Roadmap to 100 Percent Local Solar Build-Out by 2030 in the City of San Diego

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Prepared for:

Protect Our Communities Foundation

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Bill Powers, P.E., Biography

Mr. Powers is a registered professional mechanical engineer in California and Missouri with over 35 years of experience in energy and environmental engineering. He has written numerous journal articles on the strategic cost and reliability advantages of local solar power over large-scale, remote, transmission-dependent renewable resources, and he frequently testifies as an expert witness on alternatives to conventional power generation infrastructure. Mr. Powers is the author of the 2012 strategic energy plan, *Bay Area Smart Energy 2020*, for the San Francisco Bay region. The plan relies on rooftop and parking lot solar power, combined with accelerated energy efficiency measures and battery storage, as the template to reduce greenhouse gas emissions from power consumption in the Bay Area region by 60 percent by 2020.

Mr. Powers authored *San Diego Smart Energy 2020* in 2007, a local solar and battery storage alternative to SDG&E's Sunrise Powerlink transmission line. He also served as an expert witness in a landmark proceeding in 2009 where the California Energy Commission denied a new peaking gas turbine power plant in Chula Vista and determined that urban solar power could potentially serve as a cost-effective alternative to the proposed gas plant.

Mr. Powers served as an appointee to the City of San Diego's Environmental and Economic Sustainability Task Force that developed the City's Climate Action Plan, adopted in December 2015. He is a board member of the Protect Our Communities Foundation, a San Diego non-profit that advocates for local clean energy.

He began his career converting Navy and Marine Corps shore installation power plants from oil-firing to domestic waste, including wood waste, municipal solid waste and coal, in response to concerns over the availability of imported oil following the Arab oil embargo in the 1970s. Mr. Powers has obtained regulatory approvals for numerous peaking gas turbine, microturbine and internal combustion engine power plants in California. He has also assessed the environmental impacts of existing and proposed oil and gas projects in Peru, Ecuador, Mexico, and East Africa. His home has served as an urban solar-powered mini-microgrid demonstration project since 2015, to demonstrate the cost-effectiveness and reliability of this power delivery approach. The home system includes rooftop solar, battery storage, backup generation and an electric vehicle. Mr. Powers has a B.S. in mechanical engineering from Duke University and an M.P.H. in environmental sciences from the University of North Carolina at Chapel Hill.

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Cover photos: San Diego Airport Terminal 3 solar parking area, Tesla Powerpack battery (source: www.inhabitat.com), warehouse rooftop solar (Otay Mesa), author's residential mini-microgrid, University Heights, San Diego (2 photos).

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Acronyms

A/C	Air Conditioning
AC	Alternating Current
BTM	Behind-The-Meter: customer-owned or leased solar power and/or battery storage located behind the customer's electric meter and off-setting retail grid power. Also known as "Net Energy Metering," or NEM.
CAISO	California Independent System Operator
CARE	California Alternate Rates for Energy
CEC	California Energy Commission
CCE	Community Choice Energy, also known as Community Choice Aggregation
CO_2	Carbon Dioxide
CSI	California Solar Initiative
CPUC	California Public Utilities Commission
DA	Direct Access, commercial customers responsible for own electricity supply
DC	Direct Current
DOE	U.S. Department of Energy
DR	Demand Response
DRE	Distributed Renewable Energy
DWR	Department of Water Resources
EIA	U.S. Energy Information Administration
EE	Energy Efficiency
EV	Electric Vehicle
FERC	Federal Energy Regulatory Commission
FIT	Feed-In Tariff
GHG	Greenhouse Gases
GW	Gigawatt, equal to 1,000 megawatts
GWh	Gigawatt-hour, equal to 1,000 megawatt-hours
HVAC	Heating, Ventilation, and Air Conditioning
IOU	Investor-Owned Utility (PG&E, SCE, and SDG&E)
IRP	Integrated Resource Plan
kV	Kilovolt
kW	Kilowatt, equals 1,000 watts, expressed in AC. Also shown as kW_{AC}.
kW_{DC}	Kilowatt produced by solar panels in DC prior to conversion to AC for use onsite or export to the local grid
kWh	Kilowatt-hour
LSE	Load Serving Entity
NEM	Net Energy Metering: the off-setting of retail grid power with onsite BTM solar power
MASH	Multifamily Affordable Solar Housing
MW	Megawatt, equals 1,000 kilowatts, AC. Also shown as MW_{AC}
MW_{DC}	Megawatt produced by solar panels in DC prior to conversion to AC for use onsite

	or export to the local grid
MWh	Megawatt-hour
O&M	Operations & Maintenance
PCIA	Power Charge Indifference Adjustment
PG&E	Pacific Gas & Electric
PV	Photovoltaic
RA	Resource Adequacy
SASH	Single-Family Affordable Solar Homes
SCE	Southern California Edison
SDCP	San Diego Community Power
SDG&E	San Diego Gas & Electric
SGIP	Self-Generation Incentive Program
SMUD	Sacramento Municipal Utility District
SOMAH	Solar on Multifamily Affordable Housing
T&D	Transmission & Distribution
TOU	Time-Of-Use
VNM	Virtual Net Metering
VPP	Virtual Power Plant
ZNE	Zero Net Energy

I. EXECUTIVE SUMMARY

This roadmap outlines a strategy to maximize the use of solar energy and battery storage in the City of San Diego (City) to provide 100 percent clean electricity to all San Diegans by 2030. The City's Climate Action Plan sets a mandatory target of 100 percent clean electricity by 2035. Currently, the City has an electricity demand of 8,200 gigawatt-hours (GWh) per year.[1] About 45 percent of the grid power provided by San Diego Gas & Electric (SDG&E) is derived from remote renewable energy sources in Imperial County, the Central Valley, other Western states, and Mexico. But 55 percent of the grid power that the City uses comes from fossil-fuel power sources,[2] electricity sources that produce substantial greenhouse gas emissions and air pollution. The City can select a better, cleaner, local path.

The City can best deliver lower-cost electricity and provide local job growth by choosing local solar power paired with battery storage, complemented by smart energy efficiency (EE) and demand response (DR) programs,[3] to reach 100 percent clean energy. This roadmap applies the goals of the California *Long-Term Energy Efficiency Strategic Plan* to the specific case of the City as the strategy to achieve 100 percent clean energy. The roadmap also outlines how this approach can reduce the cost of electricity to City residents and provide income streams by aggregating and dispatching customer batteries.

The City should set a target of 2,100 MW_{AC} of new local solar by 2030. The City would continue the current customer-sited solar installation rate of 100 MW_{AC} per year over the next ten years, and add 110 MW_{AC} per year of commercial feed-in-tariff (FIT) parking lot and warehouse solar over the same time frame. 250 MW_{AC} of load reduction in the form of central air conditioner (A/C) cycling would also be added in the City by 2030. An EE target of 25 percent would be achieved by focusing EE upgrade efforts on customers using disproportionately high amounts of electricity. An opt-out program structure would be used to maximize the potential gains as fast

[1] MRW, *City of San Diego CCA Business Plan*, prepared for the City of San Diego, October 22, 2018, p. 3. See: https://www.sandiego.gov/sites/default/files/draft_final_cca_business_plan_city_of_san_diego_october_2018.pdf. 1 GWh is equivalent to 1,000 megawatt-hours (MWh). Customers receiving electricity supply from SDG&E will become San Diego Community Power customers in 2021.

[2] SDG&E 2018 power content label totals 43% renewable, 29% natural gas, 27% unspecified power. See *SDG&E 2018 Power Content Label*, July 2019: https://www.energy.ca.gov/sites/default/files/2020-01/2018_PCL_San_Diego_Gas_and_Electric.pdf. Unspecified power includes power from sources across the West, including coal, natural gas, large hydro, and renewables. The greenhouse gas emission factor (EF) for unspecified power (944 lb CO_2/MWh) is higher than the EF for natural gas (838 lb CO_2/MWh). See *Understanding Marin Clean Energy's GHG Emission Factors – Calendar Year 2015*, p. 5: https://www.mcecleanenergy.org/wp-content/uploads/2018/01/Understanding_MCE_GHG_EmissionFactors_2015.pdf.

[3] Demand response means reducing or shifting a customer's power needs to lower the amount of grid power needed during periods of peak demand. A common example involves cycling air conditioners off-and-on during heat waves to reduce power demand.

as they can be achieved. On-bill financing available to all customers would fund much of this local clean energy development.

This roadmap recommends the following actions:

- Protect the value of solar and battery storage on homes and businesses and maintain the current installation rate of 100 MW_{AC} per year in San Diego through 2030. This rooftop solar is also known as "net energy metered" (NEM) solar, or "behind-the-meter" (BTM) solar.
- Expand on-bill financing to allow all customers, regardless of whether they are owners or renters, to benefit from solar power and battery storage.
- Add 25 MW of A/C cycling DR each year through 2030.
- Focus EE upgrades on "high users" in each customer class.
- Incorporate customer battery storage into virtual power plants to maximize the value to battery storage owners, the City, and SDCP.
- Maximize commercial parking lot and warehouse FIT solar and battery storage project development, achieving an installation rate of 110 MW_{AC} per year through 2030.
- Maximize use of the opt-out program structure to assure rapid deployment of EE, DR, and customer solar and battery storage.
- Negotiate an equitable resolution of the PCIA exit fee.[4]
- Demand accurate accounting by the California Independent System Operator (CAISO) of the capacity value of solar power in San Diego.

The City is a founding member city of newly formed San Diego Community Power (SDCP), a community choice energy (CCE) power supplier that will begin operations in 2021, serving five cities in the San Diego area. Transmission and distribution (T&D) service will continue to be provided by SDG&E.[5] The City is the largest member city of SDCP. The targets described in this roadmap for the City may be proportionately expanded to address the larger customer base of SDCP.

The launch of SDCP offers a unique opportunity to reach 100 percent clean power the right way – locally. The City and its residents, as a part of SDCP, now have the authority to determine how the power serving the community is generated.[6] Building out locally means that the same

[4] PCIA = Power Charge Indifference Adjustment.
[5] The City of San Diego electric and natural gas 50-year franchise agreements with SDG&E expire in 2021. It is not currently known if SDG&E will continue to operate the franchises following expiration of the current agreements.
[6] SDCP will be the power supplier for most – but not all – San Diego residents. Numerous commercial businesses, representing 25 percent of the City's electricity demand and known as Direct Access customers, already procure

community paying for the power benefits economically from its development. Jobs – good jobs – stay in the community. Local financial institutions gain by investing in local projects. Local businesses benefit from the increased need for services of all kinds. Homeowners and building owners increase the value of their property. Renters gain direct access to clean power. San Diegans have been fighting for this kind of clean energy future for years. Now is the time to make it happen.

II. INTRODUCTION

The City will be responsible for power supply procurement, as a member of the SDCP, beginning in 2021. SDCP will be credited with 45 percent green power at its inception.[7] The October 2018 CCE business plan prepared by the City prioritizes development of local solar power within the City limits.[8]

State policy prioritizes clean energy solutions at the customer's point-of-use, including rooftop solar – also known as NEM solar or BTM solar.[9] California prioritizes BTM clean power solutions because they avoid building new T&D infrastructure and power plants, which would need to be built to keep the lights on if San Diegans did not generate electricity themselves through onsite solutions. The elimination of these conventional and costly capital expenditures reduces costs to all customers, including those without BTM solar and battery power.

The City leads the state's major metro areas in the quantity of installed BTM solar,[10] with about 90,000 rooftop solar installations – capable of generating about 600 megawatts (MW_{AC}) of electricity – as of January 31, 2020.[11] San Diego's installed rooftop solar production represents about 14 percent of the City's electricity demand.[12] Currently, the City adds about 100 MW_{AC} of

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their own electricity supplies. Also, a small percentage of the City's residents are expected to "opt-out" of enrollment in SDCP and continue to rely on SDG&E for power supply as well as T&D service.

[7] In 2020, the SDG&E power supply mix includes about 45 percent renewable power, primarily remote, large-scale, long-term solar and wind power contracts. See SDG&E webpage, *Our Renewable Energy Goals*, accessed April 27, 2020: https://www.sdge.com/more-information/environment/about-our-initiatives/renewable-goals.

[8] The *San Diego CCA Business Plan* refers to "rooftop solar" at p. 1. This roadmap treats the term "rooftop solar" as inclusive of battery storage. The State treats battery storage as a preferred clean technology.

[9] California's Energy Action Plan "Loading Order" prioritizes clean BTM electricity provision.

[10] priceonomics.com, *The Most Solar Places in America*, October 31, 2019. See: https://priceonomics.com/the-most-solar-places-in-america/.

[11] See California Distributed Generation Statistics database: https://www.californiadgstats.ca.gov/charts/. Total installed NEM solar capacity in SDG&E territory, January 31, 2020 = 1,260 MW; total number of installations = 176,038. The City of San Diego is approximately 50 percent of SDG&E load. Assuming the capacity and number of NEM solar installations are proportional to percentage of SDG&E load, there exists about 600 MW of NEM solar capacity, and 90,000 NEM solar installations, in the City as of January 31, 2020.

[12] The *San Diego CCA Business Plan* identifies "total City demand," including Direct Access (DA) customers, as 8,200 GWh per year (p. 2). 600 MW of BTM solar will generate about 1,140 GWh/yr at an assumed solar production rate of 1,900 kilowatt-hours (kWh) per $kilowatt_{AC}$ (kW_{AC}) of capacity per year. Therefore, BTM solar currently meets about 14 percent of the City's annual electricity demand (1,140 GWh/yr ÷ 8,200 GWh/yr = 0.139).

BTM solar each year. This BTM solar increases the clean energy content of the City's electricity portfolio beyond the clean power brought in from SDG&E's remotely located, utility-scale wind and solar projects.

BTM solar and battery storage have the added benefits of providing maximum power resiliency and reliability. Large-scale preventive power shutoffs occurred across the state in 2018 and 2019, initiated by the utilities in response to high fire threat conditions. These power shutoffs underscored the need for affected customers, especially critical facilities such as schools, police stations, and fire departments, to have the ability to "island" from the local utility grid and operate autonomously whenever necessary. Solar with battery storage provides this autonomy, and allows individual residential and commercial customers to island as required.

Many customer solar systems installed in the last three years also include battery storage, spurred by state incentives for battery storage systems and concerns over grid reliability in high fire threat areas.[13] This trend is accelerating. Sunrun, the leading installer of residential solar combined with battery storage systems, reported that 50 percent of its installations in PG&E territory in the fourth quarter of 2019 included battery storage.[14]

The matching of BTM solar with battery storage minimizes the need for upgrades to the existing T&D system while allowing development of the full BTM solar resource potential. A recent phenomenon that maximizes the value of individual residential and commercial battery storage systems uses automated aggregation of the output to allow the batteries to function as "virtual power plants" (VPP). The individual battery storage units are electronically aggregated and dispatched as if they were a single power plant.

The first residential VPP in the country, involving 2,000 residential battery systems and developed by Green Mountain Power (Vermont), began operation in 2017. Southern California Edison launched an 85 MW VPP, also in 2017, comprised of battery storage units in dozens of commercial buildings in Orange County. These two successful VPPs serve as models for the residential and commercial VPPs that can be developed by SDCP.

FITs should also be used to maximize solar development on large sites with little customer load. FITs have been used in Germany and Japan to add over 40,000 MW_{AC} of distributed solar capacity in each country. Commercial parking lot and warehouse rooftop solar arrays are good candidates to feed power directly to the grid under a FIT, as these businesses generally use little or no onsite power. The City of San Diego has over 1,400 MW_{AC} of commercial parking lot solar potential. The City and SDCP should be able to add substantial FIT capacity without creating upward pressure on the average SDCP electricity generation rate.

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[13] Self-Generation Incentive Program – SDG&E: https://sites.energycenter.org/sgip/incentives.

[14] Greentech Media, *Sunrun Deploys Record Solar Capacity in Q4 as Battery Interest Increases*, February 27, 2020. See: https://www.greentechmedia.com/articles/read/sunrun-q4-earnings-battery-resilience.

Realizing the City's BTM solar potential will require financing programs that allow customers, whether owners or renters, with good credit or marginal credit, to "go solar" at no upfront cost simply by paying their utility bill. This method of financing solar and battery systems for residential and small business use is called on-bill financing. Under this program, the customer's monthly payment – structured to be at or below the current monthly utility bill – pays the cost of the onsite solar and storage installation that provides the electricity, instead of paying for grid electricity provided by SDG&E. The availability of this on-bill financing makes possible an "opt out" deployment strategy, meaning customers are expected to add BTM solar and battery storage unless they voluntarily opt not to do so.

SDG&E increases revenue and profit by adding infrastructure to meet increasing demand. BTM solar reduces the demand for grid power, and concurrently undercuts the traditional justification for more utility infrastructure – and thus more utility profits. Customer migration to CCE programs like SDCP also reduces the demand for SDG&E-supplied grid power. These realities have resulted in generalized utility resistance to BTM resources and CCE programs. The utilities have successfully convinced the California Public Utilities Commission (CPUC) to impose high exit fees on customers leaving the utilities for local community power programs. These high fees have the potential to restrict the types of resources that the City and SDCP can economically develop, especially local BTM resources.

The City and SDCP can realize the local solar and battery storage pathway to 100 percent clean energy by: 1) focusing on FIT installations initially, to avoid concentrating the exit fee burden on non-BTM solar customers, 2) establishing an expansive and well-funded on-bill financing program open to owner-occupied and rental properties to maximize BTM solar and battery storage development, and 3) incentivizing the deployment of battery storage with BTM solar to minimize the need to make future investments in the T&D system.

Obstacles exist to the City achieving 100 percent locally-controlled clean energy – both with the current utility and its state regulator, the CPUC. There are obstacles in the City as well. Nearly half of the housing units in San Diego are renter-occupied. Areas of the City with a high percentage of rental units, whether it be Mission Hills or Logan Heights, have a low percentage of BTM solar. The challenge of developing BTM solar and battery storage on rental units must be met to ensure equal access to clean local energy throughout the City. But working together we can overcome these obstacles so that all San Diegans, and all customers of SDCP, can enjoy locally-controlled, safe, resilient, and cost-effective clean energy within 10 years.

III. BACKGROUND

A. California State Policy on Clean Energy

California state policy prioritizes reducing energy consumption in homes and businesses and adding solar power to meet the remaining need. For decades, the state has led the nation in EE measures, embodied principally in California Title 24 Building Code (Code) requirements.[15] The state was also an early leader in requiring greenhouse gas reductions from electricity generation. The CPUC and the California Energy Commission (CEC) authored the state's Energy Action Plan in 2003.[16] The Energy Action Plan directed California to "optimize energy conservation and resource efficiency, accelerate the State's goal for renewable generation, and promote customer and utility-owned distributed generation."

Energy Action Plan II, the current version issued in 2005,[17] emphasizes a "Loading Order," or order of prioritization, of clean energy actions. Energy Action Plan II states "The loading order identifies energy efficiency and demand response as the State's preferred means of meeting growing energy needs. After cost-effective efficiency and demand response, the state relies on renewable sources of power and distributed generation."[18]

Rooftop solar constitutes a major element used to achieve zero net energy (ZNE) structures in the state's 2008 *Long-Term Energy Efficiency Strategic Plan*.[19] The *Plan* includes ambitious rooftop solar targets for new and existing homes, and for new and existing commercial buildings. New homes built in 2020 and later are required to use solar power to offset grid power consumption, and the *Code* encourages the pairing of battery storage with these solar power systems.[20]

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[15] CPUC, *California Long-Term Energy Efficiency Strategic Plan – January 2011 Update*, January 2011, p. 10.
[16] CPUC news release, *PUC Approves Energy Action Plan Aimed at Ensuring Adequate, Reliable, Reasonably Priced Power*, May 8, 2003. See: http://docs.cpuc.ca.gov/PublishedDocs/WORD_PDF/NEWS_RELEASE/25998.PDF.
[17] CPUC news release*, PUC Approves Updated Energy Action Plan to Ensure Long-Term, Environmentally-Sound Energy Supply and Infrastructure at Reasonable Cost to Consumers*, August 25, 2005. See: http://docs.cpuc.ca.gov/PublishedDocs/WORD_PDF/NEWS_RELEASE/48904.PDF.
[18] *Ibid*, p. 2.
[19] CPUC webpage, *Energy Efficiency Strategic Plan*, accessed January 28, 2020: https://www.cpuc.ca.gov/General.aspx?id=4125.
[20] CEC, *2019 Building Energy Efficiency Standards for Residential and Nonresidential Buildings, Subchapter 8 Low-Rise Residential Buildings - Performance and Prescriptive Compliance Approaches*, December 2018, 150.1(c)14, pp. 304-305. "Photovoltaic Requirements. All low-rise residential buildings shall have a photovoltaic (PV) system meeting the minimum qualification requirements as specified in Joint Appendix JA11, with annual electrical output equal to or greater than the dwelling's annual electrical usage. . . EXCEPTION 6 to Section 150.1(c)14: PV system sizes from Equation 150.1-C may be reduced by 25 percent if installed in conjunction with a battery storage system. The battery storage system shall meet the qualification requirements specified in Joint Appendix JA12 and have a minimum capacity of 7.5 kWh." https://ww2.energy.ca.gov/2018publications/CEC-400-2018-020/CEC-400-2018-020-CMF.pdf.

The primary goals of the *Plan* are shown in Table 1. In addition to goals for new construction, the *Plan* establishes goals for installing rooftop solar on existing homes and businesses. In 2007, the CPUC adopted the *Plan* as state policy applicable to all California utilities.[21]

Table 1. Goals of the California Long-Term Energy Efficiency Strategic Plan[22]

Goal	Description
1	Residential: a) All new residential construction in California will be ZNE by 2020 b) 25 percent of existing residential will achieve near ZNE performance by 2020
2	Commercial: a) All new commercial construction in California will be ZNE by 2030 b) 50 percent of existing commercial will achieve ZNE performance by 2030
3	Heating, Ventilation and Air Conditioning (HVAC) will be transformed to ensure that its energy performance is optimal for California's climate
4	All eligible low-income customers will be given the opportunity to participate in the low-income energy efficiency program by 2020

The CPUC's decision in the 2012 Long-Term Procurement Proceeding mandated that the utilities must follow the Loading Order:[23]

> Section 454.5(b)(9)(C) states that utilities must first meet their "unmet resource needs through all available energy efficiency and demand reduction resources that are cost-effective, reliable and feasible." Consistent with this code section, the Commission has held that all utility procurement must be consistent with the Commission's established Loading Order, or prioritization.

The California *Long-Term Energy Efficiency Strategic Plan* envisions maximizing the first priority in the Loading Order: achieving all available EE – including rooftop solar – and all available DR, primarily in the form of optimized HVAC systems.

This roadmap applies the general *Plan* to the specific case of the City to achieve 100 percent clean energy.

[21] CPUC, *California Long-Term Energy Efficiency Strategic Plan*, September 2008, p. 6. "In order to guide market transformation in a number of key sectors, this Plan embraces four specific programmatic goals, known as the "Big Bold Energy Efficiency Strategies," established by the CPUC in D.07-10-032 and D.07-12-051."
[22] CPUC, *California Energy Efficiency Strategic Plan – January 2011 Update*, January 2011, p. 6, p. 20, and p. 34. See: https://www.cpuc.ca.gov/General.aspx?id=4125.
[23] D.13-02-015, *Decision Authorizing Long-Term Procurement for Local Capacity Requirements*, February 13, 2013, p. 10.

B. Emergence of Community Choice Energy

The authority for local government entities to form CCEs became law in 2002. Cities and counties can now assume the role of selecting the power supply for residents. The utility remains responsible for billing, and T&D.[24] CCEs is an "opt-out" program, meaning all residents are presumptively enrolled in the CCE while retaining the right to stay with the utility if they choose to do so. This CCE legislation passed in the wake of the 2000-2001 energy crisis, as an alternative for local communities to take more control over their sources of electricity production.

A key element of the CCE legislation involves the requirement that prohibits cost shifting between customers of the CCE and customers who stay with their utility. This statute created additional costs for CCE customers who leave their utility, because they are held responsible for long-term "above market price" costs that the utility agreed to when the CCE customer was a customer of the utility.

This concept evolved directly from the 2000-2001 energy crisis, when the state committed to numerous large, high-priced decade-long contracts with power companies, including Sempra Energy.[25] These contracts were collectively known as the California Department of Water Resources (DWR) contracts, because DWR entered into power contracts when the utilities were unable to participate in the electricity markets created by deregulation. Deregulation enabled sellers like Enron to exploit the utilities, which were mandated to buy power on the new – and manipulated – electricity markets to serve their customers.

