

- NREL’s 95% Clean and No New Policy cases have similar prices through around 2045, leading to very similar results in both cases
- NREL’s scenarios are from the 2021 vintage, before the more recent increase in prices due to inflation
 - This leads to a significant disconnect in the early years between the most recent actual prices and NREL’s modeled prices
 - Palo Verde forwards show that the market expects prices to return close to the levels projected by NREL by 2029
- Our recommended case uses prices from the NREL 95% Clean case with Palo Verde Forwards substituted for NREL’s energy prices through 2028

Avoided Energy Value, 2022\$/MWh



Avoided Capacity Value, 2022\$/MWh



Energy and capacity values are based on projected prices and a community solar project’s hourly generation profile (provided by Cypress Creek); NREL calculates hourly capacity costs by spreading an annual capacity price across the highest net load hours. This is intended to reflect the hours the system is most capacity-constrained and how the timing of those hours could change over time. Values are grossed up for avoided line losses of 6.5%.

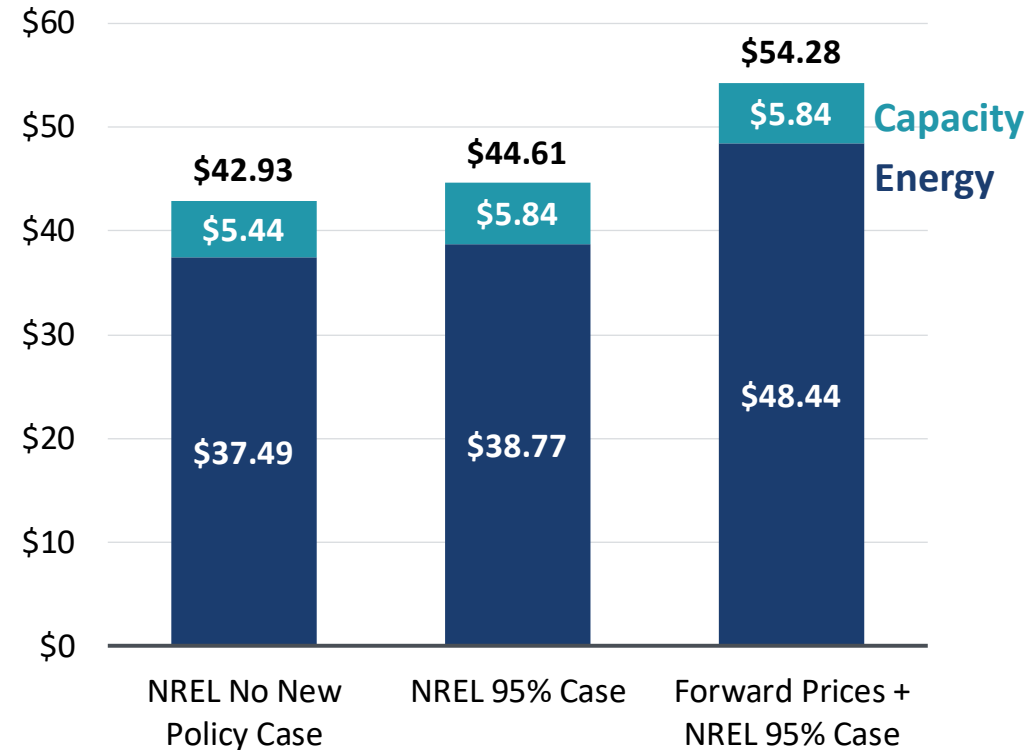
Sources: LBL [Utility-Scale Solar 2021](#) Report, NREL [Cambium 2021](#), APS IRP 2020, Forward prices pulled from [ICE](#) on 8/22/2022.

Avoided Energy and Capacity Value Results

Total estimated generation value ranges from \$42.93-54.28/MWh. We recommend the high value of \$54.28/MWh as this captures the impact of high energy prices in the near-term in addition to the long term dynamics of AZ’s electricity system.

- Levelized energy value is \$37.49/MWh in the No New Policy case and \$38.77/MWh in the 95% Clean case
- Incorporating forward prices through 2028 when using the 95% Clean case increases energy value to \$48.44/MWh (recommended case)
 - We recommend this methodology as the recent price increases lead to a disconnect between the most recent actual prices and NREL’s modeled prices in the early years
 - Palo Verde forwards are current and show that the market expects prices to return to the levels projected by NREL by 2029
- Levelized capacity value is \$5.44/MWh in the No New Policy case and \$5.84/MWh in the 95% Clean case

Levelized Avoided Generation Value, \$/MWh



Energy value is based on projected prices and a community solar project’s hourly generation profile (provided by Cypress Creek). NREL calculates hourly capacity costs by spreading an annual capacity price across the highest net load hours. This is intended to reflect the hours the system is most capacity-constrained and how the timing of those hours could change over time. Value is grossed up by 6.5% to account for avoided line losses.

Sources: Energy Ventyx, S&P Capital IQ, NREL [Cambium 2021](#), APS IRP 2020.

Value of Avoided T&D



Avoided T&D Cost Estimation Approach

Community solar projects can reduce or defer transmission and distribution costs as they are located closer to the load than utility-scale generation. Due to lack of APS-specific analysis of marginal cost of T&D service, we base our estimates on a survey of marginal T&D cost studies conducted by other utilities across the U.S.

