Powers Engineering

May 20, 2022

San Diego County Board of Supervisors Chair Nathan Fletcher
San Diego County Board of Supervisors Vice-Chair Nora Vargas
San Diego County Supervisor Terra Lawson-Remer
San Diego County Supervisor Jim Desmond
San Diego County Supervisor Joel Anderson

Subject: Powers Engineering Comments on the Renewable Energy Assumptions in the March 2022 *Draft San Diego Regional Decarbonization Framework*

Dear Members of the Board of Supervisors:

Please find attached my comments on the renewable energy assumptions in the County's March 2022 *Draft San Diego Regional Decarbonization Framework* (RDF). I participated in the County's April 7, 2022 RDF Energy Workshop and provided the attached comments in abbreviated form both verbally and in the chat during that workshop.

The renewable energy assumptions in the RDF contain three principal deficiencies that are addressed in the attached Powers Engineering comment letter and are summarized below.

Comment 1	The very low cost of transmission upgrades assumed in the RDF to calculate the Levelized-Cost-of-Energy (LCOE) of remote, utility-scale renewable energy options is in error.
Comment 2	The solar rooftop and parking lot potential estimates for San Diego County in the RDF are very low, poorly documented, and inconsistent with other available solar potential estimates for San Diego County.
Comment 3	The assumed commercial rooftop solar cost in the RDF is high and obsolete.

Correcting these three deficiencies in the RDF would result in commercial rooftop solar and/or parking lot solar with battery storage, connected to the distribution grid, being the most cost-effective renewable energy alternative for San Diego County residents.

Please call me at [redacted] if you have any questions about the attached comments on the draft RDF.

Best regards,

Bill Powers, P.E.

Bill Powers, P.E.

Board Member – Protect Our Communities Foundation

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Powers Engineering Comments on the Renewable Energy Assumptions in the March 2022 *Draft San Diego Regional Decarbonization Framework* (RDF)

Bill Powers, P.E., May 20, 2022

<u>Comment 1</u> – The very low cost of transmission upgrades assumed in the RDF to calculate the Levelized-Cost-of-Energy (LCOE) of remote, utility-scale renewable energy options is in error

The RDF calculates the LCOE for remote solar and wind resources by summing (1) the capital cost of the renewable resource and (2) the cost to interconnect that resource to the nearest transmission substation, and then amortizes the resulting total cost over a cost recovery period.[1] This cost calculation procedure does not include the cost of upgrading the transmission system to move large amounts of new remote renewable energy generation to coastal demand centers.

The RDF alludes to a very low cost for transmission upgrades, $89 million, to transport new wind and solar power from eastern San Diego County and Imperial County.[2] This transmission cost is not integrated into the solar and wind LCOE cost calculations. The implication is that the transmission upgrade costs are essentially de minimis, and therefore the lack of inclusion of the transmission upgrade cost into the remote renewable energy LCOE calculation has no significant impact on the accuracy of the calculated LCOE values.

The presumption in the RDF that the only $89 million in transmission upgrade costs will be necessary to make remote solar and wind projects deliverable to coastal San Diego load centers is in error. The $89 million transmission cost upgrade assumption is for an internal reinforcement (reconductoring) in the greater San Diego area, primarily to enable full deliverability of San Diego-area battery storage and pumped storage (1,377 MW).[3] This internal reconductoring project is likely to occur. However, it is not intended to substantially increase transmission capacity to move remote renewable power generated in eastern San Diego County and Imperial County to San Diego-area load centers.

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[1] Draft RDF, March 2022, p. 21.

[2] Ibid, p. 28.

[3] CPUC Staff Report, *Modeling Assumptions for the 2022-2023 Transmission Planning Process*, December 2021, p. 57. "San Diego & Imperial – San Diego Internal Constraint: Resources mapped in this area resulted in a 614 MW FCDS exceedance in the San Diego Internal Constraint. This exceedance is caused by the mapping of 600 MW of FCDS wind, 100 MW of FCDS solar, and 1,377 MW of batteries and pumped storage to substations within the constraint. The RESOLVE model partially triggered this upgrade to accommodate resources it selected in this area. This transmission upgrade, as noted in the updated CAISO's 2021 White Paper, would increase the FCDS constraint limit by 2,067 MW, easily alleviating the mapped exceedance, cost an estimated $89 million, and take an estimated 18 months to complete."