When the utilities ran short of liquidity, Enron and its associates convinced the State of California to step in to buy their power in order to keep the lights on in California.[26] Those DWR contract purchases, at premium prices during the height of the fraud, burdened California consumers and the state's economy for years after California stopped the fraud in the markets.

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[24] The power supply component of the electricity bill, in SDG&E territory, is on the order of one-third to one-quarter of the total bill. Most of the bill is associated with T&D charges.

[25] Business Wire, *DWR Awarded More Than $70 Million in Dispute with Sempra Energy*, April 21, 2006. See: https://www.businesswire.com/news/home/20060421005693/en/DWR-Awarded-70-Million-Dispute-Sempra-Energy.

[26] The California utilities first received billions of dollars (in higher prices) pursuant to the energy deregulation statutes. Then they protested when the sellers offered electricity only at manipulated and exorbitant prices. But their holding companies participated in the selling into California's market, and thus participated and profited from the fraudulent activity. *See*, *City and County of San Francisco v. PG&E Corp.*, 433 F.3d 1115 (9th Cir. 2006); *Cal. ex rel. Harris v. FERC*, 784 F.3d 1267 (9th Cir. 2015), and *Attorney General Lockyer Sues PG&E Corporation for Unfair Business Practices Involving Financial Draining of California Utility*, January 10, 2002: https://oag.ca.gov/news/press-releases/attorney-general-lockyer-sues-pge-corporation-unfair-business-practices.

The DWR contracts expired after a decade. At the time CCE legislation was enacted in 2002, it was understood that the imposition of substantial exit fees on CCE customers would sunset with the termination of the DWR contracts.[27]

The CPUC clarified in 2004 that no exit fee could be collected for more than ten years on new utility-owned gas-fired capacity, such as the SDG&E-owned 575 MW Palomar Energy project in Escondido (online in 2006) or the 495 MW Desert Star project (Boulder City, Nevada, purchased by SDG&E in 2009), to dissuade the utilities from over-procuring generation and creating the potential for stranded costs if cities or counties within their service territories formed CCEs.[28] However, the CPUC allowed old power purchase costs to be borne by CCE customers in disregard of its own rulings.

C. History of SDG&E's Electricity Procurement in the 21st Century

SDG&E is a privately-owned monopoly utility regulated by the CPUC and subject to the terms and conditions of its franchise agreement with the City. The utility currently enjoys 50-year franchise agreements to supply electricity and natural gas to the residents of San Diego, agreements that expire in January 2021.

SDG&E was a vertically-integrated utility until 1996, when the electric investor-owned utility industry was deregulated by state law in AB 1890.[29] Under deregulation, customers contracted directly with third-party providers for electricity supply, with the utility providing T&D service. At that time, SDG&E sold-off all of its fossil-fuel power plants and became a de facto T&D utility.

Deregulation failed in 2000. Some commercial customers, those contracting with third party providers for electricity supply at the time that deregulation was suspended – known as Direct Access (DA) customers – were permitted to continue contracting for their own electricity supply.[30] DA customers currently represent about 25 percent of the City's electricity demand.[31]

SDG&E partially re-vertically integrated in the wake of the failure of deregulation. The utility currently owns several natural gas-fired power plants with a combined capacity of

[27] Navigant Consulting, Inc, *Community Choice Aggregation - Base Case Feasibility Evaluation for County of San Diego*, May 2005, p. 51. "With the exception of the DWR bond charge ($0.005/kWh, expiring in 2023), the CRS (exit fee) is expected to become zero by 2012, as DWR contracts expire and market prices trend upwards."

[28] Protect Our Communities Foundation, *Opening Brief – A.17-06-026 Order Instituting Rulemaking to Review, Revise, and Consider Alternatives to the Power Charge Indifference Adjustment*, June 1, 2018, p. 23.

[29] AB 1890 (1996): http://www.leginfo.ca.gov/pub/95-96/bill/asm/ab_1851-1900/ab_1890_bill_960924_chaptered.html.

[30] SDG&E, Direct Access History, webpage accessed April 30, 2020: https://www.sdge.com/customer-choice/direct-access/history.

[31] MRW, *City of San Diego CCA Business Plan*, October 22, 2018, pp. 2-3. Total City demand of ~8,000 GWh/yr is split between customers receiving energy supply from SDG&E (~6,000 GWh/yr), and DA commercial customers (~2,000 GWh/yr).

approximately 1,200 MW.[32] These power plants include Palomar Energy (575 MW), Desert Star Energy (495 MW), Miramar Energy (96 MW), and Cuyamaca Energy (45 MW). SDG&E also has over 1,800 MW of gas-fired power plant capacity under long-term contract, including Otay Mesa Energy Center (589 MW), Carlsbad Energy Center (528 MW), and Pio Pico Energy Center (336 MW), as well as number of smaller units.[33]

1. Meeting renewable energy mandates at unnecessarily high cost to customers

SDG&E was required by state law in 2011 to meet a 33 percent renewable energy target by 2020.[34,35] SDG&E over-procured high cost solar and wind contracts in 2010-2012, early in the 2020 compliance timeline, reaching 43 percent renewable energy content in 2016.[36] The excessively high cost of these contracts was known by the CPUC at the time the contracts were signed, with the CPUC's Division of Ratepayer Advocates identifying $6 billion in excessive costs in 2011, at an early stage in utility solar and wind contracting.[37]

SDG&E has long-term contracts for 1,306 MW of solar capacity and 1,233 MW of wind capacity.[38] SDG&E also owns 4 MW of rooftop solar capacity.[39] All of the contracted solar and wind capacity is located far from San Diego. The high cost of these contracts is controversial.

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[32] CPUC Application A.17-06-006, *2016 ERRA Compliance - SDG&E Prepared Direct Testimony of Daniel L. Sullivan*, June 1, 2017, p. DLS-8. See: https://www.sdge.com/sites/default/files/PUBLIC%2520Sullivan%2520Testimony%2520ERRA%2520Compliance_Redacted.pdf.

[33] *Ibid*, p. DLS-8.

[34] CPUC, *California Renewables Portfolio Standard Annual Report*, November 2019, p. 2. See: https://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Utilities_and_Industries/Energy_-_Electricity_and_Natural_Gas/2019%20RPS%20Annual%20Report.pdf. "In April 2011, SB 2 (1X) (Simitian, 2011) codified achievement of the 33 percent RPS requirement by 2020. In 2015, Governor Brown signed into law SB 350 (de León, 2015), which mandated a 50 percent RPS by December 31, 2030. . . In 2018, SB 100 (de León, 2018) increased the RPS to 60 percent by 2030 and established a goal for 100 percent of the State's electricity to come from renewable and carbon-free resources by 2045."

[35] See CPUC's "33% RPS Procurement Rules" webpage, accessed January 25, 2020: https://www.cpuc.ca.gov/RPS_Procurement_Rules_33/.

[36] SDG&E, *Final 2018 Renewables Portfolio Standard Procurement Plan*, April 2, 2019, p. 2. See: https://www.sdge.com/sites/default/files/regulatory/R.18-07-003%20SDGE%20Final%202018%20RPS%20Public%20Version.pdf.

[37] Division of Ratepayer Advocates, *Green Rush – Investor-Owned Utilities' Compliance with the Renewables Portfolio Standard*, February 2011, p. 4. "The CPUC has approved nearly every renewable contract filed by the utilities, even when contracts rate poorly on least-cost, best fit criteria . . . [recommendation] Require a formal Application instead of an Advice Letter for all contracts whose expected above-market costs exceed $100 million."

[38] CPUC A.17-06-006, *2016 ERRA Compliance - SDG&E Prepared Direct Testimony of Daniel L. Sullivan*, June 1, 2017, p. DLS-8. SDG&E-owned rooftop solar = 4 MW. SDG&E contracted solar = 1,305.9 MW. SDG&E contracted wind = 1,233 MW. SDG&E reported no subsequent new solar or wind contracts in its 2021 ERRA Forecast application. See: CPUC Application A.20-04-014, *SDG&E 2021 ERRA Forecast - Prepared Direct Testimony of Stefan Covic on Behalf of SDG&E*, April 15, 2020, Attachment C, SDG&E 2021 Renewable Resource Detail.

[39] *Ibid*.

San Diego-based Protect Our Communities Foundation estimates that approximately $4 billion in excess costs are associated with the SDG&E solar and wind contracts.[40]

2. Overbuilding of natural gas-fired capacity

SDG&E overbought fossil-fuel power by buying or contracting with too many gas-fired plants in the wake of the failure of deregulation. SDG&E identified the need for only about 300 MW of natural gas-fired power generation after the 2000-2001 energy crisis.[41] Yet the CPUC authorized SDG&E to procure over 1,150 MW of capacity, consisting of the purchase of the 575 MW Palomar Energy project in Escondido and a long-term contract with Calpine's 589 MW Otay Mesa project near San Ysidro, to fill the 300 MW need. The CPUC's approval of these two gas-fired power plants was contentious, as the agency played the role of dealmaker advancing corporate interests over the public interest.[42]

Increases in utility peak load have historically driven new power plant additions. Meeting the peak load means assuring sufficient power to meet the highest hour of demand in any year. In this context, the CPUC authorized SDG&E to enter into long-term power purchase agreements, 20- and 25-year agreements respectively, with two new peaking power plants, 336 MW Pio Pico Energy Center (Otay Mesa, online in 2016) and 528 MW Carlsbad Energy Center (online in 2018). The life-of-project cost to ratepayers for these two power plants totals over $4 billion.[43]

Both of these gas-fired power plant projects were vigorously opposed by public interest intervenors at the CPUC. In each case, SDG&E asserted that the power plants were necessary to address rising peak loads in its service territory, based on overly conservative forecasting by

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[40] Protect Our Communities Foundation, *Opening Brief – A.17-06-026 Order Instituting Rulemaking to Review, Revise, and Consider Alternatives to the Power Charge Indifference Adjustment*, June 1, 2018, p. 22. "$190 million per year in avoidable solar and wind PPA contract costs . . ." Assuming all wind and solar contracts are 20-year duration, the avoidable cost = 20 years x $190 billion per year = $3.8 billion. Supporting documentation provided at p. 20, Table 3: Excess Utility-Scale SDG&E Solar PPA Payments, and p. 21, Table 4: Excess Utility-Scale SDG&E Wind PPA Payments. See: http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M224/K417/224417827.PDF.

[41] Protect Our Communities Foundation, *Opening Brief – A.17-10-007: SDG&E Update to its Electric and Gas Revenue Requirement and Base Rates Effective on January 1, 2019*, September 21, 2018, p. 7, footnote 12. [Commissioners Loretta M. Lynch and Carl Wood . . . dissenting that approval of the Otay Mesa PPA and Palomar UOG facilities would "add more than 1,000 MW to SDG&E's own forecast need of 291 MW".]

[42] Inewsource, *Inside the deal that shaped San Diego County's power picture,* June 22, 2016. See: https://inewsource.org/2016/06/22/how-san-diego-got-power-plants/. "But many believe the deal for the Palomar and Otay Mesa power plants was dirty, and some believe it set the stage for years of similarly sullied agreements that helped determine what San Diego County residents pay — or overpay — for power to this day."

[43] SDG&E bill insert, *San Diego Gas & Electric Company Notice of Application 13-06-XXX (Pio Pico) to Fill the Local Capacity Requirement Need Identified in CPUC Decision 13-03-02*9, June 2013, total cost of contract over term = $1.634 billion, and 2) extrapolation of 336 MW Pio Pico life-of-project cost to estimate 528 MW Carlsbad Energy Center life-of-project cost: $1.634 billion x (528 MW/336 MW) = $2.57 billion.

CAISO, and the need to move quickly to avoid a lack of sufficient power to meet the projected future peak demand. The CPUC and SDG&E ignored the Loading Order in both instances.[44,45]

In the case of the 528 MW Carlsbad Energy Center, public interest parties underscored the fact that there was an operational and little-used 960 MW power plant on the site and that the existing plant should continue to provide back-up power for the near-term to avoid the billions of dollars that would be spent on a replacement plant. The facts presented by these parties were not heeded. The CPUC approved these new long-term fossil-fuel power plant contracts in SDG&E territory despite California's clean energy priorities.

3. CPUC charging departing utility customers high exit fees

SDCP customers will pay for overpriced utility solar and wind contracts and unnecessary utility-owned gas-fired power plant capacity through 2041 because of a recent CPUC decision that holds CCE customers responsible, along with SDG&E ratepayers, for paying off these investments.[46] The exit fee imposed on customers that leave SDG&E service is known as the Power Charge Indifference Adjustment (PCIA). SDCP may be constrained in the amount and type of local solar development that it can support – unless the CPUC reforms the PCIA exit fee structure it approved in 2018.[47]

4. Mandated utility investments in battery storage

Not all supply resources added by SDG&E in recent years have been unnecessary. Utility-owned battery storage has been added in response to legislative mandates.[48] SDG&E's battery storage projects will be useful in storing and utilizing local solar power, as well as in providing local grid reliability. A total of 67.5 MW of battery storage, with four hours of energy storage (in MWh)

[44] CPUC Decision D.14-02-16, *Decision Granting San Diego Gas & Electric Company Authority to Enter Into A Purchase Power Tolling Agreement with Pio Pico Energy Center, LLC*, February 5, 2014, p. 3.
[45] Protect Our Communities Foundation, *A.14-07-009 Reply Brief - Application of San Diego Gas & Electric Company (U 902 E) for Authority to Partially Fill the Local Capacity Requirement Need Identified in D.14-03-004 and Enter into a Purchase Power Tolling Agreement with Carlsbad Energy Center, LLC*, December 22, 2014, p. 3.
[46] CPUC Decision D.18-10-019, *Modifying the Power Charge Indifference Adjustment Methodology*, October 11, 2018. See: R.17-06-026, Exhibit IOU-5-R - Revised Joint Utilities' Total Costs and Above Market Costs Bar Charts Pursuant to ALJ Roscow's August 21, 2018 E-mail Ruling, Table - SDG&E Above-Market Costs.
[47] At least one party to the PCIA exit fee proceeding, the Protect Our Communities Foundation, is challenging the CPUC decision in appellate court. See Protect Our Communities Foundation, *Petition for Writ of Review - Decision of the Public Utilities Commission of the State of California, No. 18-10-019 (October 19, 2018)*, Court of Appeal of the State of California Fourth Appellate District Division One, February 20, 2020.
[48] CPUC, *Energy Storage*, webpage accessed March 20, 2020: https://www.cpuc.ca.gov/General.aspx?id=3462.

for every MW of capacity,[49] is operational at SDG&E substations in Escondido (30 MW), El Cajon (7.5 MW), and Miramar (30 MW).[50]

5. The rise of behind-the-meter solar and battery storage

Utility customers in California were initially able to add BTM solar under the California Energy Commission's (CEC) Renewables Buy-Down Program, and beginning 2001, under the CPUC's Self-Generation Incentive Program (SGIP).[51] The California Solar Initiative (CSI), created by the passage of SB 1 in 2006, established the goal of achieving 3,000 MW_{AC} of BTM solar generation in California by 2017. SB 1 also envisioned that achievement of the goal would establish a self-sustaining solar industry free of ratepayer subsidies. The CSI program has been successful. As of February 29, 2020, California has moved far beyond the 3,000 MW_{AC} CSI goal. The State has 9,153 MW_{AC} of operational BTM solar capacity, of which 1,275 MW_{AC} is located in SDG&E service territory.[52]

New BTM solar installations are currently increasing at a rate of about 200 MW_{AC} per year in SDG&E service territory.[53] The installed BTM solar capacity in SDG&E territory should surpass the 1,306 MW_{AC} of utility-scale solar capacity under long-term contract to SDG&E in the first half of 2020.

BTM solar constitutes a rapidly growing, cost-effective, ground-up solar expansion occurring in SDG&E territory. The advance of BTM solar is happening despite active SDG&E opposition, and without ratepayer funds spent on these BTM solar projects (other than individual customers buying or leasing the systems).

Battery storage systems are increasingly being integrated with BTM solar systems. Thousands of BTM solar systems with battery storage have been installed in SDG&E service territory since

[49] Utility Dive, *SDG&E, AES bring world's largest lithium ion battery storage online in California*, February 24, 2017. See: https://www.utilitydive.com/news/sdge-aes-bring-worlds-largest-lithium-ion-battery-storage-online-in-cali/436832/.

[50] CPUC Application A.20-04-014, *SDG&E 2021 ERRA Forecast - Prepared Direct Testimony of Stefan Covic on Behalf of SDG&E*, April 15, 2020, p. 6.

[51] CPUC Decision D.01-03-073, *Interim Opinion: Implementation of Public Utilities Code Section 399.15(B), Paragraphs 4-7; Load Control and Distributed Generation Initiatives*, March 27, 2001, p. 6, p. 10, and p. 29. (p. 6) "AB 970, signed by the Governor on September 6, 2000, requires the Commission to initiate certain load control and distributed generation activities within 180 days," and (p. 10) "Energy Division defines "self-generation" as "distributed generation (DG) installed on the customer's side of the utility meter, which provides electricity for a portion or all of that customer's electric load," and (p. 29) "We note that only seven systems above 30 kW have been installed under CEC's renewables buy-down program (from a total of 332 systems installed, or 2%) since its inception."

[52] California Distributed Generation Statistics, click on – "Stats & Charts", Data View "SDG&E", Data Type "Capacity", accessed April 28, 2020: https://www.californiadgstats.ca.gov/charts/.

[53] *Ibid*. In 2018, 192 MW of new BTM solar was installed. In 2019, 215 MW of new BTM solar was installed.

2017, when a combination of state incentives and lower battery prices spurred the BTM battery storage market.[54]

Recent widespread preventive fire safety shutoffs throughout California – and associated concerns about grid reliability – have further boosted the deployment of BTM battery storage, with more than 50 percent of new BTM solar installations in some parts of California including battery storage.[55]

The rooftop solar industry capacity necessary for the City of San Diego to achieve 100 percent clean energy by 2035 already exists locally. The rooftop solar industry in SDG&E territory employs about 7,500 people,[56] almost twice the 4,000 employees at SDG&E.[57] However, growth in the rooftop solar industry has plateaued due to state-level policy changes that reflect utility opposition to rooftop solar.[58] Increasing the pace of the rooftop solar expansion in San Diego would revitalize the local solar industry.

D. Declining Peak Demand Should Reduce Electricity Costs

The decline of the SDG&E summertime peak demand is a relatively new phenomenon – driven in substantial part by the rapid increase in BTM solar – that should result in reduced costs for City residents. However, grid planners have been slow to recognize the magnitude of this trend, and have been reluctant to credit properly the ability of solar power to contribute to meeting the summertime peak demand.

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54 Center for Sustainable Energy, *Self-Generation Incentive Program (SGIP)*, updated March 17, 2020 (Administrator = "CSE" for SDG&E territory): https://sites.energycenter.org/sgip/statistics. As of March 17, 2020, approximately 3,600 residential battery storage systems, and 130 commercial battery storage systems, had been installed in SDG&E service territory. The dip in battery storage deployments in 2019 related to the full depletion of SGIP incentive funds. SGIP was expanded in 2020 with over $800 million in new incentive funding (see CPUC D.20-01-021).

55 Greentech Media, *Sunrun Deploys Record Solar Capacity in Q4 as Battery Interest Increases*, February 27, 2020. "More than half of Q4 solar sales in the Bay Area included battery storage, CEO Lynn Jurich said in an interview Thursday." See: https://www.greentechmedia.com/articles/read/sunrun-q4-earnings-battery-resilience.

56 The Solar Foundation, *National Solar Jobs Census 2018*, February 2019, p. 10. California has 76,838 solar industry jobs in 2018. San Diego County's population of 3.4 million is approximately one-tenth the California statewide population of about 40 million. For this reason, the solar industry employment in San Diego County is estimated at approximately 7,500 workers.

57 See SDG&E "About Us" webpage, accessed January 25, 2020: https://www.sdge.com/more-information/our-company/about-us.

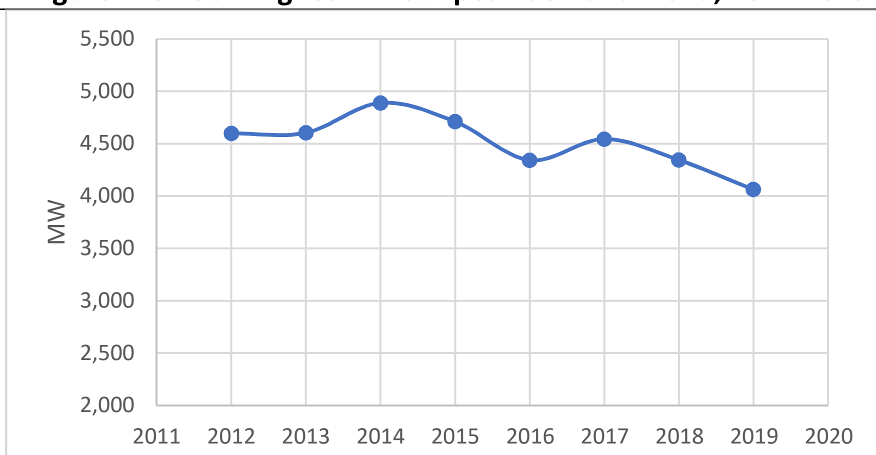
58 CALSSA, *Statement on the Solar Foundation's 2018 Annual Solar Jobs Census*, February 12, 2019. See: https://calssa.org/press-releases/2019/2/12/statement-on-the-solar-foundations-2018-annual-solar-jobs-census. "California's solar market decline is due almost entirely to policy changes at the state level including modifications in investor-owned and publicly-owned utility net energy metering policies as well as changes to rate structures that have been designed to be less solar friendly."

1. *Peak demand has substantially declined in recent years*

SDG&E's actual peak demand has declined substantially over the last several years. The one-hour annual peak demand in SDG&E territory has declined over 800 MW, or more than 20 percent, since 2014 when the Pio Pico Energy Center project was approved. The approval of Pio Pico was justified by the CPUC as necessary to fill a forecast need for 298 MW of additional local capacity beginning in 2018.[59] This need did not materialize. SDG&E peak demand declined from 4,890 MW in 2014 to 4,063 MW in 2019.[60] The population of San Diego County increased 3.5 percent during this same period.[61]

Figure 1 shows the SDG&E peak demand trend line. This downward peak demand trend was predictable in 2014, given the rapid rise in BTM solar,[62] general adoption of LED lighting, and consistent over-estimation of future peak load by CAISO. BTM solar in SDG&E territory increased from 223 MW at the end of 2013 to 1,275 MW by February 29, 2020.[63] The addition of about 1,050 MW of BTM solar, since the Pio Pico power Energy Center was approved in 2014, has had a clear impact on reducing SDG&E peak demand.

Figure 1. SDG&E highest 1-hour peak demand trend, 2012-2019[64]



[59] CPUC Decision D.14-02-016, *Decision Granting San Diego Gas & Electric Company Authority to Enter Into A Purchase Power Tolling Agreement with Pio Pico Energy Center, LLC*, February 5, 2014, p. 3.

[60] 2012-2018: SDG&E FERC Form 1(s), p. 401b. 2019: CAISO OASIS database, SDG&E, September 3, 2019, 5-6 pm.

[61] State of California Department of Finance, County Population 2010 - 2019, accessed March 18, 2020 (for period Jan. 1, 2014 – Jan. 1, 2019): http://www.dof.ca.gov/Forecasting/Demographics/Estimates/e-4/2010-19/. San Diego County, Jan. 1, 2014 = 3,235,142; Jan. 1, 2019 = 3,351, 786. Change = 116,644. Increase = 116,644 ÷ 3,235,142 = 0.0348 (3.48 percent).

[62] CAISO, *2019 Summer Loads & Resources Assessment*, May 8, 2019, p. 12. "CAISO peak demand has been significantly impacted by the growth in behind the meter solar installations. . . To a lesser extent, increasing energy efficiency and the use of demand side management has impacted peak demand as well."

[63] California Distributed Generation Statistics, click on – "Stats & Charts", Data View "SDG&E", Data Type "Capacity", accessed April 28, 2020: https://www.californiadgstats.ca.gov/charts/.

[64] SDG&E FERC Form 1 reports, p. 401b, 2015-2018; and CAISO OASIS database, "Forecast Demand" "Actual", September 3, 2019.