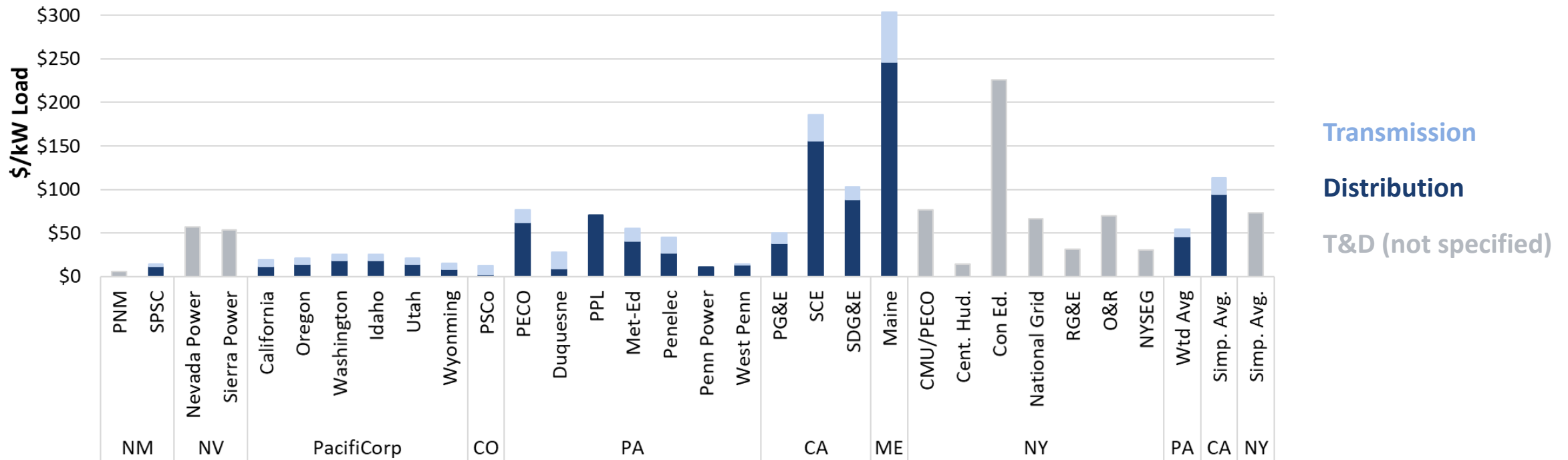
- Many utilities conduct marginal cost of service studies to estimate the T&D costs associated with load growth; these estimates are typically used in benefit cost analyses to evaluate the benefits offered by demand side management programs such as energy efficiency
- We survey 32 utilities with publicly available estimates of avoided T&D value
- Our low and high estimates are based on the bookends from the surveyed utilities
- As APS may be more similar to certain surveyed utilities than others, many of the surveyed values may not be appropriate to use to estimate avoided T&D value in APS' territory
 - To produce a more APS-specific value, we conduct a regression analysis of the relationship between historical load growth and avoided T&D value for each surveyed utility
 - We then use APS' forecast of load growth to predict an avoided T&D value for APS based on the regression results
 - The Recommended Case uses this predicted value for APS as it captures one of the factors that sets APS apart – high load growth
- We use a coincidence factor of 61% as community solar's contribution to reducing T&D load based on our analysis of average historical utility scale solar production in APS region in the top 100 load hours in each of the past 5 years

Survey of Marginal T&D Costs

We conducted a survey of US utilities to present a range of marginal T&D costs, as an APS-specific study is not available.

- Surveyed marginal T&D costs range from \$6 (Public Service New Mexico) to \$304 (Central Maine Power) per kW of load growth

Survey of Value of Avoided T&D Load, 2022\$/kW



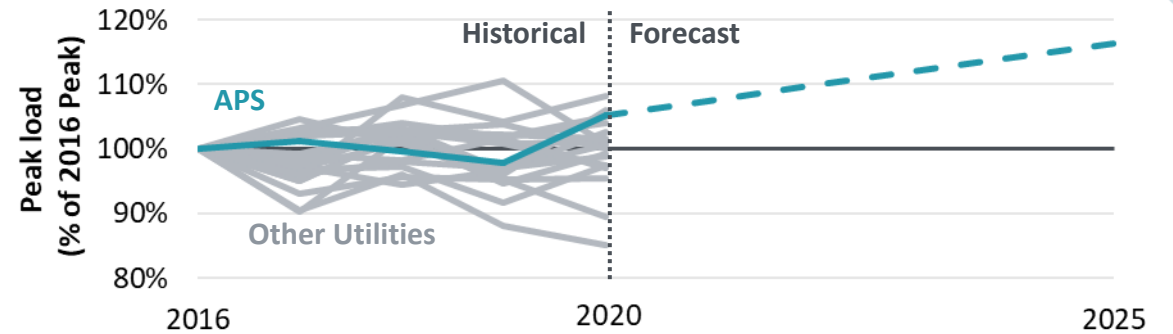
Analysis of Relationship Between Load Growth and T&D Cost

The survey shows a very broad range of costs and captures utility-specific conditions which may or may not apply to APS. In our Recommended Case, we estimate an APS-specific T&D cost.

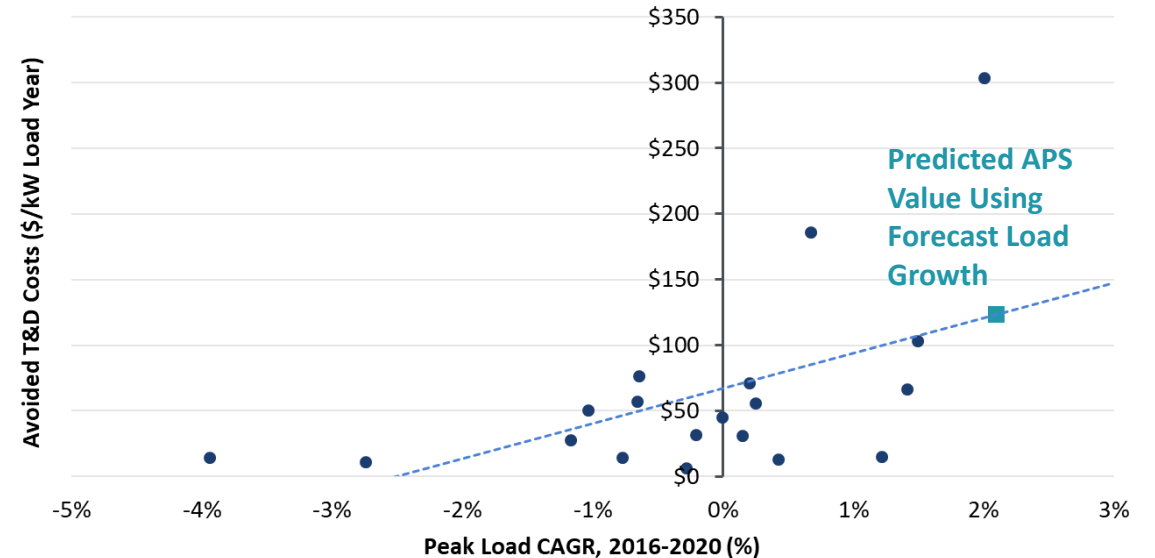
- An APS-specific marginal cost of service (MCOS) study would be the preferred method to value avoided T&D costs.
- Given the absence of an MCOS study, we conduct a high level regression analysis of load growth and marginal T&D cost for the surveyed utilities to estimate an appropriate marginal T&D cost for APS based on forecast load growth
- Though the regression analysis suggests a weak relationship between load growth and marginal T&D cost, it can be used to indicate where APS may fall within the surveyed range
- **APS forecasts load growth of 2.1%/yr** over the next 10 years²

