

State of Solar Energy in Sonoma County

PATHS TO ACCELERATE ADOPTION

Trends, Goals, and Recommendations

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ABBREVIATIONS

AC	Alternating Current	IOU	Investor Owned Utility
AMI	Advanced Metering Infrastructure	JEDI	Jobs and Economic Development Impacts
ARB	California Air Resources Board	JFW	Jackson Family Winery
BTM	Behind the meter	kV	Kilovolt/s
BTU	British thermal unit	kW	Kilowatt/s
CAGR	Compound Annual Growth Rate	kWh	Kilowatt-hour/s
CAISO	California Independent System Operator	LBNL	Lawrence Berkeley National Laboratory
CA2020	<i>Climate Action 2020 and Beyond</i>	LNBA	Locational Net Benefit Analysis
CO ₂	Carbon Dioxide	MASH	Multi-family Affordable Solar Housing
CalCCA	California Community Choice Association	MW	Megawatt/s
CALSEIA	California Solar Energy Industries Association	MWh	Megawatt-hour/s
CCA	Community Choice Agency or Aggregator	NEM	Net Energy Metering
CCE	Community Choice Energy	NEM-A	Net Energy Metering Aggregation
CCP	Center for Climate Protection	NREL	National Renewable Energy Laboratory
CEC	California Energy Commission	NSHP	New Solar Home Partnership
CPE	Clean Power Exchange	OTH	Office of the Historian
CPUC	California Public Utilities Commission	PACE	Property Assessed Clean Energy
CSI	California Solar Initiative	PG&E	Pacific Gas and Electric Company
CSS	California Solar Statistics	POU	Publicly Owned Utility
DC	Direct Current	PPA	Power Purchase Agreement
DER	Distributed Energy Resources	PV	Photovoltaic
DOE	U.S. Department of Energy	RCPA	Regional Climate Protection Authority
DRP	Distribution Resources Plan	REC	Renewable Energy Credit
DRPWG	Distribution Resources Plan Working Group	RESCO	Renewable-Based Energy Secure Community
DUP	Deloitte University Press	RPS	Renewables Portfolio Standard
EIA	U.S. Energy Information Administration	SASH	Single-family Affordable Solar Homes
EPA	U.S. Environmental Protection Agency	SCE	Southern California Edison
ESD	Sonoma County Energy and Sustainability Division	SCEIP	Sonoma County Energy Independence Program
EV	Electric vehicle	SCP	Sonoma Clean Power
FERC	Federal Energy Regulatory Commission	SCWA	Sonoma County Water Agency
FHA	Federal Housing Administration	SEIA	Solar Energy Industries Association
GHG	Greenhouse gas	SGIP	Self-Generation Incentive Program
GMI	Grid Modernization Initiative	SHC	Solar Heating and Cooling
GW	Gigawatt/s	SSC	Solar Sonoma County
GWh	Gigawatt-hour/s	T&D	Transmission and Distribution (electrical grid)
HUD	U.S. Department of Housing and Urban Development	TOU	Time-of-Use
ICA	Integration Capacity Analysis	TPO	Third Party Ownership
ICLEI	International Council for Local Environmental Initiatives	VGI	Vehicle to Grid Integration
IDER	Integrated Distributed Energy Resource	VNEM	Virtual Net Energy Metering
IER	Institute of Energy Research	ZEB+T	Zero Emission Building + Transportation
IoT	Internet of Things	ZEV	Zero Emission Vehicles

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Executive Summary

Overview

A confluence of technological and policy forces is dramatically transforming the way energy is generated, managed, delivered, and used.

Policies enacted in response to climate change are expediting the move to low- or no-carbon distributed energy resources. Simultaneously, the Internet cloud, Wi-Fi-enabled devices, and big-data analytics are driving technological and grid innovation that will provide communities with more control over energy decisions, systems, and economics.

At the heart of this energy transformation is the shift from a centralized, predominantly fossil-fuel based model to a distributed, clean energy model, called *Integrated Distributed Energy Resources* (IDER). The new model includes renewable energy, energy storage, electric vehicles, net-zero-energy buildings, demand response, data analytics, and smart control technology or “intelligence” for connecting and integrating all the parts.

This is what local solar vendors call *Solar+*, a renewables-based system that stores excess generation in onsite batteries and accesses the stored energy during dawn and evening hours when most people are using grid power to switch on lights or watch television. This ability to use stored solar energy during times of peak grid demand means Solar+ IDER systems can reduce the strain on, and cost to maintain, the electrical grid. It also helps serve new demand as people replace their cars with electric vehicles (EVs) and their natural gas furnaces and water heaters with high-efficiency electric appliances — a process known as *fuel-switching*.

Benefits of this emerging system are carbon emission reductions, electrical grid resilience, overall cost-savings from avoided grid upgrades, solar generation that can deliver round-the-clock power, job creation, local investment, and the ability to create microgrids, or independent multi-property networks, that integrate generation and storage.

As one of the first and most mature of the IDER technologies, solar has pioneered many market transformation policies, regulations, and strategies. In California, which leads the nation in installed solar, the solar industry’s success can be attributed to, among other factors, aggressive and forward-thinking state policy, the success of the California Solar Initiative incentive program for solar photovoltaic (PV) systems,¹ availability of financing, global pressure lowering component prices, and growth of an experienced workforce.

Whether installed on a home, office building, power plant, or microgrid, solar’s versatility, competitive cost, and policy advances make it the ideal platform upon which to build a robust distributed clean energy system.

For this reason, accelerating the adoption of the Solar+ approach is both feasible and in the best interests of the county, the state and the nation.

¹ The California Solar Initiative was a 10-year incentive program that provided incentives to property owners installing solar systems using a gradual step-down system in which incentive amounts decreased overtime as solar installation numbers increased. The solar photovoltaic (PV) program ended in 2016.