2. *Grid planning has not kept pace with the decline in peak demand*

The declining SDG&E peak demand trend has important implications for the cost of electric power. Load serving entities (LSEs) in the San Diego area, specifically SDG&E, SDCP, and Solana Energy Alliance, must contract for sufficient generation to be available to fully meet a 1-in-2 year peak hour demand forecast, plus a 15 percent reserve margin. This standard was set by the CPUC to ensure that adequate resources exist to meet the demand for electricity.[65] The CPUC calls its requirement for LSEs to purchase back-up capacity "resource adequacy" (RA).

Because the power purchased to meet the CPUC's RA back-up power requirements often goes unused, that power is priced differently than power that will likely be needed and therefore actually generated. Payments for RA to be available if needed, called "capacity payments," are required to be paid, even though this reserve power may never be called on or used. Utility customers currently pay hundreds of millions of dollars per year in SDG&E service territory in capacity payments.[66,67]

Despite the clear decline in peak load, state policymakers and SDG&E have failed to account fully for the decline in peak demand, or to project accurately the degree of future declines that will occur because of the ongoing impact of BTM solar and efficiency measures. The use of overly conservative peak load projections results in over-purchasing and unnecessary rate increases.

3. *Incorrect planning assumptions erode the value of solar power to meet peak demand*

CAISO performs the studies to determine how much RA capacity SDG&E should maintain.[68] Historically, these studies overstate the amount of RA capacity needed and undervalue the capability of renewable resources, especially solar power, to provide RA capacity. Solar power

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[65] CPUC, *The 2017 Resource Adequacy Report*, August 2018, p. 5. "The RA program was developed in response to the 2001 California energy crisis. The program is designed to ensure CPUC jurisdictional LSEs have sufficient capacity to meet their peak load with a 15% reserve margin." The term "1-in-2 year" peak is equivalent to "average year" peak.

[66] For example, Calpine, owner of the 589 MW Otay Mesa power plant, was paid about $670 million in capacity payments over the duration of its 10-year, 2009-2019 power purchase agreement with SDG&E. See: CPUC Application A.17-10-007, Application of SDG&E for Authority, Among Other Things, to Update its Electric and Gas Revenue Requirement and Base Rates Effective on January 1, 2019, *Opening Brief of The Protect Our Communities Foundation*, September 21, 2018, p. 5. Otay Mesa is one power plant among many that receive capacity payments from SDG&E whether or not SDG&E uses the power it pays for – or whether any power is ever generated by the plant.

[67] SDG&E, *R.17-06-026 PCIA Rulemaking Workshop #1C*, December 6, 2017, p. 33. Line 18, Market Value of Capacity (costs) in 2018 = $177,052,000 per year.

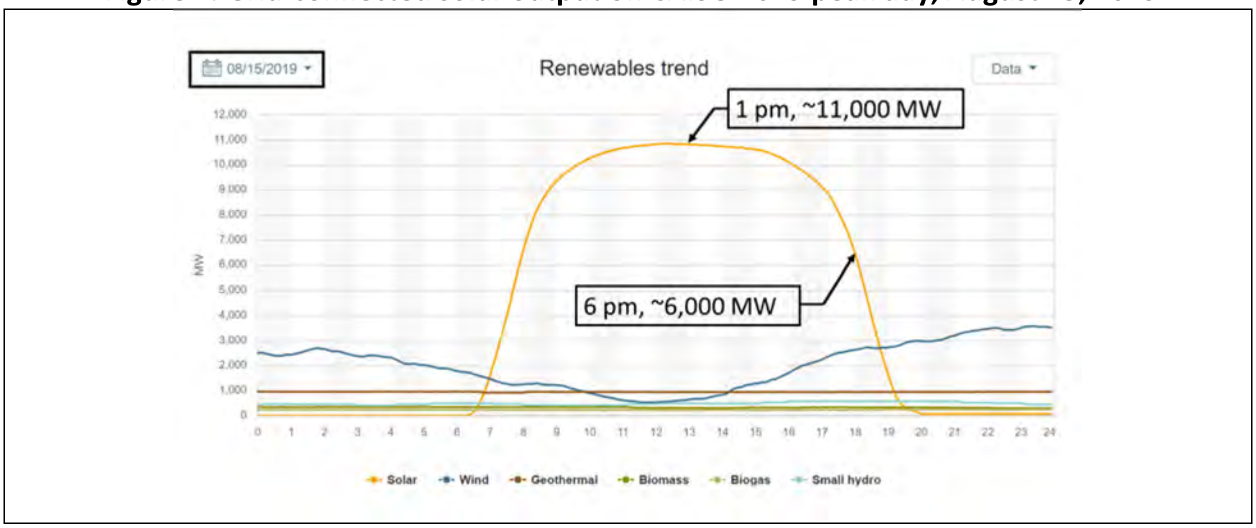
[68] CAISO was created state legislation, AB 890 (1996), that deregulated the wholesale power market in California. CAISO began operation in 1998 with the purpose of managing California's transmission grid and performing transmission planning functions.

can provide RA capacity if the peak hour occurs during daylight hours when the sun is shining and solar panels are producing electricity.

Unrealistic planning assumptions can negate the RA value of solar power. CAISO currently assumes that the 2020 summer peak hour in SDG&E service territory will occur at 8 pm.[69] Over the last five years, the summer peak hour in SDG&E service territory has occurred between 3 pm and 6 pm in the afternoon.[70] CAISO's 8 pm peak load planning assumption does not match the on-the-ground reality, and negates the contribution of solar power to meeting the peak load.

The latest the peak hour has occurred in CAISO or SDG&E service territory in recent years has been 5 – 6 pm. Figure 2 provides the hour-by-hour solar resource output in the CAISO area during the peak day in 2019, August 15, 2019, when the peak hour load occurred in the 5 – 6 pm window.[71] The solar resource is still strong in the 5-6 pm window.

Figure 2. Grid-connected solar output on CAISO 2019 peak day, August 15, 2019[72]



At 5 pm on the August 15, 2019 peak day, the solar output totals about 80 percent of the full capacity of the solar resource.[73] At 6 pm, the solar output still equals about 55 percent of the

[69] CAISO, *2020 Local Capacity Technical Study - Final Report and Study Results*, May 1, 2019, p. 144. "In year 2020 the estimated time of (SDG&E) local area peak is 8:00 PM (PDT). At the local area peak time the estimated, behind the meter, solar output is 0.00%. At the local area peak time the estimated, ISO metered, solar output is 0.00%."
[70] SDG&E FERC Form 1 reports, p. 401b, 2015-2018; and CAISO OASIS database, "Forecast Demand" "Actual", September 3, 2019.
[71] CAISO, California ISO Peak Load History 1998 through 2019, accessed April 16, 2020: https://www.caiso.com/Documents/CaliforniaISOPeakLoadHistory.pdf.
[72] See CAISO, "Today's Outlook" "Supply" "Renewables Trend" "August 15, 2019", accessed April 16, 2020: http://www.caiso.com/TodaysOutlook/Pages/supply.aspx.
[73] Peak solar output at 12 noon – 1 pm (12 – 13), 11,000 MW. Solar output at 5 pm (17) = 9,000 MW. Percentage of full solar output at 5 pm = 9,000 MW ÷ 11,000 MW = 0.81 (81 percent). Solar output at 5 pm (17) = 9,000 MW. Percentage of solar output at 5 pm compared to full solar output = 9,000 MW ÷ 11,000 MW = 0.82 (82 percent).

full capacity of the solar resource.[74] By 8 pm, the number "20" on the horizontal axis of Figure 2, the solar resource output has declined to 0 percent.

Over 2,500 MW of solar power capacity serves SDG&E service territory, equally split between remote large-scale solar and local BTM solar. At 6 pm in mid-summer, based on Figure 2, these solar projects collectively produce power at about 50 percent of their full capacity. That 50 percent production level is equivalent to more than 1,200 MW of solar output in SDG&E territory at 6 pm. At 8 pm the solar resource produces 0 MW and can no longer contribute to meeting an 8 pm peak load unless integrated with a battery storage system. CAISO's inaccurate assumption that peak demand occurs at 8 pm, and not – at the latest – the 5-6 pm hour, eliminates substantial solar capacity that should be recognized as available to meet the peak demand.

Existing solar resources should be counted by SDG&E and SDCP as reliable RA capacity at 50 percent of full capacity for a forecast peak in the 5 – 6 pm hour, consistent with actual solar performance on the peak day as shown in Figure 2. Accurately projecting peak demand and the peak hour, and crediting the solar capacity that will be available at the peak hour, will save money for both SDG&E customers and SDCP customers.

IV. SAN DIEGO HAS AMPLE SOLAR POTENTIAL TO MEET ITS 100 PERCENT CLEAN ENERGY TARGET

San Diego possesses the resources and the capability to meet its entire remaining clean power demand – and any increased demand from charging electric vehicles and building electrification – with 100 percent local solar resources. This section analyzes the data to demonstrate how San Diego's current reliance on fossil-fueled resources can be replaced with clean and local solar power. This section also explores the emerging technologies which may increase San Diego's need for electricity and calculates how that increased need can be met with local solar power.

The City's electricity demand totals approximately 8,000 GWh per year.[75] Currently, contracts for utility-scale renewable solar and wind power account for approximately 45 percent of that grid power, or 3,600 GWh per year.[76] The remaining 4,400 GWh, now provided by fossil-fuel plants, must be substituted with local clean power and energy EE to meet the City's 100 percent clean electricity mandate.

[74] Peak solar output at 12 noon – 1 pm (12 – 13), 11,000 MW. Solar output at 6 pm (18) = 6,000 MW. Percentage of solar output at 6 pm compared to full solar output = 6,000 MW ÷ 11,000 MW = 0.545 (55 percent).
[75] MRW, *City of San Diego CCA Business Plan*, prepared for the City of San Diego, October 22, 2018, pp. 2-3.
[76] It is assumed for the purposes of this calculation that the renewable energy percentage of the DA customer supply has the same renewable percentage as the electricity provided by SDG&E to bundled customers.

A. Accounting for the Electricity Demand of Emerging Technologies

The City and SDCP must meet not only its current demand, but must also plan for additional demand as new technologies that require electricity are adopted throughout California. For example, the City should account for the state's rapid expansion of EV usage, which targets 5 million EVs by 2030. The City, with a population of 1.4 million, represents 3.3 percent of California's population of 40 million. The proportional allocation to the City of a statewide EV target of 5 million by 2030 would equal 200,000 EVs. The City has about 500,000 housing units. This roadmap assumes that 40 percent of City residential electric meters will have an associated EV by 2030, and that charging of the EV will primarily occur at the residence.[77]

The electricity to power the EVs could be supplied principally by BTM solar with battery storage. EVs average 40 miles per day.[78] Each EV will require on average about 10 kWh per day of solar power to provide 40 miles of range.[79] These 200,000 EVs would add an additional 730 GWh of demand in 2030.[80] On an individual EV basis, at an average usage of 40 miles per day, the EV will have an annual electricity demand of about 3,650 kWh per year.[81] This equates to the approximate annual output of eight 300-watt solar panels.[82]

Another key emerging state priority involves building electrification.[83] Fuel combustion in buildings accounts for about 25 percent of California's greenhouse gas emissions.[84] On-site combustion, predominantly natural gas, is used primarily for space heating and water heating. These two uses account for more than 80 percent of fuel use in residential buildings and approximately 70 percent in commercial buildings.[85]

Electric heat pumps are much more efficient than gas-powered furnaces, boilers, hot water heaters, and dryers, and can be powered with renewable energy.[86] Building electric loads will

[77] 200,000 EVs ÷ 500,000 housing units = 0.40 EVs per housing unit (40 percent).
[78] CSE, per capita driving miles City of San Diego, 13. 6 miles per day: https://sites.energycenter.org/equinox/dashboard/interactive-vehicle-miles-traveled. U.S. Census indicates 2.87 people per household in San Diego County: https://www.census.gov/quickfacts/fact/table/sandiegocountycalifornia,CA/PST045219. Assume typical household consists of 3 people. Therefore, per household EV miles per day = 3 people/household x 13.6 miles per person = 40.8 miles per household per day.
[79] The EV is assumed to achieve 4 miles of range per 1 kWh of electricity on average.
[80] 200,000 EVs x 10 kWh/day x 365 day/yr = 730,000,000 kWh/yr ÷ 1,000,000 kWh/GWh = 730 GWh/yr.
[81] 10 kWh/day x 365 days/yr = 3,650 kWh/yr.
[82] NREL, PVWatts Calculator, "San Diego, zip code 92116" "20% losses" "2,400 watts$_{DC}$", accessed April 26, 2020: https://pvwatts.nrel.gov/. Output from 2,400 watts$_{DC}$ in 92116 zip code = 3,742 kWh/yr.
[83] CEC, *Final 2019 Integrated Energy Policy Report (IEPR)*, January 2020, pp. 55-56.
[84] Synapse Energy Economics, *Decarbonization of Heating Energy Use in California Buildings*, October 2018, p. 6: https://www.synapse-energy.com/sites/default/files/Decarbonization-Heating-CA-Buildings-17-092-1.pdf.
[85] *Ibid*, p. 7.
[86] *Ibid*, p. 1. Electric heat pumps move heat instead of burning fuel to create heat.

increase incrementally with the addition of electric heat pumps to displace natural gas-fired heat sources.[87,88]

New BTM solar and battery storage installations should be sized to accommodate future EV and building electrification demand. Such an approach would allow these new loads to be met by BTM solar power at the time they are added to the site.

To meet a 2030 City target of 100 percent clean electricity with local solar and EE, and meet the demand of 200,000 EVs in 2030, San Diego would require an additional 5,100 GWh of clean resources.[89] EE will meet 25 percent, or 1,100 GWh, of stationary (non-EV) demand. Meeting 25 percent of the need with EE is achievable and conservative in the context of the EE targets in the *Long-Term Energy Efficiency Strategic Plan*.[90] Approximately 4,000 GWh of the demand will be met with new local solar power.[91]

The local solar power capacity necessary to produce 4,000 GWh per year of electricity in 2030 equates to approximately 2,100 MW_{AC} of solar capacity.[92] 2,100 MW_{AC} of solar capacity is equivalent to the addition of 210 MW_{AC} per year of capacity over the next 10 years. The solar potential on rooftops and parking lots in the City, exceeds 10,000 GWh per year – more than double the 2030 target of 4,000 GWh per year – as explained below.

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[87] These heat pump loads are not quantified in this roadmap, due primarily to uncertainty concerning the rate of adoption. SDG&E has not published projections on the rate of adoption of building electrification. In contrast, SCE projects that 33 percent of the homes in its service territory will have electric space and water heaters by 2030. See: CEC, *Final 2019 Integrated Energy Policy Report*, January 2020, pp. 61-62.

[88] A typical electric heat pump water heater has an annual electricity demand of about 915 kWh per year (See Rheem Sales Company, Inc. 45-gallon electric heat pump water heater, 915 kWh per year Energy Guide rating). That demand equates to the approximate annual output of two 300 $watt_{DC}$ solar panels. Space heating: A mid-sized detached home in central San Diego (south of I-8) uses about 150 therms (15 million Btu) per year for space heating, based the author's residential usage rate. Heat pumps are generally about 3.3 times more efficient than gas furnaces (see: Trane, *Heat Pump Vs. Furnace. What Heating System Is Right For You?*, October 2019: https://www.trane.com/residential/en/resources/heat-pump-vs-furnace-what-heating-system-is-right-for-you/). 1 therm = 100,000 Btu = 29.3 kW_{heat}. Therefore, the annual electric heat pump demand to provide the equivalent of 150 therms of direct natural gas-fired heating would be: (150 therms/year x 29.3 kW_{heat}/therm) ÷ 3.3 = 1,332 kW/year. An electric heat pump demand of 1,332 kWh per year is approximately equivalent to the yearly output of three 300 $watt_{DC}$ solar panels.

[89] Displacement of City's fossil-fuel usage, 4,400 GWh/yr, and EV demand in 2030, 730 GWh/yr = ~5,100 GWh/yr.

[90] CPUC, *Long Term Energy Efficiency Strategic Plan – January 2011 Update*, January 2011, p. 20 and p. 36. "Goal 2 – Existing Homes: 75% of existing homes have a 30% decrease in purchased energy from 2008 levels, 100% of existing multi-family homes have a 40% decrease in purchased energy from 2008 levels." and "Goal 2 – Existing (Commercial) Buildings: 4 billion sq. ft. of commercial space reach the Energy Star target by 2030."

[91] Local clean energy need in 2030 = ~5,100 GWh. 4,400 GWh electricity need to be met with 3,300 GWh local solar and 1,100 GWh EE. ~700 GWh EV need to be met with local solar. Total local solar need = 3,300 GWh + 700 GWh (EV) = 4,000 GWh.

[92] 4,000,000 MWh/yr ÷ 1,900 MWh/yr/MW_{AC} = 2,105 MW_{AC}.

B. Solar Potential of City of San Diego Rooftops

The first detailed study of rooftop solar potential in SDG&E service territory was the 2005 *Potential for Renewable Energy in the San Diego Region*.[93] This study included major contributions from SDG&E personnel. The estimated 2020 technical potential for residential and commercial rooftop solar in the City was 2,085 MW_{AC}, which represented 1,239 MW_{AC} residential PV (2,774 GWh annual energy production) and approximately 846 MW_{AC} commercial PV (1,685 GWh annual energy production).[94] The 2005 analysis was conservative in a number of ways. It assumed that solar panels would cover only 25 percent of the available residential roof area, and assumed the direct current-to-alternating current (DC-to-AC) conversion efficiency was only 67 percent for both residential and commercial rooftop solar systems.[95]

The 2005 study also assumed a solar output capacity of 10 $watts_{DC}$ for every square foot of solar panel surface area.[96] The current unit output of a solar panel is approximately 17 $watts_{DC}$ per square foot.[97] The solar potential of residential and commercial rooftops in the City increases substantially, to about 3,500 MW_{AC} and 7,600 GWh per year, respectively, when a solar output of 17 $watts_{DC}$ per square foot is used, as shown in Table 2.[98]

Table 2. City rooftop potential in 2020, module output of 10 $watts_{DC}/ft^2$ and 17 $watts_{DC}/ft^2$

Roof type	2020 MW_{AC} potential		2020 GWh potential	
	10 $watts_{DC}/ft^2$	17 $watts_{DC}/ft^2$	10 $watts_{DC}/ft^2$	17 $watts_{DC}/ft^2$
Residential	1,239	2,106	2,774	4,716
Commercial	846	1,438	1,685	2,865
Total	2,085	3,544	4,459	7,581

Note: Assumed DC-to-AC conversion efficiency for residential = 80%, for commercial = 90%. Assumed annual production per kW_{AC} = 1,900 kWh-yr.

[93] San Diego Regional Renewable Energy Study Group, *Potential for Renewable Energy in the San Diego Region, Chapter 2: Solar Photovoltaic Electric*, May 2005.

[94] The report assumes an 11 percent increase in residential rooftop surface area in the City of San Diego between 2003 and 2020. The report calculates commercial rooftop area in the City for 2004 only. Powers Engineering has multiplied the 2004 commercial rooftop solar potential by 10 percent to estimate expected commercial rooftop surface area growth between 2004 and 2020. Therefore, 2020 commercial rooftop potential = 769 MW x 1.10 = 846 MW. Annual solar production potential from commercial rooftops in 2020 = 1,532 GWh x 1.10 = 1,685 GWh.

[95] San Diego Regional Renewable Energy Study Group, *Potential for Renewable Energy in the San Diego Region, Chapter 2: Solar Photovoltaic Electric*, May 2005, Table 2.5, p. 6.

[96] *Ibid*, p. 6, footnote 6. "Typically crystalline array systems produce 10 watts per square foot of array area. *A Guide to Photovoltaic (Pv) System Design and Installation*, CEC 2001."

[97] GermanSolar USA, 300-$watt_{DC}$ solar module, 17.6 square feet (65 inches x 39 inches). Module unit output = 300 $watt_{DC}$ ÷ 17.6 square feet = 17.0 $watts_{DC}$ per square foot. See: http://www.germansolarusa.com/wp-content/uploads/2017/03/PremiumLine-Silver-GSM6-60-285W-300W.pdf.

[98] By way of comparison, Google Sunroof (accessed March 18, 2020) projects a rooftop solar potential in the City of San Diego of 6,000 MW_{DC} (or about 5,400 MW_{AC} at a commercial BTM solar DC-to-AC conversion efficiency of 90 percent). See: https://www.google.com/get/sunroof/data-explorer/place/ChIJSx6SrQ9T2YARed8V_f0hOg0/.

An average installation rate of 210 MW_{AC} per year over the next 10 years will be necessary for the City to add 4,000 GWh of local solar power by 2030. At the current BTM solar installation rate of 100 MW_{AC} per year in the City, about 1,000 MW_{AC} of new BTM solar will be added by 2030. There is more than 3,500 MW_{AC} of rooftop solar potential in the City, as shown in Table 2. This is far more rooftop solar potential than necessary to add 1,000 MW_{AC} of new rooftop solar by 2030. This roadmap uses the conservative assumption that the rate of BTM solar installations remains at 100 MW_{AC} per year through 2030.

San Diego would need to incrementally accelerate its current solar installation rate by 110 MW_{AC} per year, from 100 MW_{AC} per year to 210 MW_{AC} per year, to achieve the 100 percent solar build-out target by 2030. This 110 MW_{AC} increase in solar capacity should be developed on commercial parking lots and warehouse rooftops, using a feed-in tariff (FIT) payment structure. The potential of commercial parking lot solar is described below. The FIT payment structure is discussed in Section VII of this roadmap.

C. Solar Potential of City of San Diego Parking Lots

The 2008 *San Diego Smart Energy 2020* report estimated a commercial parking unit potential in San Diego County of 1 MW_{AC} per 1,000 people, or about 1.1 MW_{DC} per 1,000 people.[99] 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.

Numerous parking lot solar arrays in San Diego, at the San Diego County Office of Education and San Diego Airport, for example, cover more than 50 percent of the available parking space, as shown in Figure 3.[100] In some cases, the surface area of the parking lot solar array(s) is greater than the surface area of the building(s) the parking lot supports, as shown in Figure 4.

The City has an estimated population of 1,426,000 as of July 1, 2018.[101] Therefore, at 1 MW_{AC} per 1,000 people, the City's commercial parking lot solar potential totals approximately 1,436 MW_{AC} (1,580 MW_{DC}), assuming only 25 percent of the available parking area is covered with

[99] The DC-to-AC conversion efficiency for commercial solar installations is assumed to be 90 percent.

[100] Photos downloaded from Google Earth, yellow borders to parking lots added by B. Powers. Solar panels in the San Diego County Office of Education parking lot, outlined in yellow, cover about 75 percent of the available area in the parking lot. Solar panels in the San Diego Airport parking lot, outlined in yellow, also cover about 75 percent of the available area in the parking lot.

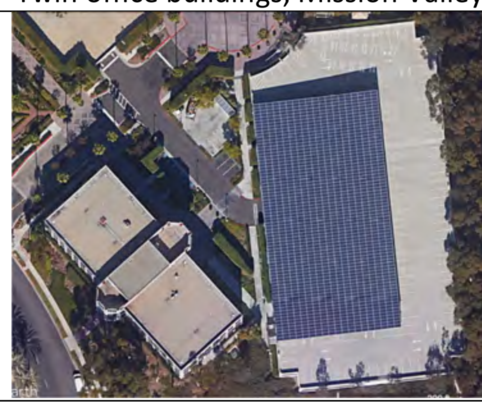
[101] U.S. Census Quick Facts, San Diego, July 1, 2018: https://www.census.gov/quickfacts/fact/table/sandiegocitycalifornia,US/PST045219.

solar panels.[102] This resource potential, at 1,436 MW_{AC}, provides more than sufficient capacity to add 110 MW_{AC} per year of commercial parking lot solar capacity through 2030.[103]

Figure 3. San Diego parking lot solar arrays covering more than 50 percent of parking lot area

San Diego County Office of Education	San Diego Airport
	

Figure 4. San Diego examples of parking lot solar exceeding roof area of associated commercial building(s)

City of San Diego Mission Valley Library	Twin office buildings, Mission Valley
	

D. Total Solar Potential of City of San Diego Rooftops and Parking Lots

The City's overall 2020 solar potential – including residential rooftop, commercial rooftop, and parking lot solar – totals about 5,000 MW_{AC} and 10,000 GWh, using the conservative estimates explained above, are shown in Table 3.

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[102] 1,436,000 x 1 MW_{AC}/1,000 = 1,436 MW_{AC}.