The regression results suggest APS' marginal T&D cost could be around \$125/kW based on its relatively high forecast load growth rate.

2016-2020 Historical Load¹ for Surveyed Utilities



Historical Load Growth vs. Avoided T&D Costs



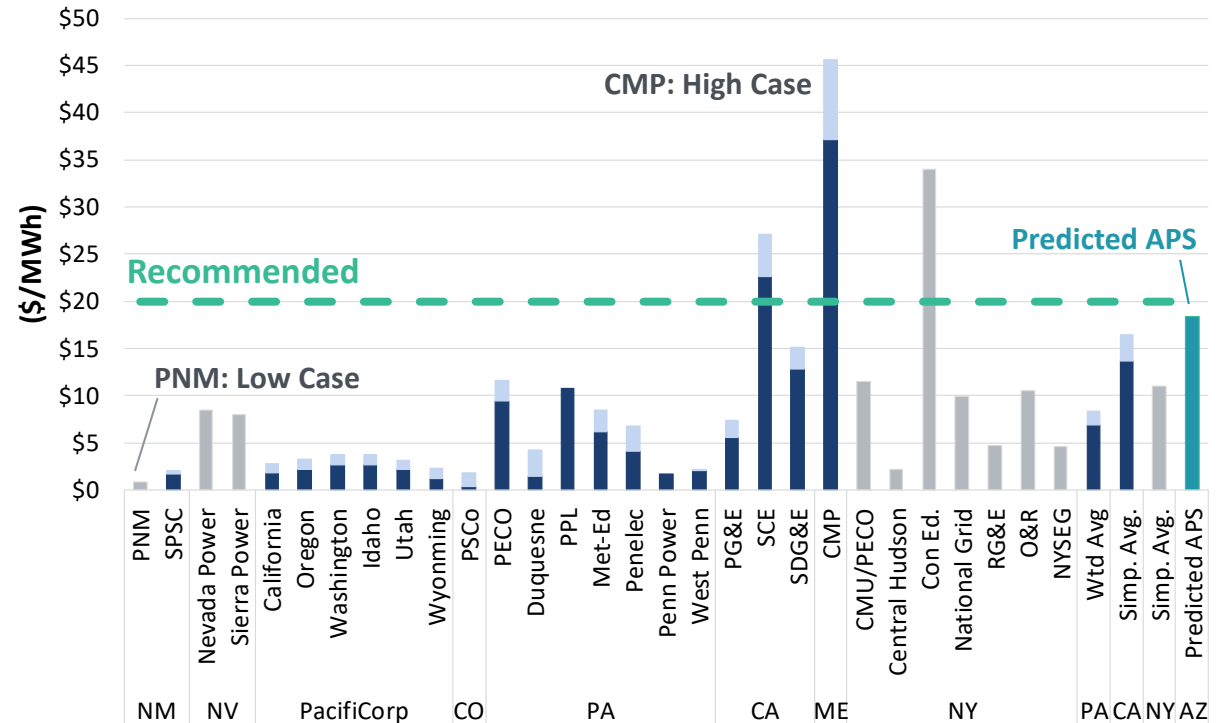
1 Historical utility peak loads from EIA 861 [Operational Data](#), 2016-2020; 2 APS forecast load growth from 2020 IRP

Avoided T&D Value of Community Solar

We use the estimated and surveyed marginal T&D costs to calculate a range for the value of T&D costs avoided by community solar projects.

- We assumed community solar projects are able to fully avoid the transmission system as they are distribution-interconnected. However, they are unlikely to fully avoid the distribution system as they require some distribution infrastructure to deliver power to customers from the community solar location. Among the surveyed utilities, avoided T&D value was comprised of 27% transmission and 73% distribution value on average. To adjust for the portion of the distribution system that may not be avoided, we apply a 25% de-rating to the T&D value of community solar.
- Using the predicted APS marginal T&D cost results with 25% de-rating results in avoided T&D value of **\$18.39/MWh**
- Using the bookends from the survey (PNM and CMP) results in **low and high estimates of \$0.86 to \$45.65/MWh**
- The estimated value of \$18.39/MWh for APS is very close to the T&D portion of the RCP rate, which sets the value of avoided T&D at a negotiated value of \$20/MWh. Though this RCP value was not set based on an actual calculation of system conditions, the survey and regression results suggest that it may be a reasonable approximation. Therefore, our **Recommended Case uses the RCP's T&D value of \$20/MWh.**

Levelized Avoided T&D Value of Community Solar, \$/MWh



Avoided T&D value of community solar calculated using 61% peak load coincidence based on Brattle analysis of the average solar generation in the top 100 peak load hours annually for the past 5 years in APS region. Value refers to 20 year revenue requirement impact discounted at APS WACC of 7.41%.