This $89 million reconductoring project is not a Competitive Renewable Energy Zone (CREZ) transmission project. The $89 million reconductoring project is specifically identified as a "non-CREZ" project by the California Independent System Operator (CAISO), as documented in the RDF. A CREZ is an area targeted for transmission development to support renewable energy generation. Extreme eastern San Diego County and Imperial County are identified as one CREZ by the California Independent System Operator (CAISO).[4] The $89 million reconductoring project is not a transmission upgrade intended to substantially increase the import capacity of utility-scale solar and wind power from extreme eastern San Diego County, Imperial County, and out-of-state points to the east of these areas.

There is only one CREZ transmission project on the list of six potential SDG&E transmission upgrade projects being evaluated by CAISO and included in the draft RDF.[5] That CREZ transmission project is the $3.7 billion Imperial-to-Serrano 500 kilovolt transmission line. This project would enable 1,412 MW of new remote renewable power to be deliverable to San Diego County demand centers on or near the coast.[6]

CAISO is projecting that California's investor-owned utilities (IOUs) will spend over $30 billion on new transmission to facilitate increased utility-scale renewable power transfer from CREZ areas like Imperial County and out-of-state Arizona and New Mexico projects to achieve.[7] SDG&E represents about 10 percent of the total IOU demand in California.[8] On a simple proportional basis it can be assumed that SDG&E would add $3 billion or more in new renewable energy transmission capacity. In this context, the LCOEs for different renewable energy resources analyzed in the RDF should be calculated with a new CREZ transmission cost "adder" included, that assumes a $3.7 billion transmission line will be necessary to make remote renewable energy deliverable to San Diego-area customers.

The proposed $3.7 billion SDG&E transmission line will enable delivery of 1,412 MW of new remote renewable energy. On a unit basis, this equates to a new renewable energy transmission cost of $2.6 million per MW of renewable power.[9] This transmission cost should be added to the cost of the remote utility-scale solar or wind projects to determine the total cost to the customer of the resource. The National Renewable Energy Laboratory (NREL)

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[4] CAISO, *Draft 20-Year Transmission Outlook*, February 7, 2022, p. 17: http://www.caiso.com/InitiativeDocuments/Presentation-Draft20-YearTransmissionOutlook-Feb072022.pdf. The California CREZ map prepared by CAISO (CREZ are represented by colored ovals) is provided in **Attachment A**.
[5] Draft RDF, March 2022, Appendix 2.G Transmission Upgrade Options and Costs, p. 61. This table is included as **Attachment B**.
[6] Ibid.
[7] CAISO, *Draft 20-Year Transmission Outlook*, February 7, 2022, p. 17.
[8] California Energy Commission, *California Load Serving Entity (LSE) Peak Load and Energy Requirements* (xls spreadsheet), Column F, 2018 Energy Need (GWh), PG&E, SCE, SDG&E: https://www.energy.ca.gov/media/3954.
[9] $3.7 billion ÷ 1,412 MW = $2.6 million/MW.

identifies the cost of new utility-scale solar (without battery storage) at $0.9 million per MW.[10] The total capital investment, including generation and transmission, to produce and deliver new remote utility-scale solar in SDG&E territory would be $3.5 million/MW.[11]

In contrast, the cost of 1 MWdc of commercial/industrial building solar, with 2.4 MWh of battery storage capacity, is about $2.2 million per MWac.[12] Projects of this type are interconnected at the distribution grid level and reduce congestion on the existing transmission system. These projects do not require new transmission capacity to make them deliverable. It would be substantially less costly for the San Diego County customer if the RDF prioritized commercial/industrial solar with battery storage over new transmission-dependent remote solar and wind projects.