Findings

Sonoma County Solar Industry

The Sonoma County solar industry is robust, versatile, and growing. Since 1999, local efforts have resulted in the installation of 95.6 megawatts (MW) of solar power² on residential, commercial, and industrial behind-the-meter projects³ that range in size from an average residential system of 5 kilowatts (kW) to large commercial systems nearing 1 MW. Thirty-eight of these MW were installed by solar vendors headquartered in Sonoma County who employ nearly 100 percent local staff and primarily source materials from local distributors. From 2003 to 2016, solar installation in Sonoma County has grown at an annual compound growth rate of 18.26 percent.

Sonoma County ranks 22nd in the state, and second among Bay Area counties, for kW installed per person under California's Net Energy Metering program,⁴ with 0.19 installed kW per person, which is 33 percent higher than the state average. In addition, Sonoma County was ranked 13th in the nation for 2016 solar job growth by The Solar Foundation's Solar Job Census, with a 44 percent increase in jobs created over 2015.

This market growth is the result of progressive state solar policy, the California Solar Initiative incentive program, and strong local solar advocacy in collaboration with local government partners to innovate market barrier solutions such as uniform permitting and building code processes and Property Assessed Clean Energy (PACE) financing.

Sonoma County can expect continued success as solar technology improves, component costs drop, the market matures, and solar generation incorporates IDER technologies such as storage and smart control services that can coordinate solar generation with grid conditions, turning a Solar+ system into a versatile plug-and-play grid resource (see Recommendation #13).

However, the local solar industry still faces challenges such as regulatory, legislative, and other policy-related decisions affecting market growth that will require ongoing vigilance to respond to threats and support opportunities and increasing public awareness about the benefits of solar and solar-related programs.

Positioned as it is at the nexus of the IDER technological revolution, the solar industry needs to develop competitive Solar+ IDER services that meet and exceed customers' expectations.

Community Choice Agencies, the County, Cities, and Associated Agencies

Think "Added Value"

In the current turbulent energy environment, electricity industry stakeholders (e.g., providers, regulators, customers, and workers) are challenged to reinvent themselves. Technology is increasingly pushing state policy toward a market-based, IDER energy services approach that is rewriting business models across the industry. According to a 2017 CPUC staff white paper on consumers and retail choice: "California may well be on the path towards a competitive market for consumer electric services" (CPUC 2017c).

² The 95.6 MW total represents all Sonoma County projects enrolled in the Net Energy Metering program since 1999.

³ *Behind the meter* means a renewable energy system designed and installed to meet the energy needs of a specific property.

⁴ Net Energy Metering is a utility billing system that tracks and pays the solar system owners for excess solar energy they contribute to the grid.

In this context, Community Choice Aggregation agencies (CCAs), the county, cities, and associated agencies⁵ have a temporary window of opportunity to redefine their roles and show they are uniquely qualified to lead the creation of robust, local IDER markets that deliver new economic and technological benefits for the community and the grid (CPUC 2016d).

This theme was echoed at the May 5, 2017, Business of Local Energy Symposium, where California Public Utilities Commission (CPUC) President Picker challenged CCAs to innovate locally-based solutions to the IDER process with “land use and local transportation planning and other tools that are specifically reserved to local government,” asking CCAs to show how they can bring added value that the Investor Owned Utilities (IOUs) cannot (CCP 2017b; 14:40 minutes).

Innovate Integrated Distributed Energy Resource Planning

To do so, Sonoma County cities, the county itself, and associated agencies can draw on their proven track record of collaboration with local solar professionals to accelerate solar adoption as a key means to meet climate action targets. These precedent-setting efforts have already created added value for the local solar market and piloted effective market barrier solutions that have served as policy models, such as countywide streamlined solar permitting, which pre-dates Assembly Bill 2188 (2014) that “requires local governments to create an expedited [solar] permitting process.”⁶

As new CPUC-funded tools for distribution grid mapping become available, CCAs, the county, cities, and associated agencies can collaborate to identify, map, and develop IDER strategies and projects that align with community priorities, such as installing Solar+ systems at emergency preparedness facilities, including solar in affordable housing developments, helping disadvantaged communities access solar resources, and innovating land use and planning strategies and local incentives for IDER investment, building on local examples (e.g., the County of Sonoma’s Renewable Energy Combining District and the City of Sebastopol’s solar ordinance for new and existing properties) to create incentives for IDER developers (see Recommendations 3, 4, and 5).

Reimagine CCA Business Model

The shift to a distributed energy system is also disrupting the traditional electricity provider business model. Entities that depend primarily on kilowatt-hour sales revenue will experience increasing challenges as renewables, energy efficiency, and demand response shift or remove customer demand, and regulators and stakeholders decide how grid costs associated with the shift will be addressed. At the same time, new roles are emerging, including as a value-add IDER services partner with the distribution grid IOU (see Recommendations 1 and 3).

This position is supported by CPUC President Picker’s comments at the May symposium (CPUC 2017b) and in a CPUC working group report recommending that CCAs and IOUs form new partnerships to capture “public benefits for which CCAs are uniquely positioned to deliver,” such as community engagement based on local priorities, development of IDER projects at key grid locations to enhance customer value, and

⁵ Associated agencies include entities such as the Sonoma County Water Agency, Regional Climate Protection Authority, Sonoma County Energy and Sustainability Division, and Sonoma County Energy Independence Program.

⁶ These solar policy and planning solutions include establishing countywide streamlined solar permitting that pre-dates current state law, participating joint-trainings for solar vendors and building officials on solar-related building and fire codes and industry best practices to improve the inspection process; adopting uniform countywide building codes; participating in community education events such as the Solar Sonoma County Solar Fairs; collaborating with the solar industry on clean energy initiatives from the founding of the Energy Independence Program to the launch of Sonoma Clean Power; and including solar as a solution in climate action planning.

integration of local resources such as land use planning, demographic data, and local greenhouse gas (GHG) policy (CPUC 2016d).