Value of Avoided GHG Emissions



Avoided Emissions Value Approach

Community solar reduces GHG emissions by reducing the need for fossil fueled generation. As both the amount of future emission reductions and the social value of reduced emissions are uncertain, we present a range of avoided GHG value based on multiple methods.

Methods for Estimating Avoided GHG Emissions

- 1. Avoided Natural Gas (NG) Generation:** Assumes solar generation reduces natural gas generation (this is the method used to estimate emission reductions in APS' 2020 IRP). This may be a reasonable simplifying assumption, as natural gas is the largest portion of APS' generation capacity and is most likely to be the generator on the margin.
- 2. Long Run Marginal Emission Rates:** This method uses projected hourly marginal emission rates through 2050 for the APS balancing area from the NREL Standard Scenarios. Similar to the avoided generation methodology, we use the NREL No New Policy Case and NREL 95% Clean by 2050 Scenarios. Long run marginal emission rates (LRMERs) represent the change in emissions due to a sustained change in demand, including both the operational (which generator would ramp up/down) and structural (capacity expansion) consequences of the change in demand; this metric is most appropriate to estimate the emission impacts of a durable asset such as a community solar project.

Methods for Estimating the Value of Avoided GHG Emissions

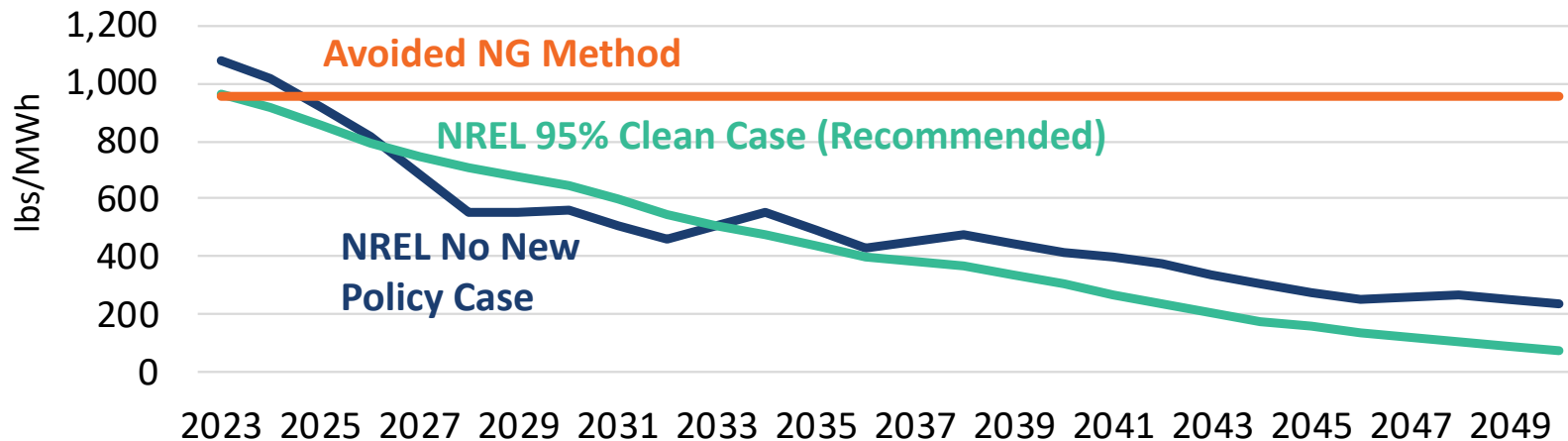
- 1. CA Carbon Prices:** APS' 2020 IRP used carbon prices from California's cap and trade program; the lower end of our estimated range uses this method with the most recent carbon price from CA's auctions, escalated at inflation
- 2. Federal SCC:** The higher end of our estimated range and our recommended case use the federal social cost of carbon through 2050

Estimated Amount of Avoided GHG Emissions

The amount of avoided GHG emissions due to community solar will decline over time as the grid is expected to become cleaner over time.

- Avoided NG case has constant avoided emissions of 952 lbs/MWh as it assumes all solar MWh avoid NG MWh
- The two NREL scenarios (No New Policy and 95% Clean) present bookends for forecast avoided emissions
 - Avoided emissions are higher in the No New Policy case as a significant amount of generation remains fossil fueled in this case
 - Avoided emissions are lower in the 95% Clean case as much of the avoided generation in this case is also clean generation
 - The 95% case is more appropriate due to APS' clean energy commitment and is used in our Recommended Case

GHG Emissions Avoided Due to Community Solar, lbs/MWh

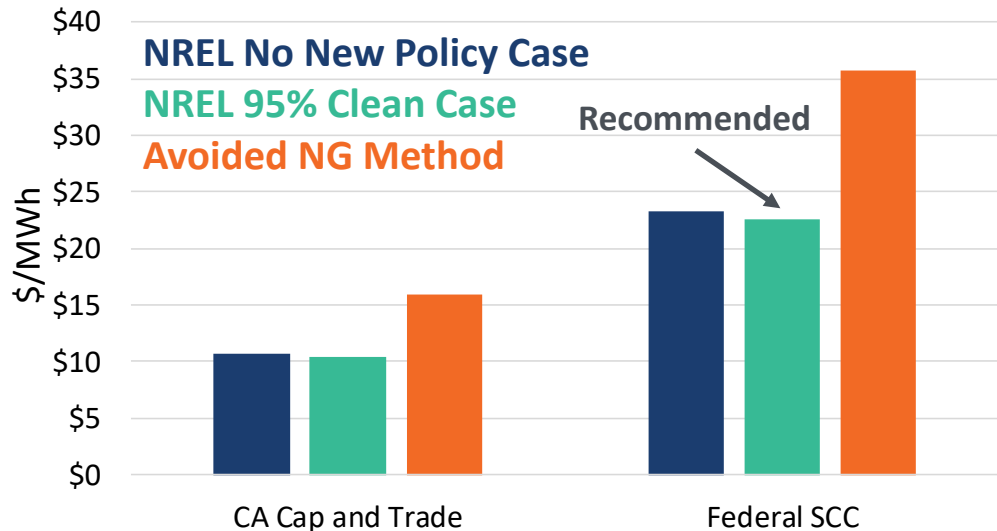


Estimated Value of Avoided GHG Emissions

In addition to the uncertainties in the scale of avoided GHG emissions, there are also different methods to value the avoided GHG. We present two methods:

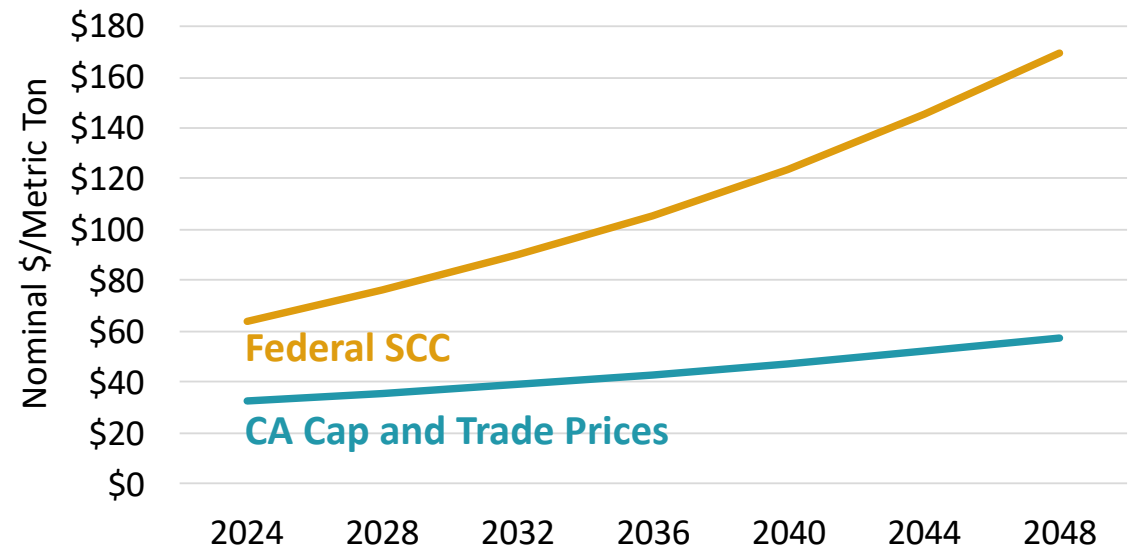
- Based on California’s cap and trade program allowance prices
- Based on the federal social cost of carbon (SCC)
- 20-year levelized value ranges from **\$10.38 to \$35.78/MWh**; our recommended methodology (NREL 95% Clean case, valued at SCC) results in a value of **\$22.55/MWh**

Levelized Value of Avoided GHG Emissions, \$/MWh



Values are grossed up by a line loss factor of 6.5% based on APS’ 2020 IRP.

GHG Price Assumptions, nominal \$/metric ton



Sources: [Technical Support Document: Social Cost of Carbon, Methane, \(whitehouse.gov\)](#), SCC using 3% discount rate

Conclusion



Summary of Findings and Next Steps

We find that the total value of community solar projects in APS territory could range from \$54/MWh to \$151/MWh, with a point estimate of \$97/MWh based on the recommended combination of methodologies and data sources.

- While the recommended value reflects a reasonable selection of market outlooks and methodologies, the broad estimated range reflects the uncertainty around forward-looking assumptions on future costs of generation, T&D, and emissions
- The value of community solar should be reevaluated on a regular cadence using the most recent data on market conditions

Once stakeholders and the ACC set an agreed upon value of community solar, that can serve as the basis for designing a compensation mechanism for projects and rates for subscribers.

Appendix



Background – Arizona’s RCP Methodology

The Resource Comparison Proxy (RCP) rate used to compensate rooftop solar generation is based on the value of avoiding an equivalent amount of utility scale solar capacity.

- The RCP methodology was set by the ACC in 2017 as the successor to full retail net metering
- The RCP rate for rooftop solar installed in each year is based on the costs of utility scale solar facilities and PPAs that went into service in the 5-year period preceding that year; this rate is locked in for 10 years for all rooftop solar installed in each year
 - i.e., a rooftop solar system installed in 2022 would receive for ten years an RCP rate set based on utility scale solar projects that went into service in 2017-2021
- The RCP rate calculation involves the following steps:
 - For the relevant utility-scale solar projects, develop revenue requirement for each APS-owned facility and calculate annual cost of power from PPAs
 - Calculate levelized cost per MWh for each facility using APS’ ATWACC as the discount rate
 - Calculate weighted average levelized cost for all facilities
 - Add adjustments for avoided transmission capacity cost, avoided distribution capacity cost, and line losses

Background – Recent RCP Rates

The RCP rate was initially set in 2017 and is revised every year in a filing by APS

- The 2017 order establishing the RCP specifies that the maximum allowed annual reduction in the RCP rate is 10%
- Accordingly, though the rate calculated by APS has been over 10% lower every year, the RCP rate in effect has only reduced by 10% per year as shown in the table below
- In the most recent filing for the RCP rate (effective 2022-2023), APS calculated an RCP rate range of **\$0.0483/kWh to \$0.054/kWh**
- However due to the cap on rate reduction, the **actual proposed rate is \$0.08465/kWh**
- While the avoided generation portion of the RCP rate is based on actual project costs, the **T&D portion of the rate is based on a negotiated value of \$0.02/kWh**; this value does not reflect an actual calculation of system conditions¹