[103] The solar energy production potential of the City's commercial parking lots, assuming a conservative solar coverage of 25 percent, would be approximately 2,700 GWh per year. Assume 1 MW_{AC} produces 1,900 MWh per year of solar production in San Diego. Therefore 1,426 MW_{AC} x 1,900 MWh/MW_{AC} = 2,709,400 MWh per year or ~2,700 GWh per year.

Table 3. Total City of San Diego 2020 rooftop and parking lot solar potential

Type	MW_{AC}	GWh per year
Residential rooftop	2,106	4,716
Commercial rooftop	1,438	2,865
Commercial parking lot	1,436	2,702
Total	4,980	10,283

The 10,283 GWh per year of available local solar potential provides more than double the 4,000 GWh that San Diego would need to achieve a 100 percent local clean energy build-out by 2030.

V. OPT-OUT & ON-BILL FINANCING CAN REALIZE SAN DIEGO'S LOCAL CLEAN POWER POTENTIAL

The opt-out program structure and on-bill financing mechanism offer excellent tools for engaging the maximum number of customers in a local solar build-out in the City. Opt-out programs maximize customer participation by automatically enrolling customers in the program, while allowing customers to affirmatively opt-out of the program if they choose to do so. On-bill financing, if properly structured, allows the entire range of customers – owner and renter, good credit or marginal credit – to benefit from local solar power and battery storage.

A. Opt-Out Programs Maximize Customer Participation

A key element of the SDCP involves the opt-out nature of the program. "Opt-out" in the context of SDCP means that all customers are enrolled in the program initially, but may opt-out if they affirmatively choose to remain a customer of SDG&E. Any customer that does not want to be in the program can opt out. Opt-out programs generally maintain high customer participation rates, typically 95 percent or greater for California CCEs like SDCP.[104] Opt-out programs are the norm to achieve high customer participation rates. SDG&E's recently launched time-of-use (TOU) billing structure provides one example of a utility employing an opt-out program.[105]

In contrast, opt-in programs require that customers affirmatively choose to enroll, with no obligation to do so. Examples of opt-in programs are many utility-run DR programs, which

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[104] Georgetown Environmental Law Review, *Power to the People: Community Choice Aggregation in California*, January 16, 2020. "Further, for the 2018-2019 fiscal year, CleanPowerSF reported a 96.6% customer retention rate, highlighting the effectiveness of the opt-out model, whereby customers are automatically enrolled and must actively "opt-out" to return to the incumbent IOU."

[105] SDG&E, *Opting Out of Time-of-Use Pricing Plans*, webpage accessed March 19, 2020. See: https://www.sdge.com/opting-out-time-use-pricing-plans.

typically do not exceed a participation rate of more than 5 percent of the customer base.[106] SDG&E's existing opt-in residential A/C DR programs have a voluntary participation rate, and a comparable load reduction impact, of about 1.5 percent.[107] Such low opt-in participation rates mean these opt-in DR programs have little impact on reducing load when the demand is high on hot summer days.

1. *Use of opt-out programs to maximize potential of A/C cycling DR*

Opt-out DR programs – where customers are provided the enabling technology, such as low-cost automated A/C temperature controllers for cycling of central A/C units[108] – can achieve 95 percent participation.[109] For the DR programs to maximize their potential, they must be structured as opt-out programs that also include a substantial public education component to enable customers to understand and support the programs.

Air conditioning DR programs have the potential, with high customer participation, to provide a major load reduction when it matters most, on hot summer days. For example, the 2019 peak one-hour load in SDG&E service territory of 4,063 MW occurred during a heat wave on Tuesday, September 3, 2019.[110] One week later during a cooler period, on Tuesday, September 10, 2019, the peak load totaled only 2,898 MW.[111] The additional 1,165 MW of demand on September 3, 2019 relative to the demand on September 10, 2019,[112] was entirely associated with A/C usage in response to the heat wave.

Cycling 95 percent of this additional 1,165 MW A/C load has the potential to reduce this cooling load by up to 500 MW in SDG&E service territory. This potential 500 MW A/C load reduction compares to the 5 MW load reduction achieved with the existing SDG&E residential A/C cycling program[113] on its peak day in 2018.

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[106] FERC, *A National Assessment of Demand Response Potential*, October 2009, pp. 24-25. See: https://www.ferc.gov/legal/staff-reports/06-09-demand-response.pdf.

[107] SDG&E, *Executive Summary of the 2018 SDG&E Measurement and Evaluation Load Impact Reports*, April 1, 2019, Table 1-1, p. 1-9. Total participating A/C cycling residential customers (AC Saver Day Ahead Residential & Day Of Residential) at SDG&E Peak Day Load Impact in MW (August 9, 2018, 7 – 8 pm) = 19,723 customers, 5.25 MW load reduction. Author's note: SDG&E has approximately 1.2 million residential customers, and the peak load on August 9, 2018, 7-8 pm, was 4,155 MW (CAISO OASIS database, System Demand – Actual, August 9, 2018). 19,723 customers ÷ 1,200,000 customers = 0.0164 (1.64 percent).

[108] Portland General Electric, *Smart Thermostat Program*, webpage accessed May 5, 2020: https://www.portlandgeneral.com/residential/energy-savings/thermostats/smart-thermostat-programs.

[109] FERC, *A National Assessment of Demand Response Potential*, October 2009, Table 1, p. 24.

[110] CAISO OASIS database, System Demand – Actual, September 3, 2019, hour ending 6 pm (1800). See: http://oasis.caiso.com/mrioasis/logon.do.

[111] Ibid, September 10, 2019, hour ending 7 pm (1900).

[112] 4,063 MW – 2,898 MW = 1,165 MW.

[113] SDG&E, AC Saver (Summer Saver), webpage accessed May 2, 2020: https://www.sdge.com/residential/savings-center/rebates/your-heating-cooling-systems/summer-saver-program.

SCE has a larger and more effective residential A/C cycling program than SDG&E that offers a better measure of the DR potential of this type of program in the City. SCE achieved an average of 1 MW reduction per 1,000 participating customers in the first hour of deployment (5 to 6 pm) over several heat waves in the summer of 2019.[114] The average SCE peak load reduction in the first hour was more than 50 MW and involved over 50,000 residential customers.[115]

The City has the potential to reduce the residential A/C load by up to 250 MW with a comprehensive A/C cycling DR program.[116] The opt-out program structure provides the vehicle to enroll up to 95 percent of the customers with residential and small commercial A/C. At an enrollment rate of 25 MW of demand reduction per year, the entire 250 MW peak demand reduction potential of the A/C cycling DR program could be available by 2030.

2. The opt-out program structure achieves focused EE reductions

SB 350 (2015) obligates California's utilities to double EE savings by 2030.[117] The utilities are not currently on track to do so, and are projected to achieve only a 20 percent reduction in demand with EE by 2030 without further action.[118] These reductions will occur primarily due to state- and federally-mandated codes and standards that increase the efficiency of electrical appliances over time.[119]

The CEC has identified the need to "develop hourly energy efficiency savings profiles based on actual customer data across each climate zone" as one step in getting back on track toward a doubling of EE savings by 2030.[120] SDG&E is obligated by state law to provide SDCP, as a CCE, with the electric usage data of individual customer meters.[121] SDCP can readily identify high

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[114] SCE, *Southern California Edison Smart Energy Program: 2019 Load Impact Evaluation*, PowerPoint, May 4, 2020, p. 5. Summer 2019 average, 5-6 pm, number of customers = 52,239, average load reduction = 1.02 kW, total load reduction = 52,239 customers x 1.02 kW per customer = 53,284 kW (53.3 MW).

[115] *Ibid*.

[116] This 250 MW load reduction potential assumes the City accounts for approximately one-half of the residential A/C load in SDG&E service territory during peak demand periods.

[117] SB-350, *Clean Energy and Pollution Reduction Act of 2015*, chaptered version, October 7, 2015. See: https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201520160SB350. "This bill would require the State Energy Resources Conservation and Development Commission to establish annual targets for statewide energy efficiency savings and demand reduction that will achieve a cumulative doubling of statewide energy efficiency savings in electricity and natural gas final end uses of retail customers by January 1, 2030."

[118] CEC, *2019 California Energy Efficiency Action Plan – Final Staff Report*, November 2019, p. 5. See: https://ww2.energy.ca.gov/business_meetings/2019_packets/2019-12-11/Item_06_2019%20California%20Energy%20Efficiency%20Action%20Plan%20(19-IEPR-06).pdf.

[119] *Ibid*, p. 2.

[120] *Ibid*, p. 7.

[121] AB-117, *Electrical restructuring: aggregation*, chaptered version, September 24, 2002, webpage accessed May 2, 2020. See: https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=200120020AB117. "Cooperation shall include providing the entities with appropriate billing and electrical load data, including, but not limited to, data detailing electricity needs and patterns of usage, as determined by the commission, and in accordance with

users of electricity in each neighborhood with this data. SDCP can then focus EE upgrades on these high usage customers, which are the customers that present the most potential for substantial EE gains.

Candidates for opt-out EE measures, including for example weatherization and comprehensive LED lighting upgrades, can be prioritized based on data available to SDCP on existing customer usage. Customers with substantially higher usage than the average customer in the applicable customer category should be included in the first group of customers placed in these targeted EE programs, as these customers represent the greatest potential for reductions. The objective of focusing on high usage customers would be to boost the current business-as-usual EE reduction forecast of 20 percent by 2030 to a reduction of 25 percent by 2030.

B. On-Bill Financing Develops Full Local Solar Potential

On-bill financing involves the use of the utility bill itself as the repayment medium to finance EE and BTM solar and battery storage upgrades.[122] On-bill financing programs have experienced low rates of default because they are paid through customers' electric bills. Loans backed by electric bill payment are relatively low risk for lenders. Funds for on-bill financing programs can come from local government, utilities, or private lenders. In the latter case, the term "on-bill repayment" is used.

Readily available financing for EE upgrades remains critical to increasing EE reductions. Even the CEC recommends the use of on-bill financing, which would not be tied to credit score or income, to accelerate these EE upgrades on low- and middle-income homes and multifamily units.[123] An on-bill financing program would be a good tool to increase EE upgrades, just as it would be for adding BTM solar and battery storage.

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procedures established by the commission . . . The electrical corporation shall read the metering devices and provide the data collected to the community aggregator at the aggregator's expense."

[122] National Conference of State Legislatures (NCSL), *On-Bill Financing: Cost-free Energy Efficiency Improvements* (webpage), April 7, 2015: http://www.ncsl.org/research/energy/on-bill-financing-cost-free-energy-efficiency-improvements.aspx. NCSL describes on-bill financing this way: "On-bill repayment programs leverage private, third-party capital for financing. Banks, credit unions or financial institutions provide the loan capital and loan payments are displayed on utility bills. This approach allows third-party institutions to take care of administrative functions, while utilities only need to process payments… On-bill repayment can also be sole sourced or open sourced—programs in New York and Oregon use a single source of capital while Hawaii is currently developing an open source model where banks and investors compete for customers."

[123] CEC, *2019 California Energy Efficiency Action Plan – Final Staff Report*, November 2019, p. 8. "Implement tariffed on-bill repayment programs statewide to open new financing mechanisms for low-to-middle-income households and multifamily units, with eligibility not based on credit score or income."

SDG&E currently runs a limited on-bill financing program, but with a program lending cap of $9 million.[124] SDG&E limits its on-bill financing program to commercial energy efficiency projects only.[125]

The on-bill financing lending level needs to be much higher to enable all San Diegans access to BTM solar and battery storage. For example, funding 100 MW_{AC} per year of BTM solar and battery storage using on-bill financing would require up to $300 million per year in capital financing over the next ten years.[126] A much larger source of capital than the utility's current on-bill financing cap would be necessary for the program to achieve its full potential.

On-bill financing exists as an efficient mechanism to ensure that all customers that pay an electric bill are able, with no up-front payment and no increase in monthly utility costs, to take advantage of solar, battery storage, and EE upgrades. On-bill financing provides a demonstrated mechanism to expand the benefits of solar power and battery storage to all residents and businesses and overcomes the initial capital requirements that prevent many people from installing solar systems now. SDCP cannot achieve ambitious BTM solar growth without an inclusive on-bill financing program.

1. *The Rate of solar adoption is uneven across the City*

The percentage of BTM solar installed across SDG&E service territory totals approximately 12 percent of customers as of January 31, 2020.[127]

Currently, an uneven distribution of BTM solar exists across San Diego, as shown in Table 4. The commonly understood dividing line in the City between the urban population and more suburban neighborhood is east-west Interstate 8 (I-8). Suburban residential areas of the City north of I-8 tend to have a higher percentage of BTM solar, generally in the range of 15 to 20 percent. "Percentage of BTM solar" in Table 4 means the number of housing units with BTM solar compared to the total number of housing units in a given zip code.

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[124] CPUC Decision D.09-09-047, *Decision Approving 2010 to 2012 Energy Efficiency Portfolios and Budgets*, September 24, 2009, p. 275.

[125] SDG&E, *Guide to On-Bill Financing Option*, webpage accessed April 1, 2020: https://www.sdge.com/sites/default/files/documents/Guide-to-On-Bill-Financing%20.pdf. Currently, any customer receiving a bill from SDG&E is eligible to participate in the on-bill financing program.

[126] The cost estimate assumes the average installed present value of residential solar + battery storage installations over the 2020-2030 period is $3 per $watt_{AC}$. Therefore, $\$3/watt_{AC} \times 100\ MW_{AC}/yr \times 1{,}000{,}000\ watt/MW = \$300$ million/yr.

[127] This percentage is determined by dividing the number of BTM solar installations by the total number of electric meters in SDG&E service territory. Number of BTM solar systems as of January 31, 2020 = 176,038. See California Distributed Generation Statistics database: https://www.californiadgstats.ca.gov/charts/. Number of SDG&E meters = 1,491,158. See *SDG&E 2020 Wildfire Mitigation Plan*, Rev. 1, March 2, 2020, Table 13, pdf p. 218. BTM solar percentage = 176,038 ÷ 1,491,158 = 0.118 (11.8 percent).

The highest levels of BTM solar in the City are found in well-to-do areas north of I-8. These include Rancho Peñasquitos and Del Cerro, each with a BTM solar percentage of about 20 percent. La Jolla, a wealthy community, has a BTM solar percentage of only 10 percent.

However, some modest- to low-income neighborhoods south of I-8, such as Skyline and Paradise Hills in City Council District 4, have high BTM solar percentages as well. The BTM solar percentage in Skyine is greater than 15 percent. This is higher than in some high income areas north of I-8, like La Jolla (10 percent) and Rancho Bernardo (12 percent). Figure 5 is a photograph of a section of the Skyline neighborhood. The relatively high density of BTM solar systems on rooftops is evident in Figure 5.

Figure 5. Photograph of BTM solar distribution on rooftops in the Skyline neighborhood

Source: Google Earth

The data in Table 4 shows that average property value alone does not provide a sufficient indicator to forecast whether or not a particular area of the City would have a high percentage of BTM solar.

Table 4. Comparison of percentage of rooftop solar systems in high- and modest-income areas of San Diego[128]

Zip code	Area of City of San Diego	Average value of houses & condos, 2017 ($)	Number of housing units, 2017	Number of rooftop solar systems, as of 1/31/20	Percentage of housing units with rooftop solar systems (%)	Total installed solar capacity as of 1/31/20 (kW)
A. Selected San Diego zip codes north of I-8						
92037	District 1: La Jolla	1,435,485	20,301	1,966	9.7	18,667
92128	District 5: R. Bernardo	642,679	21,753	2,669	12.3	15,441
92129	Districts 5, 6: R. Peñasquitos	726,908	18,590	3,826	20.6	19,338
92120	District 7: Del Cerro	633,908	12,153	2,379	19.6	14,128
B. Selected San Diego zip codes south of I-8						
92114	District 4: Skyline	396,178	18,908	2,994	15.8	14,198
92139	District 4: Paradise Hills	390,106	11,331	1,378	12.2	6,672
92115	Districts 4, 9: College	491,540	23,367	1,828	7.8	11,042
92105	Districts 3, 4: City Heights	370,089	23,032	1,210	5.3	7,074
92102	Districts 3, 4, 8: Golden Hill	404,387	15,679	752	4.8	4,830
92113	Districts 4, 8, 9: Logan Heights	336,690	14,093	598	4.2	4,561
92103	District 3: Mission Hills	779,537	19,803	899	4.5	5,288
92107	District 2: Ocean Beach	886,031	14,749	848	5.7	4,173
92106	District 2: Point Loma	1,047,516	8,316	1,131	13.6	5,288

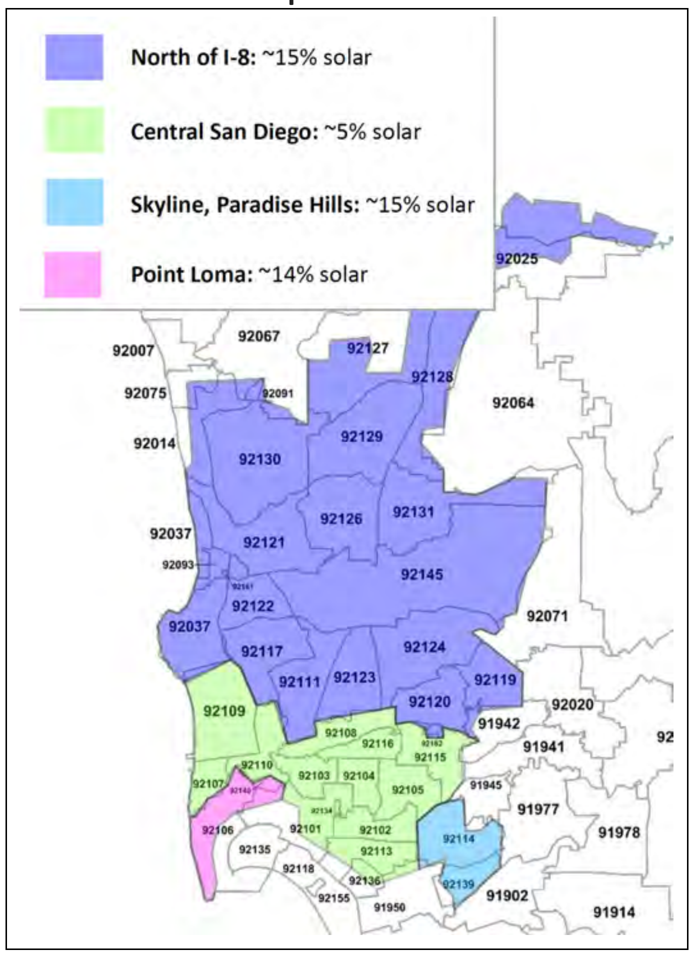
128 Zip code population, number houses/condos, value houses/condos, number renter-occupied apartments, accessed 3/9/20: https://www.city-data.com/; NEM solar systems, number and kW capacity, by zip code, accessed 3/9/20: https://www.californiadgstats.ca.gov/downloads/, see "NEM Currently Interconnected Data Set (.xls), January 31, 2019". The number of NEM solar systems are divided into number of houses/condos in each zip code to determine solar percentage. The number of renter-occupied units in each zip code north of I-8: 92037 = 7,238; 92120 = 3,540; 92128 = 7,443; 92129 = 5,892. Number of renter-occupied apartments in each zip code south of I-8: 92102 = 10,598; 92103 = 11,879; 92105 = 15,252; 92106 = 3,185; 92107 = 8,151; 92113 = 9,662; 92114 = 6,063; 92115 = 14,379; 92139 = 4,208.

A substantial portion of the City south of I-8, both in high income and lower-income areas, has consistently low levels of BTM solar, on the order of 5 percent. Figure 6 shows this section of the City by zip code. The central portion of the City with low solar penetration is bounded by a solid black line. Pockets with high levels of solar penetration also occur south of I-8, in Point Loma on the coast and in the Skyline and Paradise Hills areas of southeast San Diego.

There are numerous entities operating in central San Diego south of I-8 that are methodically adding BTM solar capacity. These include: 1) the San Diego Unified School District, which will have 75 solar projects at sites throughout the school district by the end of 2022,[129] 2) San Diego Airport, with 5.5 MW of solar and 4 MWh battery storage, [130] 3) Marine Corps Recruit Depot San Diego, with 3.6 MW of solar meeting 30 percent of the electricity need of the base,[131] 4) the City of San Diego with 6.5 MW of solar projects at fire stations, police stations, libraries, recreation centers, and water treatment facilities throughout the City,[132] and 5) big box stores like Costco, Walmart, and Ikea.

Many of these projects are highly visible solar parking structures, collectively giving the impression of a high level of solar capacity in central San Diego. This is not the case.

Figure 6. Zip codes in San Diego with low BTM solar penetration[133]



[129] San Diego Unified School District, *News Release - Vista Grande Turns Greener as Zero Net Energy Project Ramps Up*, June 27, 2019. See: https://www.sandiegounified.org/newscenter/news-release-vista-grande-turns-greener-zero-net-energy-project-ramps.
[130] renewableenergyworld.com, *San Diego Airport installs 2 MW/4 MWh storage system to complement existing PV array*, June 27, 2019. See: https://www.renewableenergyworld.com/2019/06/27/san-diego-airport-installs-2-mw4-mwh-storage-system-to-complement-existing-pv-array/#gref.
[131] Marine Corps Installations West, *MCRD San Diego receives energy award from SDG&E*, April 12, 2019. See: https://www.mciwest.marines.mil/News/News-Article-Display/Article/1823349/mcrd-san-diego-receives-energy-award-from-sdge/.
[132] City of San Diego .xls list of all City solar projects as of April 14, 2020.
[133] San Diego Association of Governments (SANDAG), *San Diego Region Zip Codes* (map), March 22, 2010. The two City of San Diego zip codes on the U.S.-Mexico border, 92173 (San Ysidro) and 92154 (Otay Mesa) are not shown.

2. High percentage of owner-occupied housing correlates to high BTM solar adoption

The section of San Diego south of I-8 generally lags by a considerable margin with respect to the BTM solar penetration achieved in other parts of the City. The reason for the low BTM solar penetration in this section of the City appears to be the high percentage of renter-occupied housing. A strong correlation exists between the percentage of owner-occupied housing and the rate of BTM solar adoption. Conversely little correlation is found between the value of the housing and BTM solar adoption. Table 5 details this relationship.

Table 5. Comparison of percentage of rental housing units to rooftop solar systems in high- and modest-income areas of San Diego[134]

Zip code	Area of City of San Diego	Average value of housing units, 2017 ($)	Number of total housing units, 2017	Number of rental units, 2017	Percentage of renters (%)	Percentage of housing units with rooftop solar systems (%)
92129	Districts 5, 6: R. Peñasquitos	726,908	18,590	5,892	33	20.6
92120	District 7: Del Cerro	633,908	12,153	3,540	31	19.6
92114	District 4: Skyline	396,178	18,908	6,063	34	15.8
92139	District 4: Paradise Hills	390,106	11,331	4,208	40	12.2
92107	District 2: Ocean Beach	886,031	14,749	8,151	61	5.7
92105	Districts 3, 4: City Heights	370,089	23,032	15,252	70	5.3
92109	District 2: Pacific Beach	899,301	26,669	16,677	73	5.2
92102	Districts 3, 4, 8: Golden Hill	404,387	15,679	10,598	73	4.8
92103	District 3: Mission Hills	779,537	19,803	11,879	65	4.5
92113	Districts 4, 8, 9: Logan Heights	336,690	14,093	9,662	73	4.2

The Skyline area in District 4, with an average home value of about $400,000 and a high owner occupancy rate, has more than three times the BTM solar penetration rate of Pacific Beach with its average home value of about $900,000 and a low owner occupancy rate. The Paradise Hills area in District 4, with an average home value of about $390,000 and a high owner-occupancy

[134] Data is from www.city-data.com for each zip code, including "percentage of renters" data. The percentage of houses and condos with rooftop solar systems is from Table 4.

rate, had about three times the BTM solar penetration rate of Mission Hills with its average home value of about $780,000 and a low owner occupancy rate.

This data demonstrates the need for an effective financing mechanism to spur the deployment of BTM solar and battery storage on properties that are not owner-occupied.

3. State low-income solar incentive programs work, but have only limited funding

A factor in the elevated level of BTM solar in some of the City's lower-income neighborhoods, in addition to the primary driver of a high level of owner-occupied homes, involves the impact of state funding programs like the Single-family Affordable Solar Homes (SASH), Multi-family Affordable Solar Housing (MASH), and Solar on Multi-family Affordable Housing (SOMAH) programs.[135,136]

The term "multi-family housing" is synonymous with renter-occupied apartment buildings. These low-income solar programs were created to "stimulate the adoption of solar power in the affordable housing sector," and in the case of the multifamily programs, "decrease electricity use and cost for tenants."[137] These are important and necessary programs. However, these programs have limited funding and will not by themselves be able to assure an equitable distribution of solar power in lower-income areas of San Diego.