As electricity-only providers, CCAs have additional added-value opportunities, such as targeting fuel switching initiatives for all electric buildings and vehicles, providing on-bill repayment services to support local clean energy investment, and focusing on shifting excess afternoon solar generation to high demand hours with a Solar+ retrofit strategy to add energy storage and smart controllers to existing solar systems (see Recommendations 6, 7, 8, 9, 10, 11, and 12).

Developing aligned and expanded services that fill the market niche for targeted local IDER investment will help CCAs adapt to and thrive in a dynamic market with a diverse suite of competitive energy services.

State Policy and Regulations

By 2020, it is estimated that as much as 60 percent of California electricity customers in eligible service territories will have the option to obtain their electricity from a CCA (CCP 2016). Yet the role of CCAs in the emerging IDER market has only just started to be examined, and ultimately defined, by the CPUC.

As noted above, CCAs, their local city and county partners, and associated agencies constitute an invaluable alliance of local expertise and resources that vital to the successful shift to a distributed energy system.

As a load serving entity, CCAs have an opportunity to lead the policy and regulatory dialogue and show how they, along with their local partners, can and do add value to the new distributed energy future (see Recommendation 2).

Dynamic Fast-Paced Global Market

Solar is a dynamic global industry that is changing daily as technology advances; market forces; and international, national, state, and local policies move toward a distributed clean energy model. The CPUC alone has more than eight rulemaking proceedings in progress dealing with IDER topics ranging from rate setting to distribution resource planning. The California Independent System Operator (CAISO), which manages the electricity transmission system, is pursuing multiple initiatives relating to wholesale IDER markets. The state legislature continues to develop clean energy bills, such as Senate Bill 700 that would create a 10-year rebate program to encourage installation of local energy storage. While the new federal administration has stopped supporting global climate action and clean energy goals, states, counties, and cities are stepping up to lead the way. This fast-paced complex situation requires vigilance to stay apprised of new opportunities and threats as the new distributed clean energy and economic systems are being built.

Recommendations

The successful acceleration of Solar+ IDER requires a team of local partners.

- In its role as a public electricity provider, the Community Choice Agency (and/or its statewide association) is uniquely positioned to represent community interests at the legislative and regulatory table as IOU liaison, technical advisor, public project developer, distribution grid coordinator, and public advocate.
- Local governments (i.e., cities and county) can lead land use and planning innovation and priority setting to identify locations and IDER project types that best meet local needs.

- Associated agencies,⁷ including the Sonoma County Water Agency, Regional Climate Protection Authority, Sonoma County Energy and Sustainability Division, and Sonoma County Energy Independence Program, can champion Solar+ IDER deployment by leading a regional approach to clean energy development and self-sufficiency; facilitating local government collaboration and communications with regional, state, and national entities; educating residents and businesses about Solar+ IDER economic and environmental benefits; and providing competitive financing for local investment.
- The local solar industry can explore new business models and customer services that incorporate Solar+ features and collaborate with government partners to address market barriers and develop public awareness.
- Community stakeholders and customers can serve as a market sounding board to ensure that programs and resources are delivering value that leads to Solar+ IDER adoption.

While government partners may provide the platform, enacting the following recommendations will call on all team members and the culture of collaboration that has distinguished Sonoma County as a clean energy leader.

CCA Role in Solar+ IDER Market

#1 — Business Model Innovation: Identify opportunities for CCA business model innovation and new IDER-related services, such as: (1) serving as a liaison between IOU/CAISO and local governments, representing local government priorities and applicable local IDER deployment resources (e.g., land use tools, code enforcement); (2) serving as consultant on community project designs that address local needs (e.g., establishing community microgrids at fire stations and other emergency preparedness sites); and (3) developing wholesale distributed generation projects and other aggregated IDER services that will provide CCA revenue from IDER deployment and distribution grid services to create an ongoing robust IDER market (e.g., Community Solar programs such as Marin Clean Energy's Local Sol or a behind-the-meter or utility side-of-meter power purchase agreement [PPA] or equity service where CCA owns the installation).

Stakeholders include: CCA, county, cities, associated government agencies, and the California Community Choice Association (CalCCA).

#2 — State IDER Advocacy: Engage in direct advocacy with State legislators and CPUC IDER and related regulatory proceedings (with assigned regulatory staff) in coordination with CalCCA to ensure CCAs lead the discussion and definition of their role in IDER deployment.

Stakeholders include: CCA, associated government agencies, and CalCCA.

⁷ Sonoma County's associated agencies are effective allies providing leadership in distinct and complementary areas. The Sonoma County Water Agency consistently leads efforts to increase reliable local clean energy generation through projects and programs that deliver energy independence and protection against market fluctuations, grid challenges, and natural disasters. The Regional Climate Protection Authority provides a unique forum for local governments to develop coordinated climate action strategies and coordinate with regional, state, and national partners to find effective solutions; the Sonoma County Energy and Sustainability Division leads community education on solar and other clean energy opportunities through its customer service program and its role facilitating initiatives within the county government to deploy clean energy strategies; and the Sonoma County Energy Independence Program serves as a clearinghouse for a range of PACE financing options and access to qualified local contractors for energy efficiency, solar, and water conservation, providing the financial resources to grow local clean energy investment.

Local Solar+ IDER Deployment Strategy

#3 — Incumbent Utility Partnership/IDER Map: Collaborate with incumbent IOU to: (1) map optimal IDER sites and assess their grid and local government value; (2) integrate priority local government IDER sites; (3) identify ways to reward developers who pursue projects that deliver grid performance and community benefits; and (4) identify how CCA can bring added value, capacity, and speed to the building of a robust distribution grid within its service territory.

Stakeholders include: CCA (lead) and the county, cities, associated government agencies, and incumbent IOU.