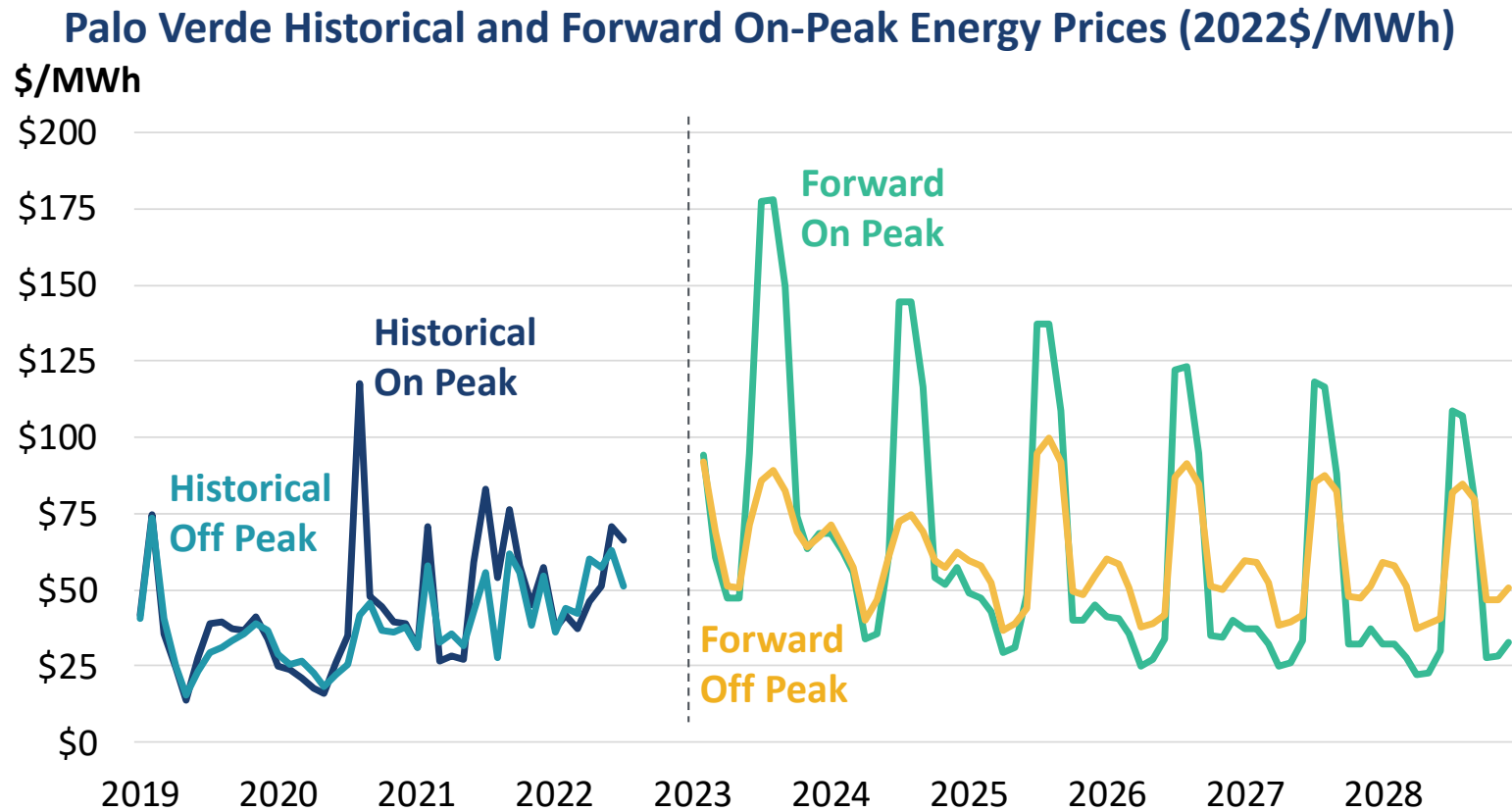
RCP Rates Approved Since Inception of the RCP Rider²

Commission Decision No.	Effective Period	RCP Rate per kWh	Percent Change from Prior Year
76295	September 1, 2017, through September 30, 2018	\$0.1290	-
76898	October 1, 2018, through September 30, 2019	\$0.1161	-10%
77421	October 1, 2019, through September 30, 2021	\$0.1045	-10%
77760	October 1, 2021, through August 31, 2022 ⁶	\$0.09405	-10%
-	September 1, 2022, through August 31, 2023	\$0.08465	-10%

¹ [Docket No. E-01345A-16-0036](#), August 18, 2017, Appendix H; ² Docket No. E-01345A-22-0105, Jun 14, 2022, Commission Staff's Memorandum on Revised RCP Rate