Approximately 1.5 to 2 MW_{AC} of BTM solar has been installed under the SASH program in San Diego, which will end in 2021.[138] Approximately 3 MW_{AC} of BTM solar has been installed on lower-income multi-family buildings in San Diego under the MASH program.[139]

Powers Engineering estimates San Diego's proportionate share of the SOMAH program to be about 15 $MWAC_{AC}$.[140] The 300 MW_{AC} SOMAH program begins in 2020 and will continue until 2030.

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[135] See *CSI Single-Family Affordable Solar Homes (SASH) Program*, webpage accessed March 20, 2020: https://www.cpuc.ca.gov/General.aspx?id=3043.

[136] See *SOMAH - Solar on Multifamily Affordable Housing*, webpage accessed March 20, 2020: https://calsomah.org/. SOMAH has a ten-year, $100 million per year budget and a target of 300 MW by 2030.

[137] See *CSI Multifamily Affordable Solar Housing (MASH) Program*, webpage accessed April 10, 2020: https://www.cpuc.ca.gov/General.aspx?id=3752.

[138] See *CSI Single-Family Affordable Solar Homes (SASH) Program*, webpage accessed March 20, 2020: https://www.cpuc.ca.gov/General.aspx?id=3043. 26 MW has been installed under the SASH program. SDG&E is approximately 10 percent of the investor-owned utility (IOU) customer base, between PG&E, SCE, and SDG&E. The City of San Diego represents about 50 percent of SDG&E's load. For this reason, Powers Engineering estimates that about 1.5 to 2 MW of SASH rooftop solar has been installed in SDG&E service territory.

[139] About 60 MW of solar capacity will ultimately be installed under the MASH program among the three IOUs. See *CSI Multifamily Affordable Solar Housing (MASH) Program*, webpage accessed April 10, 2020: https://www.cpuc.ca.gov/General.aspx?id=3752. The MASH program is no longer active. The City of San Diego represents about 50 percent of SDG&E's load, and SDG&E is 10 percent of statewide IOU load. For this reason, Powers Engineering estimates about 3 MW of MASH solar projects were constructed in the City of San Diego.

San Diego's apartment buildings provide a solar installation potential in the range of 350 MW_{AC} to 400 MW_{AC}, almost twenty times greater than the approximately 18 MW_{AC} of capacity that the MASH and SOMAH programs will install by 2030.[141] Additional financing tools will be needed to develop fully the solar potential of apartment buildings in San Diego.

4. Innovative private financing tools have promise, though they are nascent

New financing tools are available. Some commercial rooftop solar installations on apartment complexes in the San Diego area use innovative cost allocation arrangements to create an economic benefit for the renters and for the building owners. In this arrangement, the rooftop solar electricity is supplied to the apartment complex at a single point. The building owner then allocates this solar power supply to individual tenants based on their actual usage. This process is known as "virtual net metering."[142]

BTM solar now delivers sufficiently low-cost electricity that an apartment building owner can guarantee a lower monthly electric bill than the tenants would pay for an equivalent amount of grid power, a benefit for the tenants. The building owner makes additional income from the differential between the cost of BTM solar production and what the tenants are charged for the solar power, a benefit for the building owner. This arrangement provides the renter with solar power at less cost than grid power with no payment obligation by the renter – other than paying the monthly electric bill – for use of the rooftop solar system.

Ivy Energy offers an example of a local firm active in developing virtual BTM solar projects on apartment complexes in the San Diego area using its energy monitoring and disaggregation software platform.[143] Figure 7 shows a 36-unit apartment complex using the firm's platform. Each tenant will save about $144 on electric bills in the first year. The capital expense of the rooftop solar system totaled about $5,100 per apartment unit.

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[140] SDG&E is 10 percent of statewide IOU demand, and the City is 50 percent of SDG&E demand. Therefore, 300 MW x 0.10 x 0.50 = 15 MW.

[141] There were 240,844 multi-family units in the City of San Diego in 2016 (see *2018 City of San Diego Housing Inventory Annual Report*, Table 1.1, p. 6). Electricity demand: Ivy Energy, survey of 300+ units (mix of 1-3 bedroom), found average energy consumption at 3,960 kWh annually, equal to output of 2.3 kW_{AC} solar system. Roof space available for solar: On average about 70 percent of roof space on commercial rooftops in the City of San Diego is suitable for solar. *See,* San Diego Regional Renewable Energy Study Group, *Potential for Renewable Energy in the San Diego Region, Chapter 2 – Solar Photovoltaic Electric*, Table 2.9: GIS Analysis Results for SD City Buildings, August 2005, p. 11. Therefore, total solar potential on City of San Diego apartment buildings = 240,844 units x 2.3 kW_{AC} per unit x MW/1,000 kW x 0.70 = 388 MW.

[142] Virtual net metering: A bill crediting system where the output of a common rooftop solar system is shared among a number of subscribers or tenants.

[143] Ivy Energy, website accessed April 11, 2020: https://www.ivy.energy/.

Figure 7. Apartment complex in San Diego area providing tenants with solar power

Source of photo: Ivy Energy

The apartments in Figure 7 show that virtual net metering exists now as a demonstrated and cost-effective alternative for both building owners and tenants.

C. Need for On-Bill Financing for All Customers

An inclusive, well-funded, on-bill financing program – available to owners and renters – can assure an equitable distribution of BTM solar and battery storage in San Diego. For many years, SDG&E has been aware of the desirability of including residential customers in its on-bill financing program.[144] SDG&E was authorized by the CPUC to modify or expand its on-bill financing program through a simple advisory letter process in 2019.[145] This same 2019 decision recognized the need to consider opening the utility on-bill financing programs to private capital in order to expand the programs.[146]

Operational on-bill financing programs already exist that could serve as a model for San Diego and SDCP. For example, Hawaii implemented an expansive on-bill financing program in 2019,

[144] CPUC Decision D.09-09-047, *Decision Approving 2010 to 2012 Energy Efficiency Portfolios and Budgets* September 24, 2009, p. 274. "The (EE) Strategic Plan adopted in D.08-09-040 identified the need for financing solutions in both the residential and commercial sectors," and p. 278, "SDG&E reports it is investigating partnering with a financial institution to more directly offer residential retrofit financing, allowing the lending partner to absorb any risk and transaction costs. . ."

[145] CPUC Decision D.19-03-001, *Decision Granting Petition for Modification of Decision 09-09-047 Concerning On-Bill Financing*, March 14, 2019, Attachment A, p. 3. "II. New Ordering Paragraph: Decision 09-09-047 is further modified to add Ordering Paragraph 61, as follows: 61. PG&E, SCE, SDG&E, and SoCalGas may each file a Tier 2 advice letter for Commission review and approval of proposed program changes . . ."

[146] *Ibid*, p. 17, Finding of Fact 10: "NRDC has raised valid issues in its filed comments regarding how to enable the investor-owned utilities to manage their on-bill financing loan programs so that private capital is deployed, thereby enabling more loans and more energy-saving projects."

available to owners and renters.[147] Forty-three percent of customers in Hawaii are renters,[148] comparable to the 46 percent of households in San Diego County that rent.[149]

1. Hawaii Green Money Saver on-bill financing

Hawaii implemented an expansive on-bill financing program in 2019, called the Green Money Saver (GEM$).[150] Designed to reach all ratepayers, owners and renters, the GEM$ program includes the following attributes:[151]

- GEM$ solves the split incentive problem by tying the repayment obligation for EE upgrades to the utility meter rather than to an individual.
- Participating homeowners, renters, small businesses and nonprofits pay back the cost to install rooftop solar panels, solar water heaters, heat pump water heaters and other energy-efficient equipment via a line-item charge on their monthly electric utility bill.
- Program participants pay no upfront costs — the loan is offered at a fixed interest rate of 5.5 percent with terms lasting up to 20 years.
- Approval does not require a credit check or income verification. Approval is based on a good utility bill payment history — no disconnection notices in the previous 12 months — and an estimate that the project will deliver a minimum 10 percent utility bill savings, including the repayment charge, after installation of the retrofit.
- Allows financing with no upfront cost for renters to finance solar systems and where the payment is transferable to the next renter.
- The GEM$ program is available to all customers of the Hawaiian electric companies including: Hawaiian Electric, Maui Electric and Hawaiian Electric Light Company. Together they service about 95 percent of the state's population.

The GEM$ program is funded by $150 million in state bonds and is not currently open to external funding from entities like credit unions. Opening the program to private financing would supplement the limited bond financing and avoid artificially limiting the potential of the program.

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[147] Greentech Media, *Hawaii's On-Bill Financing Program Unlocks Energy Upgrades for the Masses*, June 10, 2019. See: https://www.greentechmedia.com/articles/read/justin-hawaii.
[148] *Ibid*. ". . . 43 percent of Hawaii's households are renters."
[149] See "Renter Fraction in San Diego California" (46.51 percent): https://www.deptofnumbers.com/rent/california/san-diego/.
[150] Hawaii Green Infrastructure Authority, *GEMS Financing Program – Homeowners or Renters*, website accessed April 12, 2020: https://gems.hawaii.gov/participate-now/for-homeowners/.
[151] GreenTech Media, *Hawaii's On-Bill Financing Program Unlocks Energy Upgrades for the Masses*, June 10, 2019. See: https://www.greentechmedia.com/articles/read/justin-hawaii.

2. California Senate Bill SB 37 proposed on-bill financing in 2013

SB 37, a comprehensive on-bill financing program, was proposed in the California Senate in 2013.[152] SB 37 would have covered residential and commercial customers, would have included rooftop solar as well as EE upgrades, and would have opened financing of projects to non-utility sources of capital like credit unions. SB 37 was opposed by all of the California utilities.[153]

SB 37 included on-bill financing elements similar to those in the GEM$ program, though SB 37 also opened BTM solar and EE to private financing as a vehicle to expand the financial capacity of the program. SB 37 serves as a good model for the type of on-bill financing program that would allow SDCP to accelerate the adoption of local clean power in homes, businesses, and rental units in an equitable manner. SB 37 included the following elements:

- Authorized an on-bill repayment program providing financial assistance for EE, renewable energy, distributed generation, and DR improvements by allowing for the repayment of the financial assistance to be included in the utility customer's utility bill.
- Required sellers of property or landlords to provide prospective buyers or prospective or existing tenants a disclosure indicating that a portion of the utility bill is subject to an on-bill repayment obligation.
- Specifically encouraged private financing to support the on-bill financing program.

Active participation in an expansive on-bill financing program of this type by local San Diego-area credit unions would help ensure that any on-bill financing program would be well-capitalized.

3. San Diego-area credit unions have the financial capacity to meet the on-bill financing need

San Diego-area credit unions collectively have the capacity to meet an on-bill financing capital demand of $300 million per year or more. The five largest credit unions in San Diego have total assets of over $16 billion,[154] as Table 6 details below. $300 million per year in long-term lending through an on-bill financing program represents 2 percent of the total assets of the five largest

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[152] TrackBill, *California SB 37 - Energy efficiency and renewable energy upgrades: on-bill repayment program*, as amended in Senate on March 13, 2013: https://trackbill.com/bill/california-senate-bill-37-energy-efficiency-and-renewable-energy-upgrades-on-bill-repayment-program/434937/#/details=true.

[153] Sacramento Bee, *FBI asked about de León energy-efficiency bill*, January 13, 2015. See: https://www.sacbee.com/news/politics-government/capitol-alert/article6372108.html. "The measure was supported by numerous clean energy companies and environmental groups. Utility companies – including PG&E, San Diego Gas and Electric, Sempra Energy and Southern California Edison – opposed the bill."

[154] Source: San Diego Business Journal - Book of Lists 2020.

San Diego credit unions. Credit unions typically commit on the order of 80 percent or more of their assets to loans and leases.[155]

San Diego credit unions are currently offering 20-year fixed home loans at less than 3.5 percent.[156] This rate remains well below the 20-year fixed interest rate of Hawaii's GEM$ program of 5.5 percent. Residential electric rates of the Hawaii utilities, at about $0.30/kWh,[157] are comparable to SDG&E residential rates.[158] The clear potential exists for local credit unions to realize good returns at high volume, relative to other investment opportunities, and by doing so provide the capital for an ambitious on-bill financing program to support local clean power development.

Table 6. Total assets of San Diego's five largest credit unions[159]

Credit Union	Total Assets (millions)	Number of local members
San Diego County Credit Union	8,368	409,801
Mission Federal Credit Union	3,754	244,595
California Coast Credit Union	2,607	183,098
USE Credit Union	998	63,406
Frontwave Credit Union	857	88,033

D. Combining On-Bill Financing with Opt-Out Participation

The rising cost of customer acquisition, to reach customers beyond the ideal early adopters who own their home or building, have good credit, and have a strong interest in BTM solar, has created upward pressure on solar installer bids.[160] Solar installers in saturated markets like California, where early adopters are becoming scarce, are forced to rely on more costly sales

[155] Bankrate, Rating of California Coast Credit Union, San Diego, webpage accessed March 25, 2020. "The credit union has assets of $2.39 billion . . . the credit union holds loans and leases worth $1.88 billion." See: https://www.bankrate.com/credit-unions/california-coast/471196/.

[156] See California Coast Credit Union home loan webpage (click on "View Rates"): https://www.calcoastcu.org/borrow-home-loans.htm.

[157] GreenTech Media, *Hawaii's On-Bill Financing Program Unlocks Energy Upgrades for the Masses*, June 10, 2019. See: https://www.greentechmedia.com/articles/read/justin-hawaii.

[158] See SDG&E Schedule DR - RESIDENTIAL SERVICE Effective 2/1/2020 (last column): https://www.sdge.com/sites/default/files/regulatory/2-1-20%20Schedule%20DR%20Total%20Rates%20Table.pdf.

[159] Cross Consulting, *Case Study of Innovative and Equitable Financing Programs That Enable Maximum Development of Local Clean Energy in San Diego Community Power Service Territory*, March 18, 2020, p. 7.

[160] Wood MacKenzie, *FORESIGHT 20/20: U.S. DISTRIBUTED SOLAR - Distributed solar enters the era of unsubsidized growth*, January 2020, p. 4.

and marketing campaigns to acquire new customers, as many early adopter customers now have solar.[161]

Industry observers view California's new home solar mandate as potentially transforming how solar systems are sold, at least for new homes and subdivisions. Instead of retail transactions where the individual homeowner must make an affirmative purchasing decision about solar, solar installers are submitting bids to housing developers for a package of projects.[162]

This same economies-of-scale customer acquisition cost-benefit calculation — when BTM solar is installed under one contract for an entire new subdivision — can also be achieved by including entire neighborhoods in opt-out solar and battery storage upgrade programs. For an opt-out program of this type to be effective, meaning that a large number of customers do not choose to opt out, the program would require a simple repayment system with no financial exposure to the customer, other than the obligation to pay the monthly electric bill. An on-bill financing program open to any customer paying an electric bill, owner or renter, with no upfront payments, and a monthly cost less than the monthly bill prior to the upgrade, would meet this need.

VI. THE EXISTING LOCAL GRID CAN SUPPORT A FULL LOCAL SOLAR + STORAGE BUILD-OUT WITH LITTLE OR NO UPGRADES

The City can reach its full local solar potential with little or no upgrades to the electricity distribution grid when local solar is coupled with battery storage. SDG&E's claims that the distribution grid can accept only minimal levels of rooftop solar power without major and expensive upgrades are not accurate, as the following analysis details.[163]

A. The Existing Distribution Grid Can Reliably Manage High Levels of Local Solar

The basic layout of a utility T&D system is shown in Figure 8. The dashed oval in Figure 8 represents the distribution component of the T&D system, the "local grid" serving homes and businesses.

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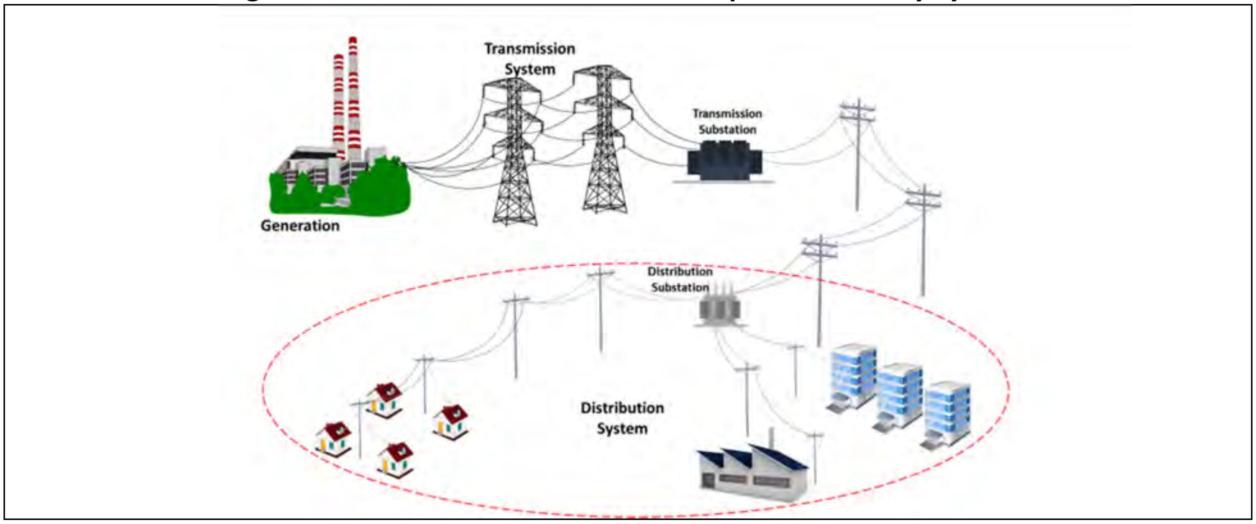
[161] *Ibid*, p. 4.

[162] *Ibid*, pp. 4-5. "California's new home solar mandate is transforming the way solar has been sold over the past decade, as homeowners are now required to make a purchasing decision about solar. . . lead generation will be through the lens of solar installers who are submitting bids to housing developers, as opposed to interfacing with customers from initial contact to system interconnection."

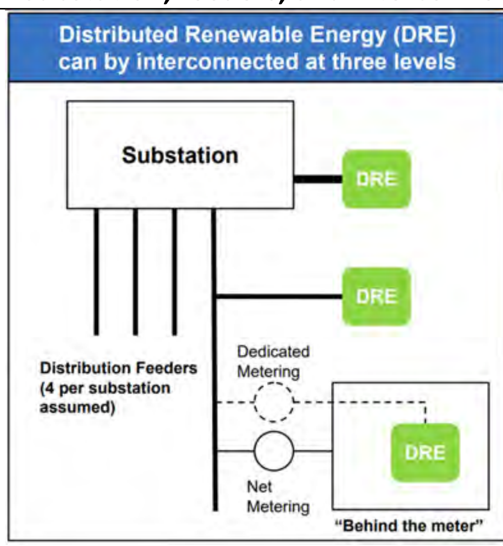
[163] GreenTech Media, *SDG&E's James Avery on the Promise of EVs and the Pitfalls of Solar*, February 27, 2015: https://www.greentechmedia.com/articles/read/Jim-Avery-on-the-Promise-of-EVs-and-the-Pitfalls-of-Solar. SDG&E identified one of the biggest problems as a 15 percent solar penetration on the distribution grid, meaning about 15 percent of the peak capability on that load could be served by solar. "When it gets to that stage, the intermittent issues associated with solar can create havoc on our system," Avery warned. "Now, keep in mind, a lot of our system is antiquated analog equipment."

Figure 8. Conventional central station power delivery system[164]



A number of circuits, also known as feeders, begin at the distribution substation and supply power to homes and businesses. Figure 9 shows a graphic of a distribution substation, where voltage is stepped-down and distributed throughout neighborhoods along the feeders.

Figure 9. Distribution substation, feeders, and interconnection options for DRE[165]



DRE = distributed renewable energy (typically rooftop or parking lot solar arrays connected to individual feeders, with or without battery storage, and larger ground-mounted solar arrays connected directly to the substation)

Voltage regulation equipment, such as voltage regulators and capacitors, maintain voltage within allowable tolerances along the feeder(s). Safety devices are also utilized, such as circuit

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[164] Clean Coalition webpage, accessed January 27, 2020.

[165] Navigant, *Distributed Renewable Energy Assessment Final Report*, prepared for PIER Program, California Energy Commission, August 11, 2009, p. 21.

breakers at distribution substations and reclosers on the feeders.[166] These safety devices protect the feeder or substation equipment in case of a fault condition.

Typical feeder safety equipment is not directionally sensitive, but has historically been coordinated in a way that assumes the electricity only flows from the substation to the customer. Reverse flow occurs when the amount of solar power generated on a feeder exceeds the customer demand for power on that feeder. This two-way flow pattern, with power now flowing back toward the substation, is known as "bidirectional flow" or "reverse flow." Reverse flow does not inherently lead to grid reliability concerns. It is simply the flow of power from where it is being generated to where it can be used.

If this reverse flow happens at the same time on all the feeders – of which there are typically four – connected to the substation, the solar power will continue moving in reverse direction through the substation, will be transformed to a higher voltage, and will flow out of the neighborhood to adjacent substations.[167] This means that one neighborhood with excess solar generation could transmit that excess solar power to another part of the same city.

The existing distribution system has the capability to move large amounts of solar power. The challenge is to assure this solar power is properly configured where it is generated to assure grid reliability, and to avoid expensive upgrades to distribution circuits that might otherwise be needed. The time and expense of making major upgrades to the distribution grid would present a bottleneck to rapid deployment of distributed solar in the City of San Diego. The most efficient solution to eliminating the need for grid upgrades involves pairing battery storage with local solar power.

Finally, it is highly unlikely that San Diegans could generate sufficient local solar power by 2030 to export that local solar power over the transmission system to nearby cities. This roadmap envisions providing about half of the City's electricity demand with locally-generated solar power by 2030. The other half of the demand would be met with power imported from outside the City. Battery storage will be paired with the local solar power, providing a mechanism to store this solar power for later use. For these reasons, significant exports of local solar power are not expected to occur.

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[166] Definition of recloser: A circuit breaker equipped with a mechanism that can automatically close the breaker after it has been opened due to a fault.

[167] There is a limit on how much reverse flow can occur across the distribution substation without adjustments. See: Electronic communication between B. Powers, Powers Engineering, and D. Brown, P.E., Principal Distribution System Engineer, Sacramento Municipal Utility District (SMUD), July 5, 2017. "Beckwith (a voltage regulation equipment supplier of "90 Devices") advises that reverse flows of 10-20% of (distribution substation) bank nameplate rating should not cause any adverse operations, but cautions against going beyond 20%. SMUD has reached just under 28% on a 224 MVA sub-transmission bank, without issue."

B. The CPUC Found That the Addition of BTM Battery Storage Addresses Grid Reliability Concerns

The CPUC has studied the scenario where all homes in a neighborhood have BTM solar. An October 2017 study commissioned by the CPUC, *Customer Distributed Energy Resources Grid Integration Study - Residential Zero Net Energy Building Integration Cost Analysis*,[168] examined the degree to which grid upgrades would be necessary when all homes have BTM solar. The CPUC conducted in effect a "worst case" assessment of the existing grid's ability to absorb distributed solar inflows when all homes on a circuit are generating solar power and potentially exporting some or all of that solar power to the grid at the same time. The study determined that, if these BTM solar systems are paired with battery storage, no distribution circuit upgrades would be needed.[169]

Distribution circuits are typically designed to accommodate double or more of the expected peak load on the circuit.[170] The conservative design of all distribution circuits provides sufficient capacity to ensure each circuit can serve as a backup source of power to an adjacent circuit in case of an outage on the adjacent circuit.

In this context, the CPUC study examined rooftop solar inflows up to 160 percent of the base case peak load of the distribution circuit analyzed. The study author, DNV GL, determined that simple steps, such as the use of "smart" solar inverters and good distribution of the solar systems along the circuit, could substantially increase the capacity of the circuit to absorb solar inflows with little or no cost in distribution circuit upgrades. Smart solar inverters are now required on all new solar installations in California.[171]

The CPUC study describes how, without battery storage, incrementally more extensive grid upgrades would potentially be necessary to address grid reliability issues. These include regulator control upgrades, re-close blocking, reconductoring of overloaded circuit sections, and/or additional voltage regulators.