#4 — Local IDER Priorities: Initiate a process among local government and agency partners to: (1) identify land use and other local tools that can be harnessed to expedite IDER deployment by building on existing solar protocols to identify best practices and ordinance strategies (e.g., City of Sebastopol solar ordinance), zoning rules, and general plan elements related to solar, and determine how these can be expanded to include Solar+ IDER features; (2) establish new Solar+ IDER protocols for affordable housing, disadvantaged communities, and the New Construction Solar Policies called for in *Climate Action 2020 and Beyond* (RCPA 2016); (3) evaluate IDER applications for emergency preparedness sites, such as fire stations, hospitals, emergency centers, nursing homes, etc.; and (4) identify IDER-friendly zoning options based on the enterprise zone model that would offer property owners within its boundaries a suite of government incentives (e.g., free permitting, fast-track permitting, and clean energy/grid performance bonus) to participate in projects or microgrid programs that include Solar+ IDER installations and apply the IDER-friendly zone model to aggregated infill projects.

Stakeholders include: CCA, the county, cities, and associated agencies.

#5 — Local IDER Deployment Plan: Prepare an IDER development plan using the aforementioned IDER map as an overlay to existing community plans (e.g., general plans; *Climate Action 2020*) to dramatically improve the “institutional and technological capacity to integrate distributed energy resources” (RCPA 2016). Working with member jurisdictions, the CCA could conduct a countywide evaluation to identify and prioritize promising local IDER sites, aided by forthcoming CPUC grid analysis tools. The CCA could use standard processes, such as Requests for Proposal, to initiate local IDER projects in member jurisdictions in partnership with associated agencies such as Regional Climate Protection Authority and Sonoma County Water Agency.

Stakeholders include: CCA, the county, cities, and associated agencies.

#6 — Evaluation/Monitoring Platform: Collaborate with the California Community Choice Association (CalCCA) to establish a metering platform (e.g., free open-source Open Energy Efficiency Meter)⁸ to monitor performance of IDER projects, support IDER mapping, and assist in planning and use of tactics such as aggregated PV generation.

Stakeholders include: CCA, the county, cities, associated agencies, CalCCA, and project developers.

⁸ The Open Energy Efficiency Meter is a free open-source, meter platform that uses utility smart meter data to monitor energy use on individual and aggregated customer meters (OEEM 2017). The Open Energy Efficiency Meter uses CalTRACK methods developed by the CPUC to import and clean smart meter data, evaluate the actual load shape impact of individual and aggregated properties, and enable electricity providers to apply research protocols to proposed solutions while developing market strategies; the meter platform is currently being tested by the CPUC in its Pay-for-Performance pilot (PG&E 2016c).

#7 — Solar+ IDER Retrofit Incentive: Incentivize adding grid-performance equipment to existing solar systems to create Solar+ resources, including the addition of bi-directional inverters, updated circuit boards, storage batteries, EV charging, and Wi-Fi enabled smart controllers that can make stored solar power available during peak grid hours.

Stakeholders include: CCA, the county, cities, and associated agencies.

Fuel Switching Opportunities

#8 — Building Electricity Conversion: Establish a comprehensive fuel switch program to: (1) provide incentives for high-efficiency electric appliances and systems that are not eligible for, and/or are in addition to incentives, under CPUC IOU ratepayer program rules.

Stakeholders include: CCA, the county, cities, and associated agencies.

#9 — Vehicle Electricity Conversion: Administer a comprehensive program for electric vehicles (EVs) and EV charging with information and tools to help customers charge their EVs when solar electricity is readily available or overall demand is low (e.g., Sonoma Clean Power's CleanCharge that shifts charging load to off-peak hours and includes free consultation with qualified vendors, web-based EV information, web-based application forms to EV programs offering smart-charging station equipment and other incentives).

Stakeholders include: CCA, the county, cities, and associated agencies.

#10 — Workplace EV Charging: Collaborate to site and fund daytime workplace EV charging stations at employer and business centers and co-locate charging stations with Solar+ IDER energy storage.

Stakeholders include: CCA, the county, cities, and associated agencies.

#11 — Solar Parking Canopy Initiative: Establish a solar parking canopy initiative, collaborating with prospective host sites, project developers, equipment manufacturers, and others to expedite the deployment of solar parking canopies throughout the county, enabling solarized parking areas to provide EV charging station power, additional solar electricity to support the host site, serve daytime EV demand that mitigates the high demand periods in the morning and evening, and provide shaded parking for vehicle owners.

Stakeholders include: CCA, the county, cities, and associated agencies.

Financing Platform

#12 — On-Bill Repayment Platform: Establish a CCA on-bill repayment platform in collaboration with incumbent IOU and financial institutions to host a range of qualified financing providers with the option to tie payments to grid-performance results of Solar+ IDER measures; CCA could also host independent meter service based on IOU smart meter data (e.g., customized meter software such as the Open Energy Efficiency Meter) to monitor and support CCA supported Solar+ IDER projects.

Stakeholders include: CCA, Sonoma County Energy Independence Program, additional financing entities, and the incumbent IOU.

Solar+ IDER Value Proposition

#13 — Solar+ Business Model: Customers rely on solar vendors to translate technical and economic details into a simple value proposition that meets their need. Residential Time-of-Use electricity rates will come into effect over the next 18 months and include higher rates for peak-hour use. The Solar+ package of technologies allows the customer to draw on stored energy during peak hours providing rates savings benefits. Solar vendors have an opportunity to expand their business model and apply their proven sales approach to a new value proposition offering Solar + services to new customers and revisiting former customers with Solar+ enhancements.

Stakeholders include: Solar companies with support from CCA, the county, cities, and associated agencies.

Introduction

The purpose of this report is to evaluate the status of the Sonoma County solar industry, review solar policy and market advancements, and assess how Sonoma County can maintain its leadership role in the emerging Integrated Distributed Energy Resource (IDER) future.

Since the first local solar systems enrolled in the California Public Utilities Commission's (CPUC) Net Energy Metering (NEM) program in 1999,⁹ the potential for local solar to provide affordable clean power has inspired government, nonprofit, business leaders, solar industry professionals, and individuals to collaborate on policies and programs to expedite its adoption.

Amid growing concern about the climate impacts of greenhouse gas (GHG) emissions, Sonoma County stakeholders have consistently recognized solar as a go-to solution capable of delivering not only clean power, but local investment and job creation as well.