This conclusory statement in the RDF at p. 36 is in error because it ignores the high cost of new renewable energy transmission necessary to make remote utility-scale solar and wind power deliverable:

> *The results of the primary, least-cost site selection scenarios are shown in Figures 2.10 & 2.11 below. In the San Diego-only Scenario (Figure 2.10) the 2030 sites selected based on LCOE cluster largely around Jacumba Hot Springs in the southeast and Borrego Springs in the northeast parts of unincorporated San Diego County.*

If accurate cost assumptions are used for the cost of (1) commercial/industrial solar and (2) new transmission to transport large quantities of renewable power from Jacumba Hot Springs, Borrego Springs, and Imperial County in the "San Diego and Imperial Scenario" included in the RDF, then commercial/industrial solar would be the most cost-effective solution identified.

<u>Comment 2</u> – The solar rooftop and parking lot potential estimates for San Diego County in the RDF are very low, poorly documented, and inconsistent with other available solar potential estimates for San Diego County

The draft RDF estimates a region-wide rooftop solar potential of 3,360 MWac.[13] This is substantially less than the 4,461 MWac rooftop solar potential estimate for San Diego County

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[10] NREL press release, *New Reports From NREL Document Continuing PV and PV-Plus-Storage Cost Declines*, November 12, 2021: https://www.nrel.gov/news/program/2021/new-reports-from-nrel-document-continuing-pv-and-pv-plus-storage-cost-declines.html. Cost of 100 MW single-axis tracking solar = $0.89/Wdc ($890,000/MWdc).

[11] $2.6 million/MW (transmission) + 0.9 million/MW (solar generation) = $3.5 million/MW.

[12] NREL, *U.S. Solar Photovoltaic System and Energy Storage Cost Benchmarks: Q1 2021*, Figure 20, p. 32. See also **Attachment C**. The solar dc-to-ac conversion efficiency is assumed to be 90 percent (to convert dc capacity to ac capacity).

[13] Draft RDF, March 2022, p. 32. The citation for the 3,360 MWac value is a link to a generic webpage titled "Microsoft Building Footprints – Features". No specific data is provided that can be reviewed for accuracy.

residential and commercial rooftops calculated by SDG&E and the Energy Policy Initiatives Center (EPIC) in 2005.[14] These two rooftop solar potential estimates are very conservative. In contrast, Google Project Sunroof estimates that San Diego County has a rooftop solar potential of approximately 12,400 MWac.[15] This is approximately four times greater that the rooftop solar potential estimate in the RDF.

Actual rooftop solar potential is much closer to the Google Project Sunroof estimate for San Diego County, based on residential net-energy-metered (NEM) rooftop solar installations in SDG&E territory. SDG&E has 1,341,338 residential meters.[16] To date, there is 1,300 MWac of residential rooftop solar capacity installed on 226,000 residential rooftops.[17] About 17 percent of the residential meters in SDG&E territory have NEM solar systems.[18] These NEM systems average about 6 kWac in nameplate capacity and are generally sized to meet the customer's existing annual electricity demand. They are not sized to fully utilize the solar potential of the rooftop. Assuming 100 percent of SDG&E residential meters averaged 6 kWac of rooftop solar, for sake of argument, the SDG&E residential rooftop solar potential would be about 7,700 MWac.[19,20]

Neither the RDF rooftop solar potential estimate nor the 2005 SDG&E/EPIC estimate include ground-level commercial parking areas. The 2019 Clean Coalition *San Diego Solar Siting Survey*, a reference cited in the RDF,[21] states that 75 percent of the solar capacity identified by Clean Coalition for large (1 MW) sites is parking area capacity.[22] Clean Coalition advocates in the *Solar Siting Survey* for large-scale development of solar on ground-level parking areas, yet San Diego County parking area solar potential is not considered in the RDF.

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[14] San Diego Regional Renewable Energy Study Group, *Potential for Renewable Energy in the San Diego Region - Chapter 2: Solar Photovoltaic Electric*, Table 2.1: Technical Potential of PV Systems in San Diego County, p. 2, August 2005.