The CPUC found that the addition of battery storage negates the need for other grid upgrades. Its report states that ". . . energy storage could be deployed to mitigate all violations on the

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[168] DNV GL, *Customer Distributed Energy Resources Grid Integration Study - Residential Zero Net Energy Building Integration Cost Analysis*, prepared for CPUC, October 2017. The CPUC commissioned the DNV GL study to examine the distribution grid reliability implications of the California mandate that all new homes built in 2020 and later must be zero net energy homes with BTM solar.
[169] *Ibid*, p. xv.
[170] The thermal rating of the conductors determines the maximum power flow.
[171] Electronic communication between B. Powers, Powers Engineering, and S. Meyer, CPUC (Rule 21 smart meter lead), March 19, 2020.

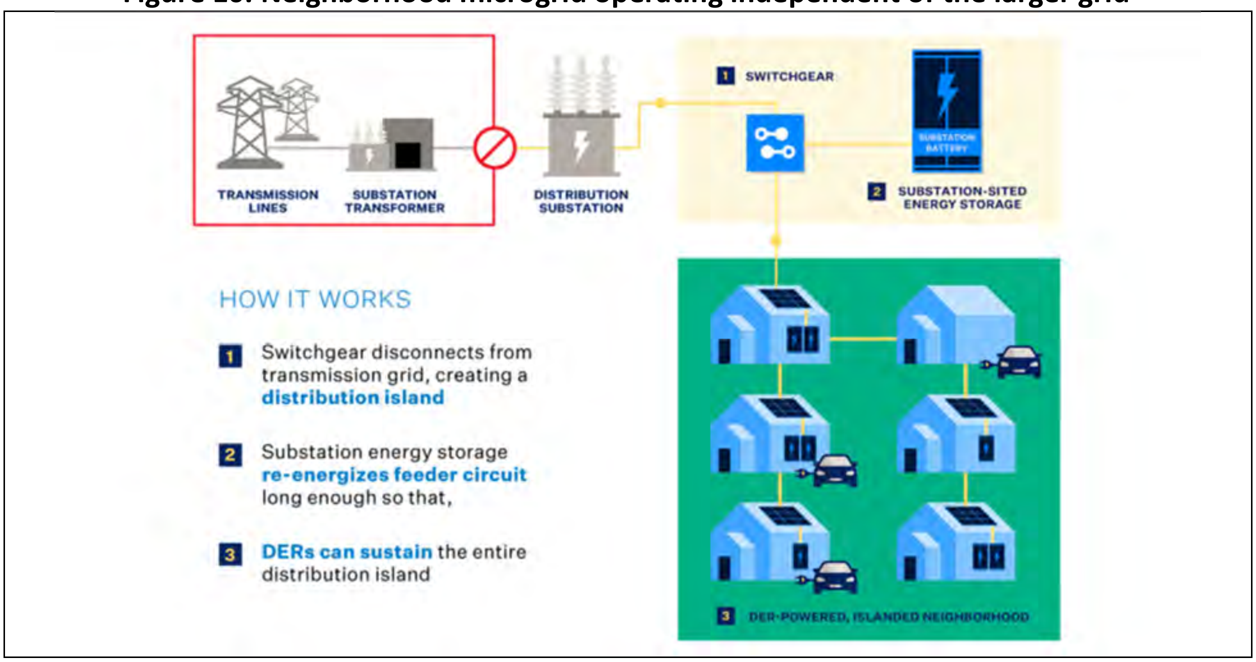
circuit rather than deploying other measures at lower penetrations that would later become redundant."[172]

DNV GL concludes its assessment of the grid reliability value of battery storage stating "… (battery storage) could prove much more cost-effective in the long run particularly given the other functions that are available from distributed energy storage systems. If energy storage was implemented at the buildings or circuits . . . then the associated integration costs identified in this study would be negated." In sum, if an appropriate capacity of battery storage is included with solar installations in existing neighborhoods where 100 percent of the homes may ultimately add BTM solar, no additional upgrades to the existing grid would be necessary.

C. The Local Grid Is Sufficient in Its Current Configuration, and Can Be Augmented as Needed

Local solar and battery resources will still require a fully reliable local grid to serve as a source of backup power and allow BTM solar to work collectively to power microgrids and VPPs, or export power from one neighborhood to another. Figure 10 provides an example of BTM solar powering a neighborhood.

Figure 10. Neighborhood microgrid operating independent of the larger grid[173]



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172 DNV GL, *Customer Distributed Energy Resources Grid Integration Study - Residential Zero Net Energy Building Integration Cost Analysis*, prepared for CPUC, October 2017, p. xv.

173 Sunrun, *Smart, Clean Neighborhood Grids: Redesigning Our Electric System to Help Communities Power Through Blackouts*, February 2020, p. 9. See: https://www.sunrun.com/sites/default/files/Neighborhood_Grid_Paper_Sunrun.pdf.

Switchgear that isolates the neighborhood, as shown in Figure 10, is added to the distribution substation. Some battery storage is also added at the substation to keep the substation energized after it is isolated from the grid. BTM solar and storage located at individual homes and businesses can then feed other loads on the isolated, or "islanded," neighborhood grid – also known as a neighborhood microgrid – to provide power to all customers on the microgrid.

SDG&E proposed in 2018 to add battery storage and switchgear to seven distribution substation feeders to enable community microgrids, at a cost of $284.6 million for 100 MW_{AC} of battery storage.[174] Ratepayer advocates protested the large size and high cost of the battery systems, and the fact that they would be owned by SDG&E. SDG&E was ordered by the CPUC in June 2019 to file a new application for the substation battery storage microgrids that included non-utility bids.

One project, the proposed microgrid in the Skyline neighborhood, a designated low-income area in City Council District 4, would have the capability to island load,[175] including Fire Station 51 and the South East Division Police Department.[176] The battery projects would receive payments from CAISO for providing local and system RA capacity for SDG&E service territory.[177]

SDG&E also proposed a $2 million pilot program to deploy BTM battery storage at expanded California Alternate Rates for Energy (CARE) facilities.[178] The pilot program at CARE facilities was denied by the CPUC as too similar to existing battery storage incentive programs.

The important takeaway of the proposed SDG&E battery storage microgrid projects, for the purposes of this roadmap, is that both SDG&E and microgrid advocates have a common understanding of the model necessary to create neighborhood microgrids.

D. The Cost to Maintain the T&D Grid Is Low and Reliance on Local Clean Power Will Not Increase It

Continued operation and maintenance (O&M) of the existing T&D grid will be necessary for neighborhood microgrids or VPPs to function.

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174 CPUC Decision D.19-06-032, *Decision Implementing the AB 2868 Energy Storage Program and Investment Framework and Approving AB 2868 Applications with Modification*, June 27, 2020, pp. 14-16.

175 The term to "island" in this case means to disconnect the Skyline Substation from the larger grid and allow the battery storage system at the substation to provide the power to the homes and businesses in the Skyline neighborhood.

176 CPUC Decision D.19-06-032, p. 15. Substation locations: Kearny, Paradise/Skyline, Clairemont, Elliot, Melrose (Vista), Santee (Santee), and Boulevard (Boulevard).

177 *Ibid*, p. 13.

178 *Ibid*, p. 11 and p. 23. Expanded CARE facilities include transitional housing (drug rehabilitation, half-way houses), short or long-term care facilities (hospice, nursing homes, children's and seniors' homes), group homes for physically or mentally disabled persons, or other nonprofit group living facilities.

SDG&E's distribution grid operation and maintenance (O&M) costs can be readily calculated. SDG&E publicly reports these costs, and its total retail sales to customers, on an annual basis.[179] The distribution grid O&M cost equals about $0.009/kWh, or about $5.30 per month, for a typical SDG&E customer.[180]

The cost of SDG&E's transmission grid O&M can be calculated in the same manner. This cost equates to about $0.00585/kWh,[181] or about $3.40 per month, for a typical SDG&E customer.[182]

These calculations demonstrate that SDG&E residential solar customers already more than fully compensate SDG&E for the average combined T&D O&M costs of about $9 per month, as these customers pay a monthly fixed fee of $10 per month.

Local solar production stays local – at the distribution grid level – and would not flow up on to the transmission system until much higher levels of local solar are online. However, CAISO currently assesses all electricity flowing on the T&D system a postage-stamp "transmission access charge" (TAC) whether the power actually flows over the transmission system or not.[183] The TAC charge adds significant costs, about $0.03/kWh to local solar producers connected at the distribution grid level,[184] and undercuts an inherent cost advantage of local solar power – not using the transmission system at all. Efforts by local solar advocates are underway to eliminate the TAC charge for local solar output.[185]

BTM solar also benefits the grid and the utility's transmission system because it reduces congestion on the high voltage transmission system by displacing power that would have to flow over the transmission system to reach demand centers like San Diego. The monetary benefit of this transmission congestion relief can be readily quantified.

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[179] SDG&E FERC Form 1 for 2018, p. 401a and p. 322. 2018 sales to end-users = 15,139,011,000 kWh. 2018 distribution grid O&M cost = $138,732,924. Therefore, unit distribution grid O&M cost = $138,732,924 ÷ 15,139,011,000 kWh = $0.0092/kWh.

[180] A typical SDG&E residential customer consumes about 7,000 kWh per year of electricity, or about 580 kWh per month. Therefore, monthly cost to residential customer for distribution grid O&M = 580 kWh per month x $0.0092/kWh = $5.34 per month.

[181] SDG&E FERC Form 1 for 2018, p. 321. 2018 sales to end-users = 15,139,011,000 kWh. 2018 transmission grid O&M cost = $88,575,245. Therefore, unit transmission grid O&M cost = $88,575,245 ÷ 15,139,011,000 kWh = $0.00585/kWh.

[182] As noted, a typical SDG&E residential customer consumes about 7,000 kWh per year of electricity, or about 580 kWh per month. Therefore, monthly cost to residential customer for transmission grid O&M = 580 kWh per month x $0.00585/kWh = $3.39 per month.

[183] CAISO, *Review Transmission Access Charge Structure - Straw Proposal*, January 11, 2018. See: http://www.caiso.com/InitiativeDocuments/StrawProposal-ReviewTransmissionAccessChargeStructure.pdf.

[184] Clean Coalition, *Transmission Access Charges,* webpage accessed May 13, 2020: https://clean-coalition.org/policy/transmission-access-charges/. $0.03/kWh is the projected TAC charge levelized over 20 years.

[185] *Ibid*. Clean Coalition has prepared proposed bill language (January 2020) to phase-out the TAC charge for solar resources connected to the grid at the distribution level: https://clean-coalition.org/wp-content/uploads/2020/02/RN-2003623_TAC-bill-proposal-2020-leg-con.pdf.

In early 2018 CAISO eliminated $2.6 billion in proposed new transmission projects due in substantial part to "increasing levels of residential, rooftop solar generation."[186] The elimination of expensive new transmission projects, made unnecessary by BTM solar, provides an economic benefit to all utility customers, not just customers with BTM solar. The true benefits and costs of BTM solar should be reflected in state rate-setting. Not only should BTM solar power not be subject to the TAC, it should receive a bill credit that reflects some portion of the avoided cost of the transmission projects that would otherwise have been built to meet the need that would exist without the BTM solar installations.

Such a bill credit would be straightforward to calculate. A capital cost savings on new transmission of $2.6 billion represents an annual savings to ratepayers of about $360 million per year.[187] 5,782 MW_{AC} of BTM solar capacity was online statewide at the end of 2017,[188] at the time CAISO determined that BTM solar had saved $2.6 billion in new transmission projects in California. Each kW_{AC} of BTM solar online by the end of 2017 avoided $62 per kW_{AC} of BTM solar per year in new transmission expenditures.[189]

The all-in cost of avoiding additional transmission infrastructure capital costs equates to $372 per year for a typical 6 kW_{AC} BTM solar system.[190] Even if only one-half of this avoided transmission cost was credited to BTM solar customers, an owner of a 6 kW_{AC} BTM solar system would receive a credit of more than $15 per month.[191] Both the City of San Diego and SDCP should be advocating at the CPUC and other state entities that BTM solar be fairly compensated for the avoided transmission cost benefits that BTM solar provides to all ratepayers.

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[186] CAISO News Release, *Board approves 2017-18 Transmission Plan, CRR rule changes - Plan calls for canceling, modifying projects to avoid $2.6 billion in costs*, March 23, 2018. "The changes were mainly due to changes in local area load forecasts, and strongly influenced by energy efficiency programs and increasing levels of residential, rooftop solar generation." See: http://www.caiso.com/Documents/BoardApproves2017-18TransmissionPlan_CRRRuleChanges.pdf.

[187] SDG&E projected average annual revenue requirement of approximately $230 million per year in first ten years of operation of the (proposed) 500 kV Sunrise Powerlink Modified Southern Route at a capital cost of approximately $1.67 billion. See: CPUC Application A.06-08-010, *SDG&E Phase II (Sunrise Powerlink) Opening Brief*, September 30, 2008, p. 160, and Ex. SD-142, Southern Route, Total Revenue Requirement, first ten full years, $2,320.2 million (average first ten full years = $232 million per year). Extrapolating to an avoided $2.6 billion in transmission capital cost, the annual avoided rate recovery would be ($2.6 billion/$1.67 billion) x $230 million/yr = $358 million/r.

[188] See "California Distributed Generation Statistics," accessed April 15, 2020, click on "2017" bar: https://www.californiadgstats.ca.gov/.

[189] $360 million/yr ÷ (5,782 MW x 1,000 kW/MW) = $62.3 per kW-yr.

[190] $62/kW-yr x 6 kW = $372/yr.

[191] ($372/kW-yr ÷ 2) ÷ 12 month/yr = $15.50/month.

VII. COST-OF-PRODUCTION OF ONSITE ROOFTOP SOLAR + BATTERY STORAGE PROVES MUCH LESS THAN THE COST OF RETAIL GRID POWER

Battery storage also provides significant value to the grid as reserve power available for use at times of peak need or in emergencies. Until recently, this role has been filled by natural gas-burning combustion turbines. Battery storage systems can also fill this role, and are doing so with increasing frequency. The charges assessed on utility customers to maintain a standby fleet of rarely-used combustion turbines could instead be directed to battery storage systems to fill the same role.

Battery storage includes additional advantages over combustion turbines, including the ability to respond quickly to dispatch commands, the ability to store renewable energy, and the ability to operate completely on solar power at a solar-powered home or commercial building. All of these advantages should be recognized and rewarded by policy makers to account thoroughly for the costs and benefits of each energy resource.

SDG&E customers pay substantial charges to assure that peaking combustion turbines are available when needed. These units typically operate only during periods of peak demand or when more efficient generators are offline for planned or unplanned outages. Utility customers pay a capacity charge to cover the cost of building and maintaining these peaking units. SDG&E customers currently pay as much as $200 per kW of capacity per year or more for new peaking combustion turbine capacity,[192] such as 336 MW Pio Pico Energy Center and 528 MW Carlsbad Energy Center.

Two BTM solar with battery storage cost-of-production calculations are provided in this section, for a commercial building and a home. Only the capacity value of the battery storage is included as a beneficial offset in the commercial system example, resulting in a conservative estimate of the economic benefits of the commercial BTM battery storage. The commercial example includes the same value for battery capacity as the historic capacity value used by the CPUC of $58 per kW-year.[193] Battery storage associated with a commercial solar project would also be used to shift the operator's load on a continuous basis to reduce TOU charges and minimize peak load (to reduce standby charges).[194]

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[192] SDG&E bill insert, *San Diego Gas & Electric Company Notice of Application 13-06-XXX (Pio Pico) to Fill the Local Capacity Requirement Need Identified in CPUC Decision 13-03-02*9, June 2013: $61,800,000/yr ÷ 305,000 kW = $203 per kW-year of capacity (in 2020).

[193] CPUC Decision D.18-10-019, *Decision Modifying the Power Charge Indifference Adjustment Methodology*, October 11, 2018, p. 42. RA (resource adequacy) = $58.27/kW-yr, 2016-2018.

[194] TOU tariffs have different rates at different times of the day, week, and season that reflect higher and lower demand periods. Standby charges (also called demand charges) are additional monthly fees typically assessed

The residential BTM cost-of-production calculation uses only the TOU load-shifting value of battery storage to quantify the economic benefits of residential battery storage. The battery storage could also be operated as an element in a residential storage VPP, or as a stand-alone system, to fully monetize the capacity value of the storage.

The commercial example in this section assumes two Tesla Powerpack batteries each with 232 kWh of energy storage capacity, at a maximum discharge rate of 50 kW (each), with an installed gross cost of about $260,000.[195] This installed gross capital cost equals a battery storage cost of approximately $560/kWh. The residential example assumes a 13.5 kWh Tesla Powerwall battery, with peak battery output of 5 kW, at an installed cost of $9,800.[196]

A. The Cost of Commercial Solar Power + Battery Power Comes at Fraction of SDG&E Retail Rates

The commercial cost of-production example in Table 7 assumes the commercial customer uses on-bill financing to pay for the system. No upfront cost occurs under this payment format. The electric bill that the customer would otherwise be paying to SDG&E for grid power would be used to pay down the cost of the solar and battery system.[197]

The onsite cost-of-production for San Diego commercial rooftop solar with battery storage would be $0.04/kWh if 100 percent financed at 5 percent interest over 20 years. The cost-of-production would be $0.03/kWh if the system is fully purchased upfront with no financing.[198] These estimated costs-of-production do not account for additional revenue streams, such as

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based on the peak 15-minute usage rate each month, intended to compensate the utility for maintaining enough capacity to supply customers with power under a maximum demand scenario.

[195] Tesla, *Commercial Solar*, webpage accessed April 10, 2020: https://www.tesla.com/energy/design/commercial. Combination selected for pricing: 120 kW_{DC} solar, two 232 kWh Powerpack battery storage units. Gross installed cost of 120 kW_{DC} of solar = $192,360. Gross installed cost of two 232 kWh Powerpacks = $260,818. SGIP incentive payment, at $0.25/Wh = $116,0007

[196] CPUC Rulemaking R.12-11-005, *Tesla, Inc.'s Opening Comments Responding to Assigned Commissioner's Ruling Seeking Comment on Senate Bill 700implementation and Other Program Modifications*, May 30, 2019, p. 8, footnote 2. "A single Tesla Powerwall, with 5 kW and 13.5 kWh, costs approximately $9,800 in total. This cost estimate reflects the costs of the Powerwall battery unit, supporting hardware and assumed installation costs of $2,000." [author's note: based on this Tesla cost description, the Powerwall equipment cost is $9,800 - $2,000 = $7,800.]

[197] The repayment rate would be based on a 20-year loan at 5 percent interest, similar to repayment terms of the successful on-bill financing program operated by the Hawaii IOUs.

[198] See Table 7. The annual amortized capital cost for this system, paid for upfront with no financing, would be: $75,559 ÷ 20 yr = $3,778/yr. O&M = $2,400/yr. Therefore, total annual cost = $3,778/yr + $2,400/yr = $6,178/yr. Annual solar production = 210,486 kWh/yr. Cost-of-production = $6,178/yr ÷ 210,486 kWh/yr = $0.0294/kWh.

TOU cost shifting, that are likely to be generated.[199] These costs total less than one-sixth the 2019 SDG&E small commercial retail rate of approximately \$0.25/kWh.[200]

The typical additional capital cost of solar support structures in parking lots would be approximately \$0.50/watt$_{DC}$.[201,202] The additional cost of the solar structural supports for a commercial parking lot installation would be expected to add about \$0.01/kWh to the cost-of-production relative to a commercial rooftop installation. This addition would increase the all-in cost-of-production for the commercial solar parking lot from \$0.04/kWh to \$0.05/kWh for the 100 percent financed example in Table 7, and from \$0.03/kWh to \$0.04/kWh if the system is fully purchased upfront with no financing.[203]

Table 7. Cost of electricity for 120 kW$_{DC}$ commercial rooftop solar system with 464 kWh of battery storage capacity (financed at 5 percent interest, 20-year term)

Cost or (Credit), \$	Cost Element
192,360	Gross installed cost of 120 kW$_{DC}$ rooftop solar system @ \$1.60/watt$_{DC}$
260,818	Cost of 464 kWh battery storage, two Tesla Powerpack storage units
(117,826)	26 percent federal tax credit on gross cost in 2020
(116,000)	Self-Generation Incentive Program (SGIP) incentive, \$0.25/watt-hr (Wh)
219,352	Net cost of PV + battery storage system
(137,993)	Depreciation on gross system cost less ½ tax credit: ((\$453,178 - \$58,913) × 35% marginal tax rate) = \$137,993
(5,800)	Capacity payment: \$58/kW-yr x 100 kW = \$5,800/yr
75,559	Net cost of PV + battery storage system, adjusted for depreciation, and capacity value
\$6,060/yr	Annual cost of system, 20-year, 5 percent financing, capital recovery

[199] CPUC Decision D.19-02-010, *Application of SDG&E for Approval of its 2018 Energy Storage Procurement and Investment Plan*, February 26, 2019, p. 13. "For all (battery storage) projects, SDG&E proposes the facilities will be able to participate in the California Independent System Operator (CAISO) market used to provide local resource adequacy to the extent these resources qualify for resource adequacy. SDG&E also expects CAISO participation to generate energy market revenues."

[200] SDG&E, *Small Commercial Rate Sheet*, webpage accessed January 27, 2020 (TOU-A, effective June 1, 2019): https://www.sdge.com/sites/default/files/regulatory/6-1-19%20Summary%20Table%20for%20Web_Small%20Comm.pdf.

[201] B. Powers telephone communication with two solar carport structure manufacturers (Kern Solar Structures and RBI Solar), April 29, 2020. \$0.50/watt$_{DC}$ is a reasonable installed cost for double-cantilever support structure arrangement. A 50 percent premium, or \$0.75/watt$_{DC}$, is reasonable for a single cantilever arrangement.

[202] Solar Builder Magazine, *Solar carports will spread across the country as costs decline*, October 20, 2015 (see graphic, "PV Carport System Cost Declines – 2018"). See: https://solarbuildermag.com/news/costs-decline-solar-carports-will-spread-across-country/.

[203] The addition of a \$60,000 capital cost (\$0.50/W$_{DC}$ x 1,000 W/kWx 120 kW$_{DC}$ = \$60,000) for the solar parking lot support structure to the first line of Table 7 results in an adjusted cost-of-production of \$0.05/kWh.

	factor = 0.0802 per year: $75,559 x 0.0802/yr = $6,060/yr
$2,400/yr	Annual fixed O&M, $20/kW-year
210,486 kWh/yr	Annual electricity production, fixed solar array, San Diego, assuming 10% losses (source: NREL PV Watts calculator, zip code 92116)
$0.040/kWh	Cost of electricity: $8,460/yr ÷ 210,486 kWh/yr = $0.040/kWh
$0.25/kWh	Average SDG&E tariff, small commercial customer category, 2019

As the calculations in Table 7 demonstrate, the all-in cost-of-production of a commercial BTM solar and battery storage system, using conservative assumptions and without including likely additional revenue streams, totals less than one-sixth the retail rate SDG&E charges to small commercial customers. Commercial customers have a strong economic incentive to install BTM solar and storage systems operating on 100 percent local solar power.

B. Costs of Residential BTM Solar Power + Battery Power Total One-Third to One-Fifth the SDG&E Retail Rate

Table 8 details the cost-of-production of a residential BTM solar and battery storage system. The primary functions of battery storage in a residential application include: 1) absorbing and dispatching solar power, 2) shifting demand to hours of lower-cost grid power under TOU rates, 3) being available to supply peaking power to the grid, and 4) serving as an onsite backup power source available when the grid goes down.[204]

The TOU value of shifting use from the on-peak period to the off-peak period using battery storage significantly increases the economic benefit of the battery system to the residential customer.[205] The customer can rely on battery power during the 4 pm to 9 pm on-peak period, avoiding the cost of expensive on-peak grid power, and shift grid power demand to the much lower cost off-peak period after 9 pm.

The onsite cost-of-production of this residential solar and battery storage system would be $0.122/kWh, assuming the project is 100 percent financed at 5 percent interest over 20

[204] Onsite direct usage and batteries absorbing electricity occur at the same time. If there is a lot of sunshine and those first two demands are fully met, excess solar will flow from the home/business to the closest neighbors that can use it. If that sunny afternoon is a peak demand period when the utility wants to discharge supplemental power from the batteries (which are at that point 100% full), that discharge can also occur. The last action might reduce the batteries to a low charge level over 3-4 hours, but they would be recharged later in the evening when the peak demand had passed and there is no stress on the grid.