Nearly 20 years and 95.6 MW later, Sonoma County's local solar industry has proven that solar power is a versatile, scalable, compatible, "plug and play" technology that provides a platform for building a local distributed clean energy system.

Resources

To inform its Sonoma County analysis, this report used the following data resources in addition to select reports and interviews:

- **NEM Currently Interconnected Data Set:** Solar systems currently connected to the grid within PG&E, Southern California Edison, and San Diego Gas and Electric utility territories
- **California Solar Initiative (CSI) Working Data Set:** Solar systems that received a solar incentive from Investor Owned Utility (IOU) CSI programs
- **Publicly Owned Utilities' SB1 Solar Program Status Reports:** Solar systems that received a solar incentive from Publicly Owned Utilities (POU)
- **National Renewable Energy Laboratory (NREL) Jobs and Economic Development Impact (JEDI) calculator:** Economic impact calculator using kW installed, project cost, percent of local spending, and year installed data to produce local spending and sales tax revenue estimates

Organization

The report begins with solar industry metrics providing a statistical profile of the local market. A summary of federal, state, and local solar policy is followed by a comprehensive review of current and upcoming solar and Integrated Distributed Energy Resource (IDER) policy initiatives. Finally, the report explores the opportunities and challenges posed by the technological and policy trend toward IDER and offers findings and recommendations.

⁹ Under the CPUC Net Energy Metering program a local solar system is connected to the electric grid and any excess energy flowing from the solar system to the grid is metered. The utility customer receives a retail-rate credit on his/her utility bill for the excess electricity supplied to the grid by the solar system. At the end of the year, the customer pays the utility only for electric they drew from the grid over-and-above the amount generated by the solar system.

Appendices offer solar project case studies, a review of Sonoma County–specific solar-related reports, and profiles of community partners.

This report uses the author-date reference system in which reference sources are identified with a text citation featuring the author name and publication date; for example, a text citation for the *2008 Sonoma County Community Climate Action Plan* published by the Center for Climate Protection (CCP) would appear as “(CCP 2008).” The reader can use the author name and publication date to locate full publication details and hyperlink in the References section.

Solar Industry Metrics

Within the 12 months of 2016, the national solar industry grew 97 percent, according to the Solar Energy Industries Association (SEIA 2017d), citing solar generation capacity from utility, commercial, and residential installations.

The utility solar sector accounted for 72 percent of the national and 75 percent of the California 2016 installed capacity, while distributed generation (i.e., residential and commercial projects) represented 28 and 25 percent respectively. In Sonoma County, utility-scale solar is one of several eligible renewable energy sources that electricity providers can use to satisfy the state Renewables Portfolio Standard (RPS), which calls for 50 percent renewable electricity capacity by 2030 (CEC 2017).

Sonoma Clean Power, the local (Sonoma and Mendocino County) Community Choice Agency (CCA), currently offers 42 percent RPS-eligible sources in its new default service, CleanStart (SCP 2017a), while the RPS ratio for Pacific Gas & Electric (PG&E) is 32.8 percent (PG&E 2016a).¹⁰ Distributed generation, also referred to as “behind the meter” (BTM) deployment, the primary subject of this report, is not an eligible renewable resource in the current RPS program.

However, technological advances, competitive pricing, market transformation programs, and climate action initiatives have put distributed energy resources — like small-scale BTM solar — at the center of state and local policy (CPUC 2016a).¹¹ In addition, developing local solar capacity delivers clean power and local economic and community benefits such as jobs and investment.

Local Industry Metrics

The state of solar energy in Sonoma County can be evaluated with key industry metrics including kW or MW of installed capacity, number of companies, and price per watt as well as local economic benefits such as jobs created and dollars invested. Table 1 provides national, state, and local industry metrics. Note: California is ranked No. 1 in the nation representing 34 percent of national solar capacity installed in 2016 (The Solar Foundation 2017a, 17).

Table 1: Solar Industry Metrics Comparison — 2016

2016	<i>MW Installed Non-Utility</i>	<i>Number of Companies</i>	<i>Price per Installed Watt</i>	<i>Jobs Created</i>
<i>National</i>	4,169 MW ^(g)	9,000 ^(f)	\$4.15/W _{DC} Res ^(d) \$3.70/W _{DC} Com ^(d)	260,000 ^(f)
<i>California</i>	1,262 MW ^(a)	2,459 ^(e)	\$4.40/W _{DC} Res ^(d) \$3.80/W _{DC} Com ^(d)	100,050 ^(e)
<i>Sonoma County</i>	13 MW ^(a)	45 Local ^(a) 98 Non-Local ^(a)	\$5.45/W _{DC} Res/Com ^(b)	3,487 ^(c)

Sources: (a) Net Energy Metering Currently Interconnected Data Set; (b) California Solar Initiative (CSI) Working Data Set; (c) The Solar Foundation State Solar Jobs Map— Sonoma County (The Solar Foundation 2017c); (d) LBNL Tracking the Sun IX 2016 (Barbose 2016, 29); (e) Solar Energy Industries Association, Solar Spotlight: California 2016 (SEIA 2017c); (f) Solar Energy Industries Association, Solar Industry Data 2017 (SEIA 2017b); (g) U.S. Solar Market Insight: 2016 Year in Review (SEIA 2017d)