[15] Google Project Sunroof, San Diego County, 14,600 MWdc: https://sunroof.withgoogle.com/data-explorer/place/ChIJHWD_IzDr24ARKAeA6yv9DTU/. Assuming a dc-to-ac conversion factor of 85 percent, 14,600 MWdc = 14,600 MWdc x 0.85 ac/dc = 12,410 MWac.

[16] California Public Utilities Commission (CPUC), Rulemaking A.22-05-XXX (SDG&E 2024 General Rate Case), SDG&E Exhibit 40 - *Prepared Direct Testimony of Kenneth E. Schiermeyer (Electric Customer Forecast)*, May 2022, Table 1, p. 1. 2022 SDG&E residential accounts = 1,341,338; 2022 SDG&E small commercial accounts = 134,297; 2022 SDG&E medium & large commercial/industrial = 17,248.

[17] California Distributed Generation Statistics, "Charts," April 30, 2022: https://www.californiadgstats.ca.gov/charts/.

[18] 226,000 meters w/NEM ÷ 1,341,338 meters = 0.1685 (16.85 percent)

[19] 1,300 MWac ÷ 0.1685 = 7,715 MWac.

[20] SDG&E territory also includes a small portion of southern Orange County in addition to San Diego County.

[21] Draft RDF, March 2022, p. 50 (footnote 39).

[22] Clean Coalition, *San Diego Solar Siting Survey, Task 2.2, Final Summary Report: Solar Photovoltaic (PV) Commercial-Scale Sites for 1,000 kWac and Larger*, September 2019, p. 10. ". . . parking lots and parking structures represent approximately 75% of the potential found in this survey . . ."

San Diego County ground-level commercial parking area solar potential is conservatively estimated at 3,300 MWac by Powers Engineering.[23] The combined San Diego County rooftop and parking lot solar, assuming the 12,400 MWac Google Project Sunroof estimate for residential and commercial rooftops and the 3,300 MWac Powers Engineering estimate for commercial parking areas, is 15,700 MWac. This is nearly five times greater than the RDF estimate of 3,360 MWac.

The RDF projects that 3,360 MWac of rooftop solar can only provide about 12 percent of the County's 2050 electricity demand.[24] Without analyzing the validity of the RDF's 2050 electricity demand projection here, a five-fold increase in rooftop and parking lot solar potential would enable rooftop and parking lot solar to potentially meet 60 percent of the 2050 electricity demand estimated in the RDF.

<u>Comment 3</u> – The assumed commercial rooftop solar cost in the RDF is high and obsolete

The commercial rooftop solar cost assumption should be $44/MWh, not the $92/MWh commercial rooftop solar cost assumed in the RDF.[25] NREL estimated a commercial rooftop solar LCOE, for a single 200 kW array in a good solar area such as San Diego and including tax incentives, of $49/MWh for the first quarter (Q1) of 2020.[26] NREL subsequently identified a 10 percent year-over-year reduction in the cost of commercial solar between Q1 2020 and Q1 2021.[27] This reduces the LCOE of commercial rooftop solar from $49/MWh in 2020 to $44/MWh in 2021. $44/MWh should be the base case commercial rooftop solar assumption used in the RDF, not $92/MWh.

The most economically-competitive remote utility-scale solar sites shown in the RDF, with LCOEs of $32/MWh to $40/MWh, are in parts of the Jacumba Hots Springs area of San Diego County and in Imperial County.[28] Most of the remote utility-scale solar candidate project areas in eastern San Diego County (including Borrego Springs) and Imperial County have a projected

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[23] Powers Engineering, *Roadmap to 100 Percent Local Solar Build-Out by 2030 in the City of San Diego*, May 2020, p. 22. "The *2008 San Diego Smart Energy 2020* report (by Powers Engineering) estimated a commercial parking unit potential in San Diego County of 1 MWac per 1,000 people, or about 1.1 MWdc per 1,000 people. This relationship conservatively assumes that solar panels cover only 25 percent of the City's commercial parking lot area. Actual practice demonstrates that parking lot solar installations can achieve more than 50 percent coverage." The San Diego County population in 2020 was 3.3 million. Therefore, a conservative estimate of San Diego County commercial parking lot solar potential is: 3.3 million people x 1 MWac/1,000 people = 3,300 MWac.