[205] San Diego Union Tribune, *What 'time of use' rates will mean for SDG&E rooftop solar customers*, March 22, 2019. See: https://www.sandiegouniontribune.com/business/energy-green/sd-fi-timeofuse-rates-solar-20190322-story.html. On-peak, 4 pm – 9 pm, June 1 – September 30, weekdays and weekends. Residential on-peak tariff = $0.43/kWh. Residential off-peak tariff = $0.21/kWh.

years.[206] Finance charges constitute a considerable component of the overall cost-of-production for a system that is 100 percent financed. Table 8 demonstrates that the net cost-of-production of a residential solar and battery storage system, even when completely financed, totals only one-third the cost of SDG&E's current residential retail electricity rate.[207]

The cost-of-production would be substantially lower if the system is paid for upfront and not financed. In that case, the cost-of-production for this residential solar and battery storage system would be \$0.07/kWh – or one-fifth the cost of SDG&E's current residential electricity rate.[208]

Table 8. Cost of electricity for 6 kW_{DC} residential rooftop solar system with 13.5 kWh battery storage capacity (financed at 5 percent interest, 20-year term**)**

Cost or (Credit), \$	Cost Element
16,500	Gross installed cost of 6 kW_{DC} rooftop solar system @ \$2.75/$watt_{DC}$[209]
9,800	Installed cost of battery system, Tesla Powerwall, 13.5 kWh. Assumed peak demand export capacity of battery storage system = 5 kW
(6,838)	26 percent federal tax credit on gross cost in 2020
(3,375)	SGIP incentive payment, \$0.25/Wh.
16,087	Net cost of PV + battery system
1,290/yr	Annual cost of system, 20-year, 5 percent financing, capital recovery factor = 0.0802 per year: \$16,087 x 0.0802/yr = \$1,290/yr
120/yr	Annual fixed O&M, \$20/kW-year
(268/yr)	TOU load shifting with battery, 2 kW average shift during every summer on-peak hour. 122 days/yr x 5 hr/day x 2 kW x (\$0.43/kWh - \$0.21/kWh)

[206] This calculated cost would be the expected cost-of-production under an on-bill financing program, similar to the Hawaii GEM\$ on-bill financing program, where there is no up-front payment and the system is amortized over a 20-year period.

[207] SDG&E, *Residential Rate Sheet for Time-of-Use Tariff TOU-DR-1*, webpage accessed January 27, 2020 (TOU-DR-1, effective June 1, 2019) available at http://regarchive.sdge.com/tm2/pdf/ELEC_ELEC-SCHEDS_TOU-DR1.pdf. All new solar customers in SDG&E's service territory are on a TOU tariff. The average price of electricity for TOU-DR-1 in the winter, including all times of the day, = ((0.34+0.33+0.32) ÷ 3)) = \$0.33/kWh. The average rate in the summer is ((0.52+0.32+0.27) ÷ 3) = \$0.37/kWh. When summer and winter pricing is averaged the kWh rate over the course of the year is approximately \$0.35/kWh. \$0.122/kWh ÷ \$0.35/kWh = 0.35 (35% or approximately one-third).

[208] The "annual cost of system" would decline from \$1,290/yr, as shown in Table 8, to "net cost of PV + battery system" ÷ 20 years = \$16,087 ÷ 20 years = \$804/yr. The cost-of-production under this "cash transaction" scenario would be: (\$804/yr + \$120/yr - \$268/yr) ÷ 9,355 kWh/yr = \$0.070/kWh.

[209] www.energysage.com, *Table - Solar panel (system) pricing in U.S. states*, webpage accessed May 14, 2020. Lower end of California installed system price range = \$11,455 net after federal tax credit. Gross cost prior to 26 percent federal tax credit (6 kW_{DC}) = \$11,455 net ÷ (1 – 0.26) = \$15,450 gross. \$15,450/6,000 $watt_{DC}$ = \$2.575/$watt_{DC}$. The pricing in Table 8 assumes competitive system pricing near the low end of 2020 California price range for 6 kW_{DC} system.

	= $268/yr.[210]
9,355 kWh/yr	Annual electricity production, fixed solar array, San Diego, 20% DC-to-AC losses (source: PV Watts Calculator, zip code 92116)
0.122/kWh	Cost of electricity: ($1,290/yr + $120/yr - $268/yr) ÷ 9,355 kWh/yr = $0.122/kWh
0.35/kWh	Average SDG&E residential cost of electricity, 2019

The all-in cost-of-production of a 6 kW_{DC} residential BTM solar and battery storage system, as shown in Table 8, totals about one-third to one-fifth the retail residential rate that SDG&E charges, depending on whether the system is completely financed or paid for upfront. Clearly a strong economic interest exists for residential customers to install these BTM solar and storage systems.

C. San Diego Needs Higher Compensation for Its Excess Generation to Maximize BTM Solar

SDG&E pays about $0.03/kWh on average for excess generation produced by a BTM solar installation, roughly equivalent to the wholesale cost of power produced by a natural gas-fired combined cycle power plant.[211] The CPUC has allowed the utilities to set this wholesale rate for solar power at a rate far too low to provide a financial incentive for the BTM solar system owner to increase the size of the system beyond the need of the home or business.

In contrast, a number of operational CCEs pay substantially more for excess generation from BTM solar systems. For example, CleanPowerSF pays just under $0.09/kWh for excess generation.[212] This rate, $0.09/kWh, approximates the average TOU-adjusted wholesale value of solar power in the Bay Area, where CleanPowerSF is located.

The $0.09/kWh payment for excess generation may be sufficient to fully cover the cost-of-production for the expansion of a net-metered BTM system. Take for example a 6 kW_{DC} BTM

[210] There are 1.2 million residential SDG&E customers (see: energycentral.com, *SDG&E wants to ditch winter and summer pricing on customers' bills*, October 31, 2019: https://energycentral.com/news/sdge-wants-ditch-winter-and-summer-pricing-customers-bills). Residential customers represent about 36 percent of SDG&E's demand on an annual basis (see: SDG&E, *R.17-06-026 PCIA Rulemaking Workshop #1C*, December 6, 2017, p. 34). SDG&E summer 2019 moderate weather peak load = ~2,900 MW, summer peak load = ~4,100 MW. Assume 1,200 MW additional load on summer peak day is predominantly residential load. Therefore, unit residential summer demand during on-peak period = 1.2 million customers x [((0.36 x 2,900 MW) + 1,200 MW) x 1,000 kW/MW] ÷ 1.2 million customers = 1.9 kW unit residential demand.

[211] SDG&E, True Up Monthly Rate Table (webpage), accessed April 10, 2020: https://www.sdge.com/residential/savings-center/solar-power-renewable-energy/net-energy-metering/billing-information/excess-generation.

[212] CleanPowerSF, *Rooftop Solar – Annual True-Up*, accessed March 19, 2020. Excess generation rate = $0.0893/kWh. See: https://www.cleanpowersf.org/solar.

solar system sized to meet 100 percent of the customer's onsite with at total gross cost of \$18,000. The incremental gross cost of adding another 4 kW_{DC} of solar modules to this base system (panels, racking, labor) is assumed to be \$4,000. The production cost from this 4 kW_{DC} addition would be about \$0.06/kWh. Therefore, CleanPowerSF's \$0.09/kWh excess generation rate would provide – when viewed from this perspective – a sufficient financial incentive to maximize the roof space dedicated to solar power production.

New BTM systems should also be sized to accommodate substantial new electric loads at some point early in the useful life of the solar installation. These would include one or two EVs, electric heat pump space heating and cooling, and an electric heat pump water heater. An adequate excess generation payment would provide a financial motivation for new BTM solar customers to maximize rooftop solar production upfront and already be generating the onsite solar power needed to meet new electric loads at the property as they are added.

The average fair-market-value cost of power generation for residential customers in SDG&E service territory, excluding T&D charges, ranges from \$0.071/kWh to \$0.074/kWh.[213] Even with SDG&E's new on-peak TOU window of 4 pm to 9 pm, the TOU-adjusted wholesale value of a 100 percent solar power resource would be \$0.08/kWh.[214] An SDCP excess generation rate of approximately \$0.09/kWh would make SDCP solar customers financially whole – without significantly raising the average SDCP generation rate – until such time as an EV or other substantial electric loads are added to utilize the excess solar generation.

D. A Feed-In Tariff for Solar Electricity – A Potential Revenue Generator from the Start

"Feed-In" means sending power directly to the grid. FIT projects are installed in front of the customer's meter and function as a grid power resource. Many large developed sites with substantial solar power potential have little or no onsite electric load. Commercial parking lots and large warehouses are examples of such sites. These properties are good candidates to feed power directly to the grid, as opposed to generating power on the customer side of the meter and off-setting retail electricity rates. Figure 9 shows the difference between the three common

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[213] Solana Energy Alliance, *Joint Rate Comparison - Solana Energy Alliance vs. San Diego Gas & Electric*, webpage accessed April 28, 2020 (Standard – DR-Residential): https://solanaenergyalliance.org/billings-rates/rate-comparison/. The 2020 residential generation rate for the one operational CCE in SDG&E service territory, Solana Energy Alliance (SEA), ranges from \$0.071/kWh (50% RPS) to \$0.074/kWh (100% RPS).

[214] About 20 percent of daily production from a fixed rooftop or parking lot solar project will occur after 4 pm in summer. The on-peak TOU premium is approximately 2x the value of off-peak production. Therefore, the TOU-adjusted value of solar (relative to the off-peak value) would be, assuming about 20 percent of daily summertime production occurs after 4 pm: 1 x (1 – 0.20) + 2 x (0.20) = 1.20. This multiplier would be applicable during the 5-month summer period, June 1 – October 31. Applying this multiplier to an assumed average wholesale value of 100% RPS electricity of \$0.074/kWh gives an adjusted wholesale value of solar = [(7 months/12 months) x \$0.074/kWh] + [(5 months/12 months) x 1.20 x \$0.074/kWh] = \$0.080/kWh.

types of interconnection: directly to a distribution substation, directly to a substation feeder circuit, and on the customer side of the meter.

A model FIT program, sized specifically to San Diego, already exists. The Clean Coalition developed a proposed FIT for large solar arrays in San Diego in 2019 under contract to the City of San Diego.[215] The Clean Coalition proposed a FIT tariff of $0.08/kWh for larger distributed solar projects, with a target of 50 MW_{AC} online by 2022. The Clean Coalition envisioned that FIT projects would be built under a build-own-transfer structure by third parties in a competitive bidding process. The City would own and operate these FIT projects. A FIT at $0.08/kWh would be equivalent to the average San Diego-area wholesale generation rate, adjusted for the time-of-delivery of solar power, and would therefore not create upward price pressure on the wholesale generation rate.

The Clean Coalition also noted the challenge of identifying the right FIT tariff to spur development without exposing ratepayers to unnecessary costs. One potential approach to addressing this challenge would involve setting a bid ceiling price, for example $0.08/kWh, that does not put upward pressure on the generation rate, and combining the ceiling price with an auction mechanism so that qualified bidders submitting the lowest price are awarded the project(s). The auction mechanism approach has already been demonstrated in SDG&E service territory. An auction mechanism, known as the Renewable Auction Mechanism,[216] has been used to award numerous solar projects of 20 MW_{AC} or less in SDG&E's renewable energy portfolio.[217]

These FIT projects could become substantial revenue generators for the City or SDCP. Commercial solar with battery storage can be developed for $0.05/kWh for a single 120 kW_{DC} project, as shown in Table 7. The Clean Coalition anticipated the City bidding-out 7.5 MW_{AC} blocks of FIT capacity each quarter over two years.[218] Some economies-of-scale would be realized by bidding-out relatively large blocks of capacity at one time, resulting in lower-cost bids relative to the bid price for a single project.

FIT projects would feed power directly to the grid, as shown in Figure 9, which would then be delivered by SDG&E over the distribution system to customers. Sending power directly to the grid is advantageous given the current configuration of the PCIA exit fee, which allocates a fixed

[215] Clean Coalition, *City of San Diego - Draft Final Feed-in Tariff Design*, September 9, 2019.
[216] CPUC, *Renewable Auction Mechanism - Renewable Auction Mechanism Program*, webpage accessed March 21, 2020: https://www.cpuc.ca.gov/Renewable_Auction_Mechanism/.
[217] SDG&E, *San Diego Gas & Electric Company (U 902 E) Renewable Auction Mechanism Program Annual Compliance Report*, February 12, 2016. See: http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M159/K671/159671207.PDF.
[218] Clean Coalition, *City of San Diego - Draft Final Feed-in Tariff Design*, September 9, 2019, p. 5.

annual exit fee charge over the amount of grid power delivered to customers.[219] FIT projects do not reduce the amount of grid power, and therefore have no role in concentrating fixed PCIA exit fee costs on fewer-and-fewer kWh of grid power.[220]

The Clean Coalition also evaluated adding battery storage to these FIT solar projects to allow shifting of solar power delivery to the more lucrative 4 pm to 9 pm on-peak period and to provide RA capacity. The addition of battery storage would make the FIT solar installation a dispatchable power plant.

FIT solar installations in commercial parking lots would have the added value of serving as shade structures for customers and employees of the associated commercial businesses. Figure 11 provides an example parking lot, where a very large parking area serving a major retail complex, including a Costco, Ikea, and Lowe's in the Mission Valley area of San Diego, could be made available for solar development.

Third party developers of a FIT rooftop solar project would typically pay a lease to the property owner for use of the rooftop to generate and sell solar power. One form of non-monetary lease payment by the solar developer for use of the parking area shown in Figure 11 could be the added-value benefit of shade structures – at no cost to the business owners – to customers of these commercial businesses.

The FIT also provides a viable model to develop solar installations on large-scale warehouse rooftops. Developing large amounts of solar capacity on industrial warehouse rooftops, with lease payments paid to the warehouse owners for use of the rooftops, has already occurred in Southern California. Southern California Edison (SCE) developed over 100 MW of rooftop solar, beginning over a decade ago, using this approach on large industrial warehouses east of Los Angeles.[221]

Figure 12 represents an aerial view of the City of San Diego's Otay Mesa industrial warehouse district along the U.S.-Mexico border. Figure 12a shows one of a few warehouse rooftops in the Otay Mesa warehouse district with rooftop solar. Figure 12b includes an aerial view of a portion of the Otay Mesa warehouse district to provide an example of the potential of the rooftop solar

[219] The SDG&E PCIA exit fee will be approximately $450 million/yr in 2020, rising to $500 million/yr in 2026. See: CPUC Decision D.18-10-019, *Modifying the Power Charge Indifference Adjustment Methodology*, October 11, 2018, and CPUC Rulemaking R.17-06-026, *Exhibit IOU-5-R - Revised Joint Utilities' Total Costs and Above Market Costs Bar Charts Pursuant to ALJ Roscow's August 21, 2018 E-mail Ruling, Table - SDG&E Above-Market Costs*.

[220] In contrast, all "top of the Loading Order" priority resources, including EE, DR, and BTM solar and battery storage systems, reduce the demand for grid power and therefore reduce the total grid kWh available to share the PCIA exit fee cost. Some revenue from FIT projects could be allocated to offset this phenomenon, to assure that customers without BTM solar and battery storage do not bear an unequal share of the PCIA exit fee.

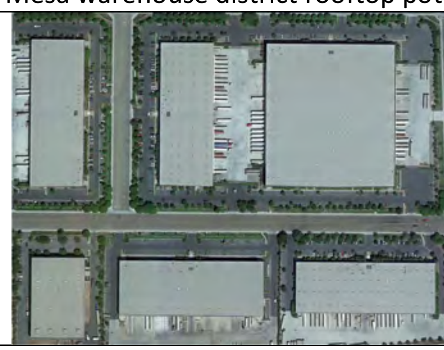
[221] Electrical Wholesaling, *Leasing Your Rooftop for a Solar Installation*, December 1, 2010. See: https://www.ewweb.com/green-market/article/20920680/leasing-your-rooftop-for-a-solar-installation.

resource there. Powers Engineering previously estimated the rooftop solar potential of the Otay Mesa warehouse district at 40 MW_{AC} to 80 MW_{AC}.[222]

Figure 11. Available commercial parking area for solar development, Mission Valley, San Diego
(note solar installed on Costco and Ikea rooftops)

Source: Google Earth, outlines and labels added by B. Powers.

Figure 12. Solar potential of warehouse rooftops in Otay Mesa, San Diego

a. Otay Mesa warehouse rooftop w/ solar	b. Otay Mesa warehouse district rooftop potential
	

Source: Google Earth.

Figures 11 and 12 show examples of the potential FIT capacity that exists in San Diego. FIT solar and battery storage projects can be built and operated at a cost below the expected SDCP generation rate. As a result, FIT projects have the potential to become revenue generators for SDCP.

These projects send power directly to the grid, and do not reduce the amount of grid power delivered to customers. For this reason, FIT projects do not impact how PCIA exit fees are

[222] CPUC Application A.08-07-017, *Opening Testimony of Bill Powers on Behalf of UCAN - Application of SDG&E for Approval of the SDG&E Solar Energy Project*, January 14, 2009, Attachment B, pdf p. 28. The solar potential estimate in this 2009 testimony of 40 MW_{AC} for Otay Mesa warehouse rooftops assumes low-efficiency thin-film solar panels. The estimate would approximately double, up to 80 MW_{AC}, if monocrystalline or polycrystalline solar was assumed to be the base case.

allocated between customers. A focus on FIT projects in the near-term would allow the SDCP to accelerate local solar additions now. This focus can occur while working in parallel to achieve an equitable resolution to the challenges created by the current PCIA exit fee structure on the development of BTM resources.

VIII. MICROGRIDS AND VIRTUAL POWER PLANTS INCREASE SAFETY AND RELIABILITY

Innovative configurations of solar power and battery storage, microgrids and VPPs, present San Diego with new possibilities to maximize the grid reliability value and economic value of these technologies. Microgrids enable sections of the grid to operate independently of the larger grid, or "island," to keep the lights on in emergencies when the grid is not available to provide power. The microgrid assures very high levels of reliability. VPPs take advantage of advanced communications to aggregate hundreds or thousands of individual customer batteries electronically to act as if they were a single "virtual" large battery. The VPP can be scheduled and dispatched as if it were a traditional peaking power plant, and can obtain the revenue streams associated with this capability, while at the same time providing back-up power reliability in the homes and businesses where the batteries are located.

A. Microgrids

A microgrid involves connecting electrical distribution for a single building, a home or commercial structure, or a collection of such buildings interconnected on the same distribution circuit, which can be isolated from the grid and operated autonomously. Individual homes or commercial buildings with solar panels and battery storage can be considered as a single-structure microgrid, or a form of mini-microgrid.[223] Large complexes that consist of many buildings, such as the San Diego Airport and UC San Diego,[224,225] have very sophisticated microgrid management systems. These microgrids can isolate from SDG&E and auto-supply with either onsite renewable power or a combination of onsite renewable power and onsite conventional power.

[223] ABC 10 New, *Green Homes Tour gives San Diegans a look at efficient options (video)*, October 18, 2019: https://www.10news.com/news/local-news/san-diego-news/green-homes-tour-gives-san-diegans-a-look-at-efficient-options.
[224] Microgrid Knowledge, *With San Diego Airport Microgrid, No More Blackouts and $6.4M/year Saved*, October 26, 2018. See: https://allafricasolarenergy.com/solar-for-airports/.
[225] Lawrence Berkeley National Laboratory, *Microgrids – UCSD*, 2019. See: https://building-microgrid.lbl.gov/ucsd.

1. *Microgrids for critical facilities*

The Sterling Municipal Light Department (Massachusetts) battery storage project provides a good example of an operational community-scaled microgrid. Sterling Municipal, a publicly-owned utility, serves 3,700 residential, commercial, municipal and industrial customers. Sterling possessed the most solar watts per customer in the country in 2013, with PV power accounting for approximately 30 percent of the utility's peak load at the time. Sterling Municipal faced higher costs for grid services, and Sterling's high solar penetration was also causing some power quality issues.[226] The costs of capacity and transmission services purchased from the grid operator rose from $500,000 in 2010 to $1.2 million in 2017. Action needed to be taken to resolve these challenges.

Sterling installed a 2 MW, 3.9 MWh lithium battery storage system in October 2016 to address these issues. The system is designed to island from the grid during a power outage. The battery storage is supported by 2 MW of existing solar generation. The battery storage, the 2 MW of solar capacity, and the police department are all on the same electrical feeder. The feeder can be isolated to form an islanded microgrid in the event of a grid outage. This configuration can provide 12 days or more of backup power to the Sterling police station and dispatch center when it is operating as an islanded microgrid.

Battery storage was chosen over the gas turbine alternative that was initially considered. Over the project's 10-year guarantee period, the project is expected to save at least $400,000 per year. These savings represent significant savings for the Sterling municipal utility, which has an annual budget of $8.2 million. The battery storage also allows Sterling to increase solar penetration while maintaining good power quality.[227]

2. *Microgrids for schools*

Schools are classified as critical facilities in California, along with police stations, fire stations, and hospitals, and are expected to be capable of operating during emergency events and outages.[228] At least one school district in the state has converted all schools in the district to microgrids to enable them to fulfill the critical facility function. The Santa Rita Union School District in Salinas completed microgrids at each of its six campuses in May 2018.[229] These solar and storage microgrids are designed to serve as continuously powered emergency response

[226] Home Power, *Sterling Municipal Light Department - Energy Storage System*, August 2018, pp. 25-26.
[227] The battery storage allows Sterling Municipal to control the feeder voltage level within a tight tolerance to assure good power quality.
[228] CPUC Decision D.19-09-027, *Decision Establishing a Self-Generation Incentive Program Equity Resiliency Budget*, September 12, 2019, p. 25.
[229] Santa Rita Union School District press release, *Solar Plus Energy Storage Microgrid Kick-Off Event*, May 14, 2018: http://sruesd-ca.schoolloop.com/file/1516177487510/1442471980548/2697312800308938586.pdf.

centers during prolonged power outages. Each campus has 115 kW_{AC} to 262 kW_{AC} of solar capacity, and an average of about 200 kWh of usable lithium ion battery storage capacity.

The Santa Rita Union School District microgrids in Salinas provide a useful real-world case study to estimate the cost of battery storage in a commercial (school) application. The Santa Rita Union School District has an average of about 200 kWh of battery storage capacity per school microgrid. In the case of a sealed lead-acid Outback EnergyCell XLC battery, about seven batteries would be required to provide 200 kWh of useful storage.[230] The gross equipment cost of seven EnergyCell XLC batteries would be about $120,000.[231] This investment in battery storage capacity assures that the school can serve as a critical gathering point with electric power during power outages and other community emergencies.

3. Battery chemistries for microgrids

The dominant battery types currently used with solar power systems are lithium ion, lithium iron phosphate, and lead-acid. The lead-acid batteries are either sealed lead-acid, known as absorbent glass mat or AGM batteries, or conventional wet lead-acid. A nascent commercial battery chemistry, zinc-air, is on the threshold of commercialization. Cost, fire safety, source of material inputs, and recyclability are all factors to consider in battery selection.

Lithium

A number of lithium battery chemistries exist. Lithium batteries generally come with 10-year guarantees and can be discharged to nearly 100 percent of capacity on a daily basis.[232] Lithium ion batteries are lightweight, cost-competitive, and are the battery standard for EV applications. The Tesla Powerwall and Powerpack batteries are examples of lithium ion batteries used with solar power installations.

Lithium iron phosphate batteries are another form of lithium battery, popular because they do not require the higher energy density of lithium ion batteries and can be used where the operator desires minimum fire risk. Lithium iron phosphate batteries do not use cobalt. Lithium iron phosphate is a very stable chemistry, which makes it safer to use than other lithium chemistries.[233] When exposed to air due to an accident (for example a break in the battery

[230] 29.5 kWh per battery x 7 batteries = 206.5 kWh.
[231] Inverter Supply, Outback Power EnergyCell XLC battery, $16,625, webpage accessed April 10, 2020: www.invertersupply.com. 7 batteries x $16,625 per battery = $116,375.
[232] This characteristic is known as "depth-of-discharge," or DoD.
[233] Data Frontier Center, *Lithium Iron Phosphate – The Ideal Chemistry for UPS Batteries?*, September 12, 2018. See: https://datacenterfrontier.com/lithium-iron-phosphate-ups-batteries/.

casing), the lithium iron phosphate chemistry will not react with oxygen, and therefore will not cause an explosion or fire.[234]

Lead-Acid

Lead-acid batteries have been in use for many decades, are low-cost, and have a very high rate of recycling. There are two types of lead-acid batteries, flooded (wet) and sealed. Flooded lead-acid batteries require relatively frequent maintenance in the form of water addition. They also must be located in a ventilated area, as small amounts of hydrogen gas are emitted, to avoid a potential fire hazard. Flooded lead-acid batteries built for use with solar power systems are durable if properly maintained.