Palo Verde Hub Energy Prices

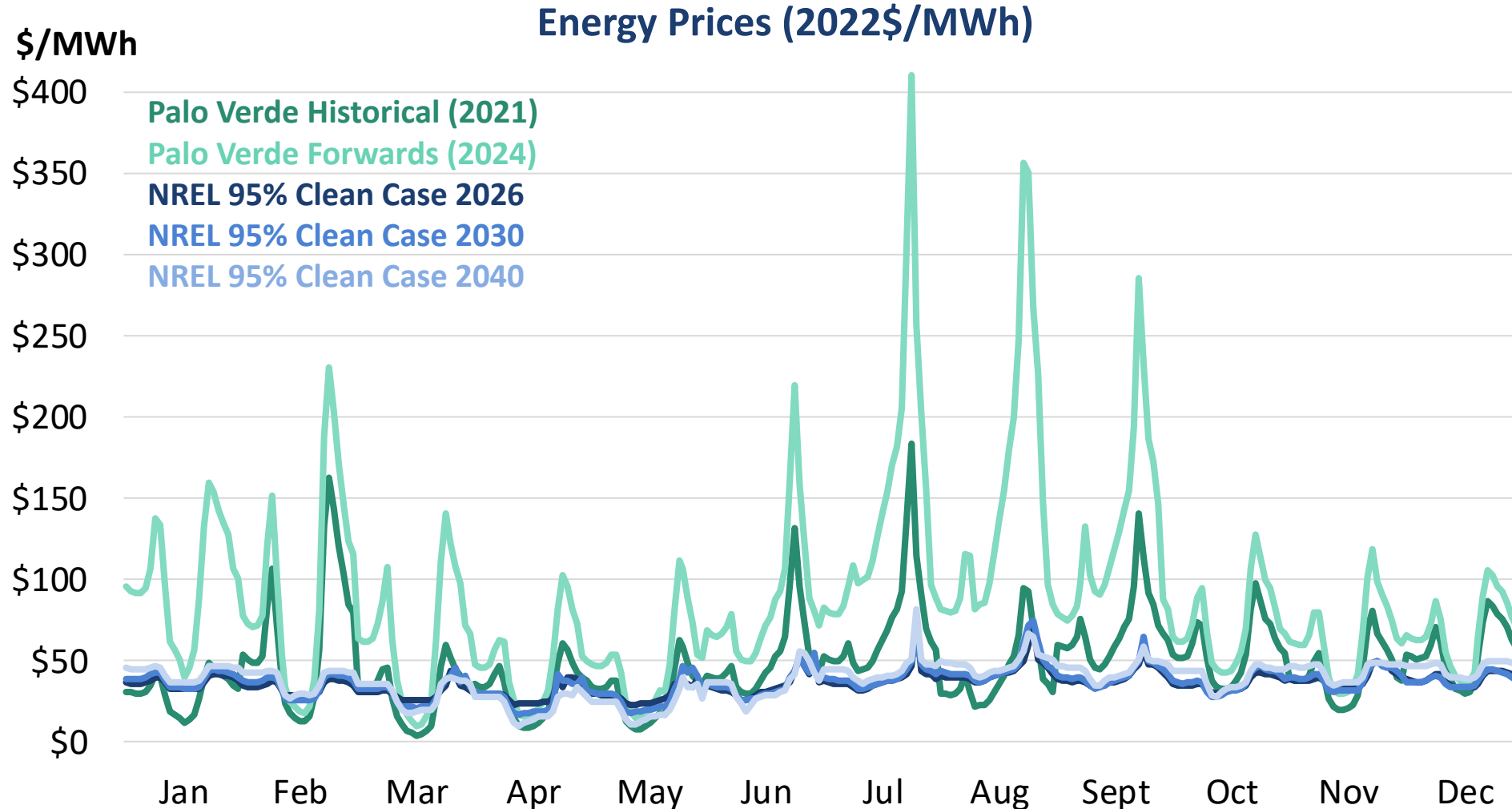
Energy prices at Palo Verde are used as one reference for estimating energy value of community solar. On Peak forwards trend downward at about 12.8%/year through 2028 while Off Peak forwards trend downward at about 2.7%/year through 2028



Source: S&P Capital IQ.

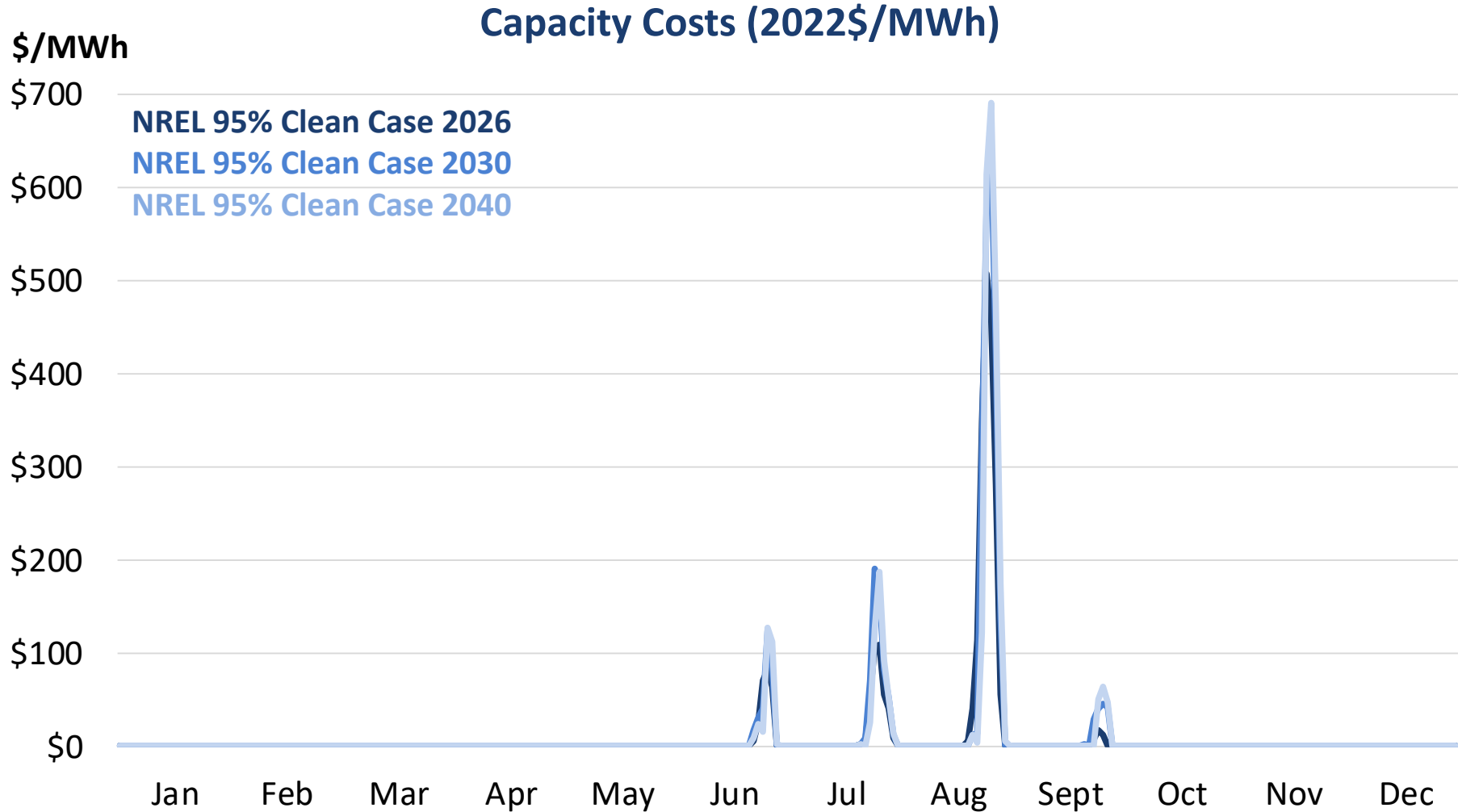
Privileged and confidential. Prepared at the request of counsel.