[24] Draft RDF, March 2022, p. 32.

[25] Ibid.

[26] NREL, *U.S. Solar Photovoltaic System and Energy Storage Cost Benchmark: Q1 2020*, January 2021, p. 102, Attachment B [Commercial Rooftop (200 kW), High resource (CF 20.4%), ITC].

[27] NREL press release, *New Reports From NREL Document Continuing PV and PV-Plus-Storage Cost Declines*, November 12, 2021: https://www.nrel.gov/news/program/2021/new-reports-from-nrel-document-continuing-pv-and-pv-plus-storage-cost-declines.html.

[28] Draft RDF, March 2022, Figure 2.5 (yellow areas), p. 26.

LCOEs of $40/MWh to $42/MWh.[29] There is little difference between an accurate and current LCOE for a single 200 kW rooftop solar array, $44/MWh, and the LCOE identified in the RDF for most of the candidate solar project areas evaluated in eastern San Diego County and Imperial County.

However, when an accurate cost for the new transmission that will be necessary to move large amounts of renewable power from these areas to coastal demand centers is incorporated into the LCOE cost calculations, commercial rooftop/parking lot solar – combined with battery storage – is a substantially more cost-effective alternative.

Commercial solar with adequate battery storage qualifies for local resource adequacy (RA) payments that further reduce the net cost of solar production. Load serving entities, like SDG&E and San Diego Community Power, are required by the CPUC to have sufficient reliable resources under contract to withstand peak demand conditions with some major infrastructure, such as one or more transmission lines, out-of-service. Reliable resources receive RA payments to assure they are available when needed. The current average value of RA in SDG&E territory is about $60,000 per MWac per year.[30]

The LCOE for a 1 MWdc solar/2.4 MWh battery storage commercial parking area project would be approximately $33/MWh with the RA payment credited to the project.[31]

Commercial rooftop/parking lot solar with battery storage, at a net production cost of $33/MWh, would compete effectively against the $32/MWh to $40/MWh "best case" remote utility-scale solar in San Diego and Imperial Counties identified in the RDF.

Additionally, commercial rooftop/parking lot solar also avoids the high cost of new transmission. A new CREZ transmission line adds a cost premium of $90/MWh or more onto the $/MWh production cost of remote utility-scale solar and wind generation cost based on the actual cost of SDG&E's 500 kilovolt Sunrise Powerlink transmission line.[32] This new transmission cost must be accounted for when assessing the complete cost of remote utility-scale renewable resources.

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[29] Ibid, Figure 2.5 (light green areas), p. 26.

[30] CPUC, *2020 Resource Adequacy Report*, December 2021, Table 10. Local RA Capacity Prices by Month, 2020, p. 29. SDG&E-IV weighted average, approximately $5/kW-month ($60/kW-yr).

[31] See cost calculations in **Attachment D**.

[32] B. Powers, P.E., *Local clean energy or remote – who wins the battle?,* presented as Clean Coalition webinar, June 23, 2021, p. 10: https://clean-coalition.org/news/webinar-remote-or-local-clean-energy-generation-who-wins-the-battle-wednesday-23-jun-2021/. See cost calculations in **Attachment E**.