Sealed lead-acid batteries, either absorbent glass mat (AGM) batteries or gel batteries, are maintenance free, spill-proof, fully recyclable, non-hazardous, and have no fire hazard. Sealed lead-acid batteries are a good candidate for sites where minimal maintenance is a priority.

Manufacturers of sealed lead-acid batteries are working diligently to compete with lithium batteries. For example, Outback Power introduced the EnergyCell XLC sealed lead-acid battery in late 2019 for large residential and smaller commercial applications. The EnergyCell XLC has about 30 kWh of useful storage capacity and a 10-year full warranty, the same warranty duration as that of lithium batteries.[235] The cost of sealed lead-acid batteries and lithium batteries for residential and smaller commercial applications - with similar warranties - are roughly comparable in 2020.[236]

Zinc-Air

Zinc has the benefit of being a common, low-cost material that raises no fire safety concerns in a battery application. The New York Power Authority (NYPA) announced in January 2020 plans to install a demonstration100 kW, 1 MWh zinc-air energy storage system.[237] Duke Energy operates a 95 kWh zinc-air battery storage system, as part of a microgrid that helps power emergency communications in the Great Smoky Mountains National Park. Zinc-air batteries are best suited to store energy for longer time periods, for example absorbing energy during the day and dispatching through the night.[238]

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[234] *Ibid*.

[235] Outback Power, *EnergyCell XLC*, webpage accessed April 10, 2020: http://www.outbackpower.com/products/energy-storage/energycell-xlc.

[236] Tesla, *Powerwall*, webpage accessed April 10, 2020: https://www.tesla.com/powerwall. The Tesla Powerwall lithium battery equipment cost is $14,100 for two units, with 27.0 kWh of useful capacity, unit cost = $522/kWh. Outback Power EnergyCell XLC equipment cost is $16,625 for 29.5 kWh of useful capacity, unit cost = $564/kWh.

[237] Utility Dive, *NYPA turns to zinc-air storage amid lithium-ion safety concerns*, January 27, 2020. See: https://www.utilitydive.com/news/nypa-zinc-air-storage-lithium-ion-safety-concerns/571095/.

[238] *Ibid*.

B. Virtual Power Plants: Maximizing the Value of BTM Solar with Storage

The VPP represents an effective tool for maximizing the value of individual battery storage systems, while minimizing the cost of battery storage to the customer. VPPs are created by utilizing control software to communicate electronically with many battery storage systems at individual homes and businesses. The software electronically aggregates the battery output from these sources to create a "virtual" power plant that is the sum of the many battery systems being aggregated and can be dispatched as a single unit.

SDCP could rapidly launch VPPs, which would reduce customer electricity costs and create a revenue stream for the CCE. There are numerous storage aggregation firms to choose from to develop these VPPs.[239] The revenue stream would include capacity payments, peaking power dispatch payments, and payments for contributing to the maintenance of good power quality.

Three examples of VPPs are provided below.

1. Green Mountain Power, Vermont, 2,000 solar + battery low-income homes, 10 MW

Green Mountain Power (GMP), a Vermont utility, began offering retail customers 13.5 kWh battery storage units for $15 per month in 2017.[240] The revenue to be generated by participation in the VPP enabled GMP to sell these battery storage units to customers for $1,500, about 20 percent of the $7,000 full installed capital cost of the battery.[241] This VPP project reached its full build-out of 2,000 residential units in 2019. The project is meeting revenue expectations.[242]

GMP saved $500,000 during a July 2018 heat wave by dispatching 500 of these Tesla Powerwall™ batteries to operate as a VPP.[243] On a unit basis, GMP saved $1,000 per battery during this heat wave. The savings were obtained by reducing the peak load for all GMP customers, and thereby reducing the demand for power, at a time when the cost of power was

[239] A partial list of aggregation firms include Tesla: https://www.tesla.com/support/autobidder; Sunverge: http://www.sunverge.com/sunverge-distributed-energy-resource-control-and-aggregation-platform-supports-lgs-home-energy-storage-solution/; Geli: https://geli.net/geli-platform/aggregation-and-management/; Stem: https://www.stem.com/; Naak: https://naak.io/how-it-works/.

[240] The customer can own the Tesla Powerwall after 10 years of payments. The customer also has the option to make a one-time upfront $1,500 payment to purchase the unit outright.

[241] Electronic communication between B. Powers, Powers Engineering, and J. Castonguay, Chief Innovation Officer, Green Mountain Power, October 26, 2017. Installed all-in cost of 13.5 kWh Powerwall is about $7,000 on average.

[242] Green Mountain Power, *GMP – Grid Transformation Innovative Pilot – Update*, prepared for Vermont Public Utility Commission, April 15, 2019, p. 3.

[243] Utility Dive, *Tesla batteries save $500K for Green Mountain Power through hot-weather peak shaving*, July 23, 2018. See: https://www.utilitydive.com/news/tesla-batteries-save-500k-for-green-mountain-power-through-hot-weather-pea/528419/. Tesla completed the 2,000-unit Powerwall™ deployment in 2019.

very high. Tesla introduced a software update in 2018 that allows its Powerwall™ to be optimized for charging and discharging on TOU rates.

2. Government of South Australia, 50,000 solar + battery low-income homes, 250 MW

This project consists of 50,000 grid-tied low-income and social housing units, and is twenty-five times the size of the GMP-Tesla project in Vermont. The initial phases are supported by Government of South Australia grants and loans. All the housing units are equipped with 5 kW of solar panels and a 13.5 kWh Tesla Powerwall™ battery storage unit.[244] The aggregated project would have 250 MW_{AC} of discharge capacity, with total storage of 650 MWh. This project will have a capacity in the same range as the 336 MW Pio Pico Energy Center.

This South Australia residential housing VPP follows Tesla's "built in 100 days" battery storage project in Jamestown, Australia, which has 100 MW_{AC} discharge capacity and 129 MWh storage capacity. The Jamestown project became operational in December 2017.[245] With an initial capital cost of $66 million, the Jamestown battery storage system made $40 million in its first year of operation.[246]

3. Southern California Edison, 100+ commercial buildings, 85 MW

In 2014, SCE signed a contract with Stem Inc. to build and operate an 85 MW_{AC} VPP consisting of distributed energy storage systems in more than 100 commercial buildings.[247] Stem dispatched these distributed storage systems more than two dozen times in 2017, often after sunset when solar power could not be utilized to meet increasing evening loads. The VPP's performance demonstrated that aggregated commercial building battery storage is consistently reliable and can be dispatched quickly.

IX. HURDLES AND SOLUTIONS TO A 100 PERCENT LOCAL SOLAR + BATTERY STORAGE BUILD-OUT

The hurdles to achieving a 100 percent local solar and battery storage build-out originate with SDG&E and the CPUC. These hurdles are described below. Solutions do exist to these hurdles. A

[244] www.teslarati.com, *Tesla's world's largest "virtual power plant" gets the green light in South Australia*, May 24, 2018. See: https://www.teslarati.com/tesla-virtual-power-plant-south-australia/.
[245] Power Magazine, *Tesla Bet and Delivered 100-MW/129-MWh Energy Storage System Within 100 Days*, January 3, 2018. See: https://www.powermag.com/tesla-bet-and-delivered-100-mw129-mwh-energy-storage-system-within-100-days/.
[246] Electrek, *Tesla's giant battery saved $40 million during its first year, report says*, December 6, 2018. See: https://electrek.co/2018/12/06/tesla-battery-report/.
[247] Smart Electric Power Alliance, *Non-Wires Alternatives - Case Studies from Leading U.S. Projects, Appendix: Southern California Edison—Distributed Energy Storage Virtual Power Plant*, November 2018, pp. 70-73.

100 percent local solar and battery storage build-out can be achieved by 2030 with a well-crafted strategy. Solutions available to achieve the build-out are also described in this section.

A. Hurdles

1. SDG&E

SDG&E makes substantial profit from building high voltage transmission lines. The utility has a powerful financial interest in seeing renewable power generation located far from San Diego, that must flow over the transmission system to reach San Diego customers. The imposition of excessive PCIA exit fees on CCE customers, insistence on unjust fixed fees (for example a $40 per month fixed minimum bill),[248] attacks on the value of BTM solar, and shifting high summertime on-peak electric rates to the 4 pm to 9 pm window – from the prior on-peak window of 11 am to 6 pm when solar systems are highly productive,[249] lessen the economic benefits of solar power generally and impede the City's ability to meet its 100 percent clean energy target with local solar and battery storage.

2. CPUC

The modern CPUC was created by voter initiative in 1911 to regulate private monopoly electric, natural gas, and telecommunications companies. A reformist Governor, Hiram Johnson, took an initiative to the people to reform the California Railroad Commission, which regulated transportation and the budding energy industry. In what was then an innovative use of California's initiative process, the state took over regulation of electric and gas utility service companies from local authorities.

A major challenge generally with commissions that regulate private monopolies concerns regulatory capture, a phenomenon where the regulated industry exerts de facto control over the regulatory agency and converts the commission into an advocate for the utility monopoly's interests.[250]

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[248] San Diego Union Tribune, *SDG&E wants to add $10 fixed charge, nearly quadruple minimum monthly bill*, September 25, 2019. See: https://www.sandiegouniontribune.com/business/energy-green/story/2019-09-25/sdg-e-wants-to-add-10-fixed-charge-nearly-quadruple-minimum-monthly-bill.

[249] PV Magazine, *California regulators call for later peak under SDG&E time of use rates*, August 7, 2017. See: https://pv-magazine-usa.com/2017/08/07/california-regulators-call-for-later-peak-under-sdge-time-of-use-rates/.

[250] Sustainability: Science, Practice, & Policy – K. P. Brown, *In the pocket: energy regulation, industry capture, and campaign spending*, Fall 2016, p. 3. See: https://www.tandfonline.com/doi/pdf/10.1080/2052546.2016.11949232. "Government regulatory agencies, meant to serve the public interest, proliferated in the Western world following the Great Depression and World War II. However, scholars observing these bodies in the mid-twentieth century were quick to notice the tendency of regulators to promote the interests of those they are supposed to regulate (e.g., Bernstein, 1955; Kolko 1963; Stigler, 1971). Although regulatory capture can be conceived broadly, it is especially applicable to regulated monopolies, such as private utilities."

In California, a utility need only obtain the vote of three out of the five CPUC commissioners to carry the day on any matter before the Commission. CPUC commissioners are appointed by the governor, not elected, and thus are relatively immune from public opinion. The CPUC is the only California state regulatory agency not subject to the state-level Administrative Procedures Act, limiting the tools available to opposing parties in CPUC proceedings to develop a full evidentiary record that can be reviewed by a court for its reasonableness and factual basis.

Because the CPUC creates its own procedures and rules, and enjoys very limited judicial review of its actions, the CPUC can act contrary to the evidentiary record developed by its own judges and staff. For example, any CPUC commissioner can submit an alternate decision to be voted on before the proposed decision prepared by the presiding administrative law judge (ALJ) is considered. The alternate decision can differ from the proposed decision of the administrative law judge and need not contain any factual or evidentiary basis – it can even conflict with the facts and evidence that are in the administrative record. If a decision receives three votes, it becomes the CPUC's final decision and enjoys the force of law.

The use of alternate decisions to veer away from the evidence and facts developed in the administrative process has occurred repeatedly in SDG&E proceedings before the CPUC in the 21st century. For example, the ALJ's proposed decision to deny the 500 kilovolt Sunrise Powerlink failed in 2008 when an alternate decision approving the line, written by former CPUC President Michael Peevey, was approved on a 4-1 vote.[251]

CPUC commissioners periodically come from senior utility management or leave the CPUC to join a utility in senior management positions. For example, Michael Peevey, a former president of SCE, was president of the CPUC from 2003-2014.[252] His tenure ended in controversies, including: 1) his relationship with PG&E executives, brought to light with the publication of his e-mail exchanges after the San Bruno gas pipeline explosion and his reluctance to investigate or hold PG&E responsible, and 2) his irregular allocation of cost responsibility between SCE and its ratepayers concerning the forced closure of the San Onofre nuclear power plant due to a design flaw in the replacement steam generators, arising from a deal made with the utility in a Warsaw luxury hotel.[253]

Former CPUC commissioner Carla Peterman, the author of an alternate decision in the PCIA exit fee proceeding, left the CPUC at the end of her 5-year term in December 2018. Within a few months, she became the senior vice president of regulatory affairs at SCE, despite the one-year

[251] Notably, the one commissioner opposing the alternate decision, Dian Grueneich, had been the presiding CPUC commissioner over the Sunrise Powerlink application for three years at the time of the vote.
[252] See Michael Peevey biography, accessed January 26, 2020: https://energy.ucdavis.edu/peevey-michael/.
[253] Los Angeles Times, *State investigator lays out developing criminal case against former PUC president*, December 29, 2015. See: https://www.latimes.com/business/la-fi-watchdog-peevey-20151230-story.html.

ban on government decisionmakers lobbying their former agency.[254] The median senior vice president compensation at SCE in 2018 totaled over $1 million per year.[255]

The CPUC'S professional civil service staff, most prominently represented by the ALJs who preside over specific utility applications and the staff of the internal Public Advocates Office,[256] frequently assess the merits of the utilities' applications thoroughly and responsibly, only to be overruled by commissioners without explanation or support.

With respect to SDG&E, it has enjoyed a steady rise in profits, profits that are authorized by the CPUC, during a time period that includes a major economic downturn (2008) and declining grid power demand. SDG&E earned $767 million in profits in 2019, of which about $345 million is attributable to customers in the City.[257] SDG&E'S annual profits for the period 2006-2019 are shown in Figure 13.

Figure 13. SDG&E profits overall (red) and from City residents (purple), 2006-2019[258]

Business-as-usual, supported by regulatory capture, remains profitable for SDG&E. Both the City and SDCP will have to be vigilant and active before CPUC to assure that a local clean energy build-out is not undermined in relevant CPUC proceedings.

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[254] SCE press release, *Peterman to Join Southern California Edison, Powell and Anderson Named to Newly Created Senior Executive Posts*, August 23, 2019. See: https://www.businesswire.com/news/home/20190823005342/en/Peterman-Join-Southern-California-Edison-Powell-Anderson.

[255] SCE disclosure document pursuant to General Order No. 77-M at PDF p. 4 (There were 11 senior VPs at SCE in 2018. The 6th highest-paid VP made $1,017,820 that year). See: https://www.cpuc.ca.gov/uploadedFiles/CPUC_Website/Content/Utilities_and_Industries/Energy/Energy_Programs/Electric_Costs/Historical_Data/SCE%20Annual%20GO%2077-M%20Report%202018%20Public.docx.pdf.

[256] CPUC's Public Advocates Office: https://www.publicadvocates.cpuc.ca.gov/.

[257] Sempra Energy, 2019 SEC Form 10-K, February 27, 2020, p. 57. "2019 SDG&E earnings attributable to common shares = $767 million." The City is 45 percent of SDG&E's load (see MRW, *City of San Diego CCA Business Plan*, October 22, 2018, p. 2.) Therefore, SDG&E profits attributable to City load = 0.45 x $767 million = $345 million.

[258] Sempra Energy, SEC Form 10-K reports, 2008 - 2019: http://investor.sempra.com/sec-filings.

B. Solutions

This roadmap applies straightforward steps to reduce grid power demand and to expand and accelerate local solar and battery additions in the City and SDCP. The key steps to this local energy independence include:

- Protect the value of BTM solar and battery storage on homes and businesses and maintain the current installation rate of 100 MW_{AC} per year in San Diego through 2030.
- Expand on-bill financing to allow all customers, regardless of whether they are owners or renters, to benefit from BTM solar power and battery storage.
- Add 25 MW per year of A/C cycling DR through 2030.
- Focus EE upgrades on "high users" in each customer class.
- Incorporate customer battery storage into virtual power plants to maximize the value to battery storage owners, the City, and SDCP.
- Maximize commercial parking lot and warehouse FIT solar and battery storage project development, achieve an installation rate of 110 MW_{AC} per year through 2030.
- Maximize use of the opt-out program structure to assure rapid deployment of EE, DR, and BTM solar and battery storage.
- Negotiate an equitable resolution of the PCIA exit fee.
- Demand accurate accounting by CAISO of the capacity value of solar power in San Diego.

These steps are addressed in more detail in the following subsections.

1. Actions necessary to maximize San Diego's local clean energy potential

This roadmap anticipates maintaining the current BTM solar installation rate in the City of 100 MW_{AC} per year over the next ten years, and adding 110 MW_{AC} per year of commercial parking lot and warehouse solar FIT projects over the same time frame. The overall plan adds 2,100 MW of new local solar and 250 MW_{AC} of A/C cycling DR by 2030. These targets can be expanded proportionately to apply to SDCP. An EE reduction target of 25 percent can be achieved by focusing EE upgrade efforts on customers using disproportionately high amounts of electricity. An opt-out structure should be used with these steps to maximize the potential gains as fast as they can be achieved.

A necessary companion to protection of BTM solar and battery storage involves a simple financial mechanism that ensures all customers who pay an electric bill, homeowners and renters alike, have ready access to BTM solar and battery storage. The mechanism, on-bill financing, uses electric bill monthly payments as the source of funds to pay for solar and storage installations.[259]

This program should be opened to non-utility capital, with no cap, to ensure the availability of sufficient capital to realize the potential of on-bill financing. A robust on-bill financing program would dramatically increase the equity of the local BTM solar and battery storage transition by giving all customers who pay an electric bill equal access to favorable financing.

A dynamic FIT program focused on commercial parking lots and warehouse rooftops is also necessary. These projects can produce electricity at a lower cost than the current average generation rate.[260] FIT projects also avoid adding to the problem created by the current format of the PCIA, which averages a fixed annual fee across the total amount of grid power consumed by customers. This results in the rising concentration of fixed exit fee costs on non-solar customers, who are completely reliant on grid power, as the number of BTM solar customers increases and the overall demand for grid power decreases. FIT projects are in front of the meter and as a result function as a grid power resource. Over time the City and SDCP will need to fully develop these resources to maximize local solar development. The current regulatory environment favors prioritizing these FIT projects now.

2. Protecting San Diego's clean electricity resources

Protecting the value of net-metered BTM solar against utility actions intended to undermine the wide-scale adoption of local solar is essential. The ability to net-meter has created over 9,000 MW_{AC} of BTM solar in California, growing at a rate of 1,200 MW_{AC} per year.[261] Following the *California Long-Term Energy Efficiency Strategic Plan* and the Loading Order should suffice to protect net metering, but utility attempts to undermine BTM solar continue.

California acts inconsistently – and against the state's interests – when it first requires solar on all new residential construction but then allows the CPUC to aid the utilities in erecting barriers to BTM solar on existing residential and commercial properties. Protecting net-metering will

[259] SDG&E has an existing and limited on-bill financing program for certain qualifying commercial customers for energy efficiency upgrades (solar and batteries are not included in the program). See: https://www.sdge.com/sites/default/files/documents/FINAL_S1870123%20OBF%20Fact%20Sheet.pdf.
[260] Solana Energy Alliance, *Joint Rate Comparison - Solana Energy Alliance vs. San Diego Gas & Electric*, webpage accessed April 28, 2020 (Standard – DR-Residential). The 2020 residential generation rate for the one operational CCE in SDG&E service territory, Solana Energy Alliance (SEA), ranges from $0.071/kWh (50% RPS) to $0.074/kWh (100% RPS).
[261] See California Distributed Generation Statistics – 2019 capacity added, 1,180.9 MW, accessed May 1, 2020: https://www.californiadgstats.ca.gov/charts/.

likely require additional legislation if the CPUC continues to fail to implement the current statutes correctly.[262,263]

Both the City of San Diego and SDCP should pursue remedies at the CPUC to the out-of-balance PCIA exit fee imposed by the CPUC on departing load customers, a burden that will be borne by SDCP customers. An unresolved issue at the CPUC concerns establishing rules-of-the-road so that CCE providers such as SDCP can buy-out the older solar and wind contracts held by SDG&E that constitute a substantial portion of the exit fee burden. A legislative remedy should be sought if the CPUC is unable to resolve this issue in a manner equitable to CCEs generally, and SDCP specifically, within the next 12 months.

The City of San Diego and SDCP must also defend the clean power assets they already have in their portfolio. Both the City and SDCP should advocate before the CPUC and CAISO for accurate and fair treatment of the capacity value of existing solar resources serving City residents, to avoid those residents paying twice for reliable capacity they have already paid for.

3. Assuring that SDG&E partners with the City to fully support the City's clean energy goals

The pending expiration of the City's franchise agreement with SDG&E can be a part of the solution as well. The 50-year franchise agreements between the City of San Diego and SDG&E for electric and natural gas service expire in January 2021. The coincidence of the franchise agreement expiration and the launch of SDCP offers the opportunity to develop a new agreement that establishes the City's franchisee as a partner in SDCP's local clean power development focus.

Other major U.S. cities, including Salt Lake City and Minneapolis, have included climate action objectives and short terms, five years in the case of Salt Lake City, in their recent franchise agreements with their private utility companies. A short term length becomes critical in providing the City with the ability to choose a new franchisee, or to municipalize, if the incumbent franchisee fails to support the City in reaching its local clean energy goals and related requirements defined in the franchise agreement.

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[262] Solar Bill of Rights legislation, SB 953, introduced in February 2020, should be passed into law. See: *SB-953 - Customer-sited renewable energy or energy storage systems: discriminatory fees or charges*, introduced February 10, 2020. See: http://www.leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201920200SB953.

[263] SDG&E opposes SB 953. See: Sempra/SDG&E, *Letter to Senator Ben Hueso in Opposition to SB 953*, March 10, 2020. "San Diego Gas & Electric (SDG&E) opposes SB 953. The bill would require the California Public Utilities Commission (CPUC) to ensure that customers with solar and/or battery storage sited on the customer side of the electric meter are not subject to 'discriminatory fees or charges levied as a result of installing or using those customer-sited renewable energy or energy storage systems.'"

San Diego requires a strong franchise agreement that complements the objectives of the City and SDCP, which include rapid expansion of local solar power and battery storage and equity in the distribution of that solar and storage, to realize the City's renewable energy potential.

X. CONCLUSION

This roadmap applies the goals of the *California Long-Term Energy Efficiency Strategic Plan,* described in Section III, to the specific case of the City and SDCP to detail a workable and affordable strategy to achieve a 100 percent clean energy build-out in San Diego. The *Plan* encompasses the CPUC-sanctioned strategy for maximizing the renewable energy priorities advanced by California – to achieve all available EE, of which BTM solar and battery storage is an integral component – and all available DR. The roadmap's approach will reduce the cost of electricity to City residents, create revenue opportunities for SDCP as an aggregator and dispatcher of BTM batteries and of A/C cycling DR, create new well-paying jobs in the community, and spread the economic benefits of this clean energy conversion – both job opportunities and lower electric rates – among all City residents and City businesses.

Several key components of this roadmap must be used concurrently to maximize the benefits of the overall strategy. As a threshold requirement, San Diego must provide the benefits of its clean energy transformation to all its residents, not just the early adopters. A robust low-cost A/C cycling DR program can offset expensive energy costs at times of peak demand. An equitable on-bill financing program ensures that everyone participates in the comprehensive BTM solar and battery storage expansion. An ambitious FIT solar and battery storage development program will provide a source of revenue and a financial counterweight to the inequities the current PCIA exit fee imposes on BTM resources. A focus on maximizing local solar resources will create new livable wage jobs in San Diego. An equitable franchise agreement will assure that SDG&E partners with San Diego to support its policies, instead of allowing the City's franchisee to oppose the City before state agencies.

The launch of SDCP offers a unique opportunity to reach 100 percent clean power locally. The City and its residents, as a part of SDCP, determine how the power serving the community will be generated. Building-out locally means the community benefits economically from clean power development. Jobs both stay in the community and increase as the local build-out expands. Local financial institutions benefit by investing in local projects. Local businesses benefit from the increase in direct and indirect economic activity. Homeowners and building owners reduce their cost of electricity and increase the value of their property. Renters gain direct access to clean power. San Diegans have fought for this future for years. Now is the time for all of us to make it happen.