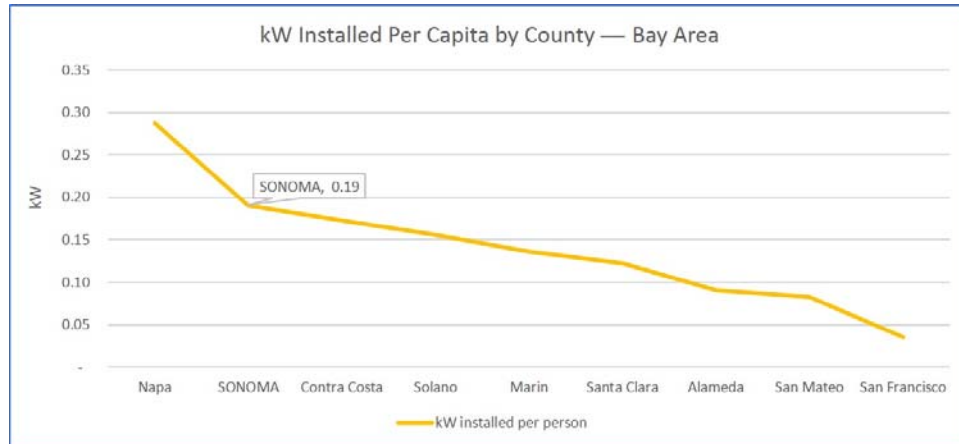
¹⁰ The Renewables Portfolio Standard includes a range of eligible renewable resources, such as wind, solar, biomass, and geothermal energy,

¹¹ Distributed energy resources are defined by the California Public Utilities Commission as “distribution-connected distributed generation resources, energy efficiency, energy storage, electric vehicles, and demand response technologies.”

Kilowatts Installed

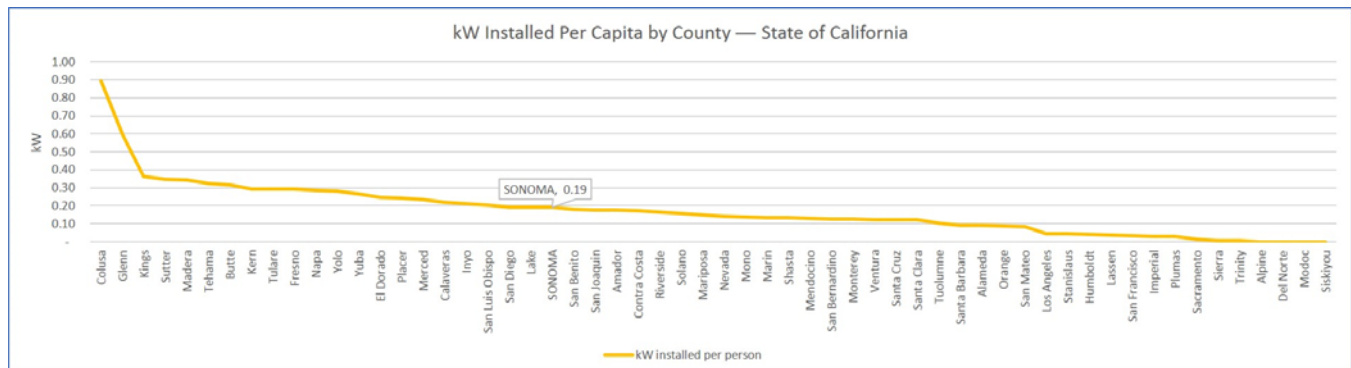
On a kW-installed per person basis, Sonoma County ranks second in the Bay Area, and 22nd among all 58 California counties as shown in Figures 1 and 2 below, with 0.19 kW installed per person.

Figure 1: KW Installed Per Capita — Bay Area



Sources: NEM Currently Interconnected Data Set / California Energy Commission; Publicly Owned Utilities Report Summary 1-1-2015 to 12-31-2015 (Solar Installations); U.S. Census population records.

Figure 2: KW Installed Per Capita — Statewide



Sources: NEM Currently Interconnected Data Set / California Energy Commission; Publicly Owned Utilities Report Summary 1-1-2015 to 12-31-2015 (Solar Installations); U.S. Census population records.

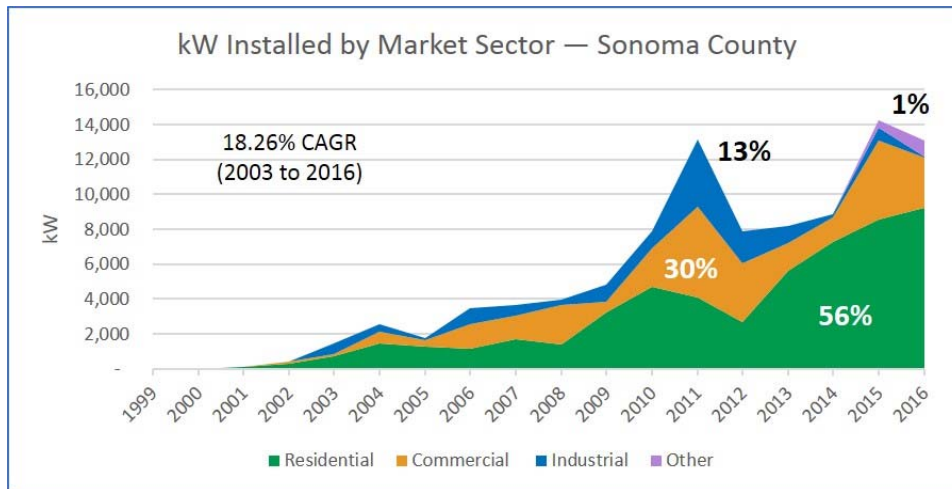
Sonoma County data from the NEM Currently Interconnected Data Set, which lists all behind-the-meter solar projects connected to the California electric grid, shows an 18.26 percent compound annual growth rate (CAGR) in kW installed from 2003 to 2016 across residential, commercial, industrial, and other (i.e., education, nonprofit, and government) projects as shown in Figure 3 below.¹²

Residential represents the largest sector with 56 percent of kW installed followed by commercial (30 percent), industrial (13 percent), and other (1 percent).

Note: In 2009, the first near 1-MW industrial system was installed and in 2011 two near 1-MW commercial systems were installed; in addition, 2011 also included 16 large commercial systems (≥ 150 kW), representing a 300 percent increase over the prior five-systems-per-year average.

¹² The 2003 to 2016 timeframe for calculating the CAGR was selected because 2003 is the first year Sonoma County's annual installed kW yielded a consistent volume above 1,000 kW per year.