Integration of the resources in SB100 Starting Point

Appendix 2.G Transmission Upgrade Options and Costs

Table 2.G.4 Transmission upgrades and costs in SDG&E Territory

Transmission Constraint	Affected Zones	Estimated Full Capacity Deliverability Status Based on On-Peak Study Resource Output		Area Delivery Network Upgrades (ADNU) & Cost Estimate			Wind/Solar Area Designation
		Existing System (MW)	Increase due to ADNU (MW)	ADNU	Construction Time (months)	Cost ($millions)	
East of Miguel Constraint	Arizona, Imperial, Baja, Riverside	731	1,412	New Imperial Valley - Serrano 500 kV line	120	$3,680	Solar
Encina-San Luis Rey Constraint	Arizona, Imperial, Baja, Non-CREZ within San Diego	2,901	3,718	New Encina - San Luis Rey 230 kV line	120	$102	Solar
Imperial Valley transformer Constraint	Imperial	1,959	400	New Imperial Valley 500/230 kV Bank at new substation	105	$214	Solar
San Luis Rey-San Onofre Constraint	Arizona, Imperial, Baja, Non-CREZ within San Diego	1,748	4,269	New San Luis Rey-San Onofre 230 kV line	120	$237	Solar
San Diego Internal Constraint	Imperial, Non-CREZ within San Diego	968	2,067	Internal San Diego reconductoring	18	$89	Solar
Silvergate-Bay Boulevard Constraint	Imperial, Baja, Non-CREZ within San Diego	1,202	2,119	Silvergate - Bay Blvd 230kV 3-ohm Series Reactor	72	$31	Wind
San Diego Oceanside Constraint	Non-CREZ within San Diego	280	301	Oceanside ADNU	60	$133	Solar

NREL 2021, capital cost for 1 MWdc solar plus 2.4 MWh battery

NREL, *U.S. Solar Photovoltaic System and Energy Storage Cost Benchmarks: Q1 2021*, November 2021, p. 32: https://www.nrel.gov/docs/fy22osti/80694.pdf.