Energy Prices Assumptions



Note: Chart is made with one representative day from each month in the NREL cases and hourly averages by month for Palo Verde day-ahead historical and forward prices.

Capacity Costs Assumptions

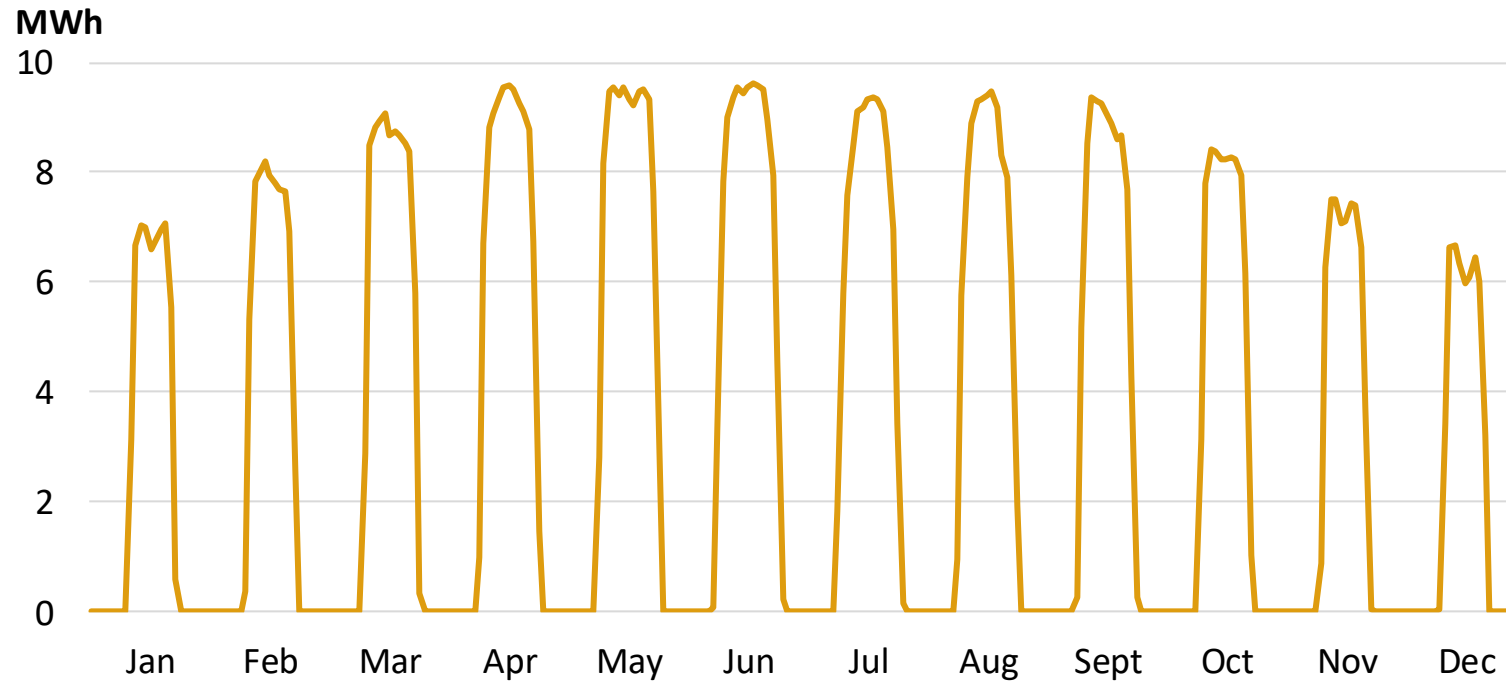


Note: Chart is made with one representative day from each month. NREL calculates hourly capacity costs by spreading an annual capacity price across the highest net load hours. This is intended to reflect the hours the system is most capacity-constrained and how the timing of those hours could change over time.

Community Solar Generation Profile



Community Solar Generation Profile (MWh)



Disclaimer

PLEASE NOTE

- This report was prepared for Cypress Creek Renewables Inc., in accordance with The Brattle Group's engagement terms, and is intended to be read and used as a whole and not in parts.
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- The projections provided in this presentation are necessarily based on assumptions with respect to conditions or events which may or may not arise or occur in the future. While we believe these assumptions to be reasonable for purposes of preparing our analysis, they are dependent upon future events that are not within our control or the control of any other person. Actual future outcomes can and will differ, perhaps materially, from those evaluated in these projections. No one can give any assurance that the assumptions and methodologies used will prove to be correct or that the projections will match actual results of operations. We do not make any representation with respect to the likelihood of any specific future outcome, and cannot and do not accept liability for losses suffered.
- While the analyses presented may assist Cypress Creek Renewables in rendering informed decisions, it is not meant to be a substitute for the exercise of Cypress Creek Renewables' own business judgment. Neither we nor Brattle will accept any liability under any theory for losses suffered, whether direct or consequential, arising from the reliance on the analyses presented, and cannot be held responsible if any conclusions drawn from this presentation should prove to be inaccurate.
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