Figure 3: kW Installed by Market Sector — Sonoma County



Source: NEM Currently Interconnected Data Set. "Other" sector includes projects identified in the data set as education, nonprofit, and government.

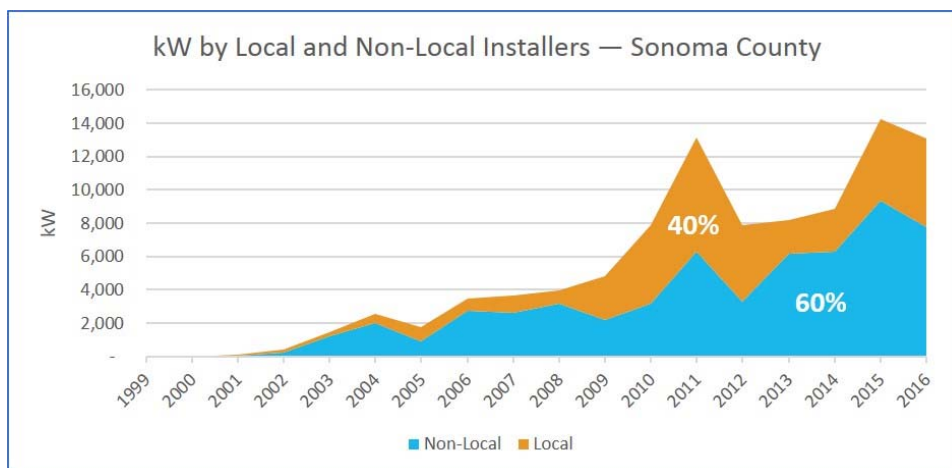
Number of Companies

As the local solar market has grown, the number of solar installation companies has steadily increased, as shown in Figures 4 and 5 below, even though some companies entered and exited the market as the demand for solar services matured.

Local companies installed 40 percent and non-local companies 60 percent of the cumulative distributed solar capacity. In 2016, there were 45 local installer companies working in the county and another 98 non-local installers ranging from small to regional to national vendors.

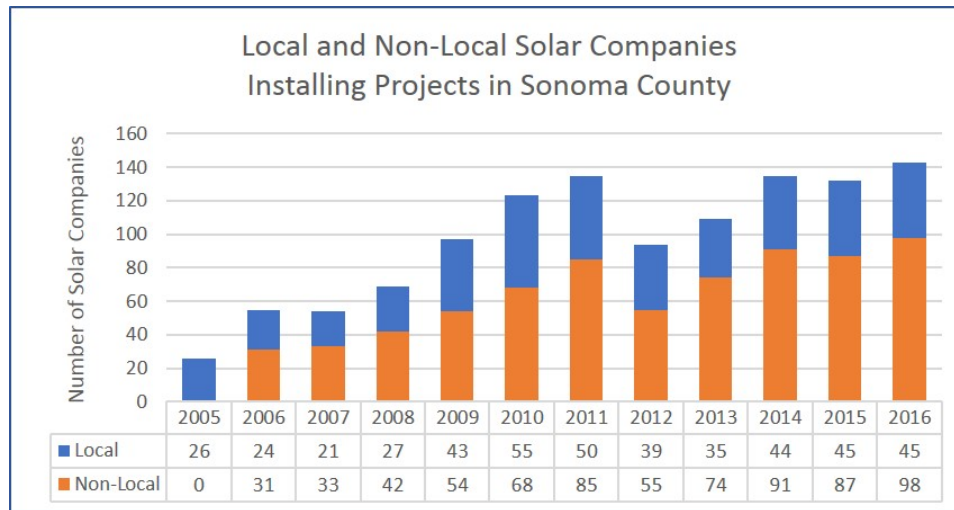
In addition, Sonoma County has six solar distributors, two solar-analysis equipment companies, and is world headquarters for Enphase, a global solar microinverter company.

Figure 4: kW Installed by Local and Non-Local Vendors — Sonoma County



Source: NEM Currently Interconnected Data Set.

Figure 5: Local and Non-Local Solar Installer Companies— Sonoma County

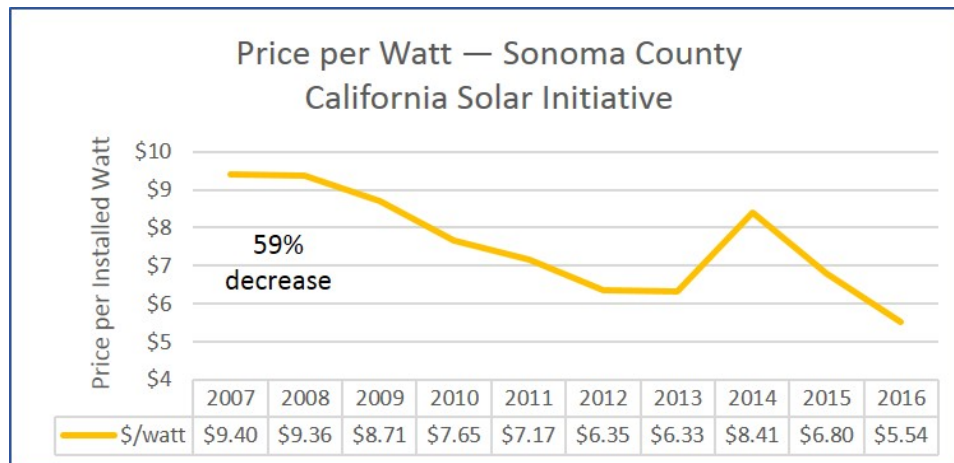


Source: Net Energy Metering Currently Interconnected Data Set.

Price per Watt

Sonoma County cost data (residential and non-residential projects) from the California Solar Initiative Working Data Set shows a 59 percent decrease in the cost per installed watt from \$9.40 per watt in 2007 to \$5.54 per watt in 2016 as shown in Figure 6 below.

Figure 6: Price per Watt — Sonoma County:



Source: California Solar Initiative Working Data Set.