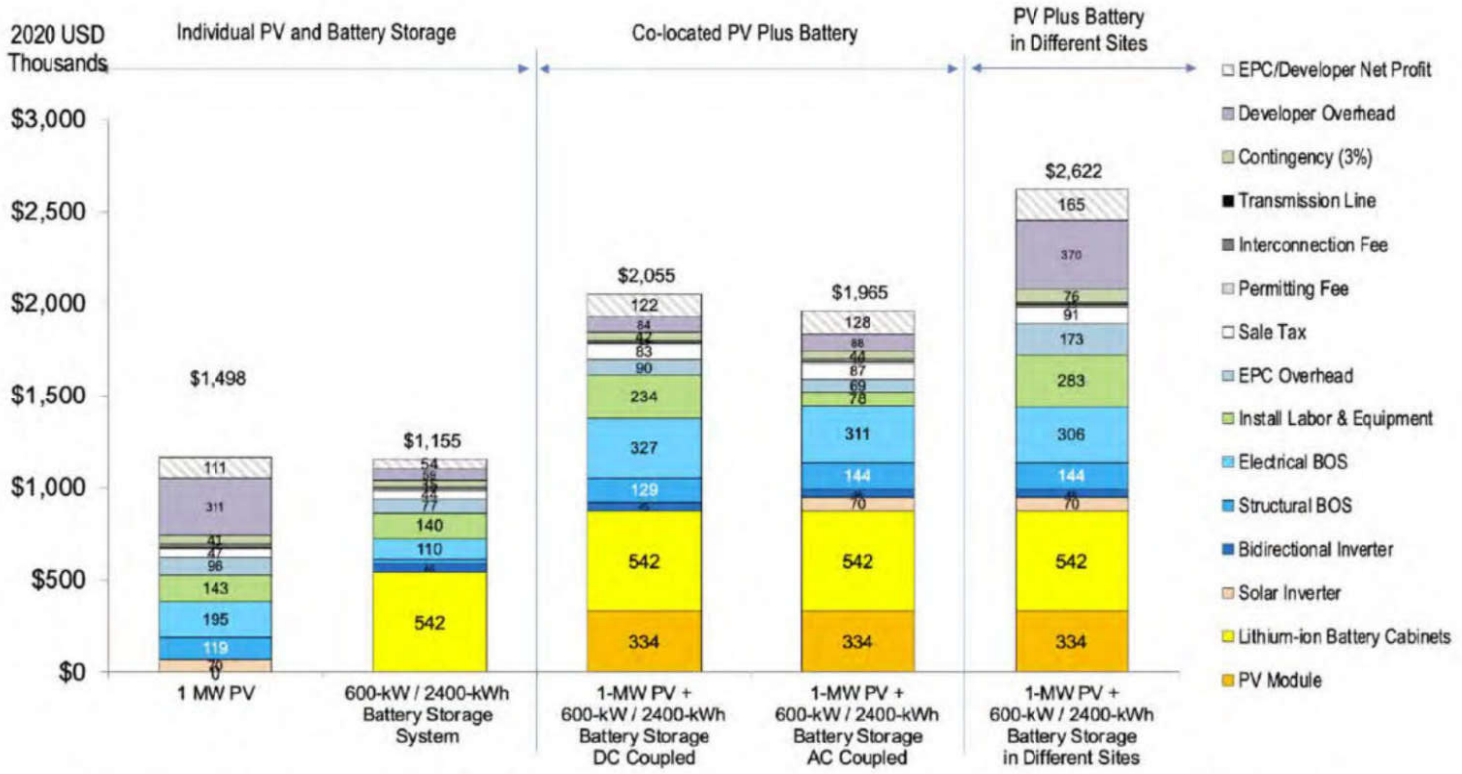

Figure 20. Cost benchmark for Commercial PV-plus-storage systems (4-hour duration) in different sites and the same site (DC-coupled and AC-coupled cases), Q1 2021

Cost of electricity for one 1,000 kW_{DC} commercial parking area solar, 3rd party-owned, with 2.4 MWh battery + RA payment (financed 5.5%, 20-year term)

Cost or (Credit), $	Cost Element
2,000,000	Gross installed cost of single 1,000 kW_{DC} rooftop solar system + 2.4 MWh battery (NREL 2021, p. 32)
500,000	Gross installed cost of double-cantilever parking area shade structure, $0.50/watt (2020 installed-cost estimate from two shade structure vendors, Kern Solar Structures and RBI Solar, for double-cantilever solar shade structures)
(650,000)	26 percent federal tax credit on gross cost in 2022
0	Battery storage incentive payment (in-front-of-meter battery storage is not eligible for SGIP incentive)
1,850,000	Net cost of PV + battery storage system
(649,020)	Depreciation on gross system cost less ½ tax credit: [($2,500,000 - $325,000) × (21% federal marginal corporate tax rate + 8.84% California marginal corporate tax rate)] = $2,175,000 x 0.2984 = $649,020.
1,200,980	Net cost of parking area PV + battery storage system, adjusted for depreciation.
100,402/yr	Annual system cost, 20-yr, 5.5% interest, capital recovery factor = 0.0836/yr: $1,200,980 x 0.0836/yr = $100,402/yr.
0 (parking area)	SDCP rooftop lease payment to 3rd party building owner: It is assumed there is no lease fee for parking areas where solar panel shade structures provide shade and weather protection for vehicles of 3rd party customers/employees.
$18,000	Annual fixed O&M, $18/kW-year (NREL Q1 2021 solar & battery storage cost, Figure 25, p. 43).
($48,600/yr)	Local RA payment: $60/kW-yr x 0.9 x 1,000 kW x $0.9_{dc\text{-}ac}$ = $48,600/yr [assume 90% net qualifying capacity for 4-hr storage (CPUC/Astrape, ELCC, Oct. 2021) , average value of resource adequacy (RA) in SDG&E territory from Dec 2021 CPUC's "2020 RA Report, Table 10"]. Also includes a dc-to-ac conversion factor of 90 percent.
1,793,300 kWh/yr	Annual production, fixed solar, San Diego (Otay Mesa), assuming 10% losses (NREL PV Watts, zip code 92154)
$0.033/kWh	100% financed solar + battery power: ($118,402/yr - $48,600/yr) ÷ 1,793,300 kWh/yr = $0.033/kWh

SDG&E 500 kV Sunrise Powerlink (SPL)

- Final capital cost: $1.883 billion
- Final annualized cost: $254 million/yr
- Rejected in October 2008 proposed decision as unnecessary for near-term reliability & no RPS deficit to meet
- Approved December 2008, voluntary SDG&E commitment to add 1,000 MW of solar
- Current interconnected renewables : 999 MW solar,
  265 MW wind
- Total renewables annual production: 2,873,543 MWh/yr
- Cost premium of SPL transmission line: $0.09/kWh