The U.S. Department of Energy's SunShot Initiative funds programs to reduce the cost of residential, commercial, and utility-scale PV and concentrating solar technologies in order to achieve cost parity with conventional electricity sources.

According to the DOE's SunShot Initiative, 2016 prices per installed watt ranged as follows (DOE 2016b):

Table 2: DOE SunShot 2016 National Price/Watt Data

System Size	80th Percentile Price/W _{DC}	20th Percentile Price/W _{DC}
2.5W to 10W	\$5.63 (California)	\$2.97 (Arizona)
10W to 100W	\$5.04 (New York)	\$2.84 (Arizona)

The 2016 Lawrence Berkeley National Laboratory (LBNL) report *Tracking the Sun IX* cites average installed-watt prices as follows: \$4.40/W_{DC} California and \$4.20/W_{DC} national for residential and \$3.80/W_{DC} California and \$3.90/W_{DC} national for non-residential projects (Barbose 2016, 29).

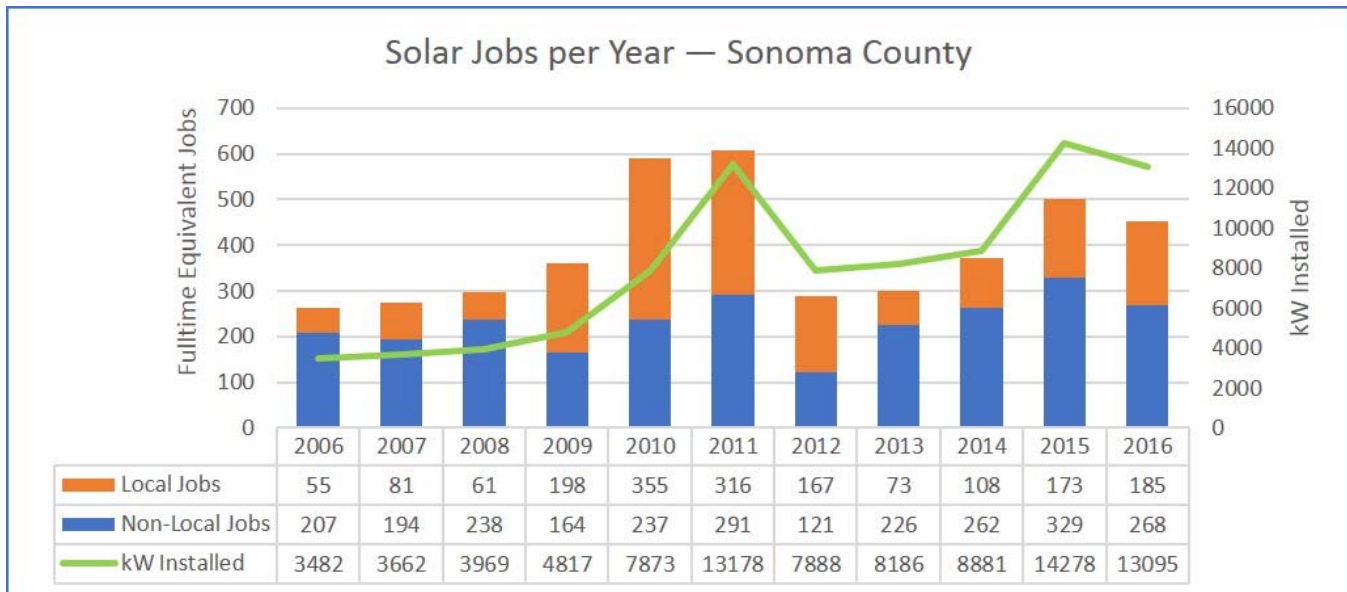
Jobs Created

In March 2017, The Solar Foundation, a nonprofit non-partisan organization, launched an interactive Solar Jobs Map that tracks state, metropolitan area, county, and congressional district data on solar jobs. The interactive State Solar Jobs Map (The Solar Foundation 2017b) provides searchable access to industry and jobs data obtained by the organization's annual National Solar Jobs Census that involves over 500,000 phone calls and 60,000 emails in direct communication with solar companies.

A review of the new resource by *Solar Industry Magazine* showed that the Santa Rosa–Petaluma metropolitan area ranked 13th in the nation for job growth reporting 3,476 jobs in 2016, a 44 percent increase in local solar jobs over 2015 (Bebon 2017).

The numbers provided in Figure 7 below were determined by applying a jobs-per-MW factor to installed MW data for Sonoma County obtained from the NEM Currently Interconnected Data Set. According to The Solar Foundation, "*jobs per MW* is a broad productivity measure depicted by the ratio between total installation related jobs in the Fall of a given year and total installed capacity (output) over that same year. Solar jobs are defined as those where someone spends at least 50 percent of their time in solar-related work. This measure also includes support jobs such as staff to obtain permits, order parts, and manage human resources" (The Solar Foundation 2016).

Figure 7: Estimated Solar Jobs — Sonoma County



Source: NEM Currently Interconnected Data Set, California Solar Initiative Working Data Set, Solar + Storage: A Discussion Paper (The Solar Foundation 2016).

Figure 7 does not include *indirect* jobs created in the supply chain or *induced* jobs created in the community as solar workers spend their earnings.

Dollars Invested

The National Renewable Energy Laboratory (NREL) Jobs and Economic Development Impact (JEDI) Photovoltaic model was used to estimate investment in the solar sector.¹³ JEDI is an input-output model that provides “reasonable estimates” for key economic indicators (NREL 2015) using project kW size and cost data. JEDI estimates were calculated for each year using kW size and cost data based on portfolios of solar projects.

The amount of local investment and sales tax revenue generated by solar systems installed from 2003 to 2016 was estimated in the JEDI model using residential, small commercial, and large commercial portfolios; average cost per kW installed by sector was derived from the Lawrence Berkeley National Laboratory and U.S. Department of Energy SunShot *Tracking the Sun* annual report series; and an average local sales tax of 1.25 percent, as presented in Table 3 below.

Project cost includes state and local sales tax. Local spending includes locally obtained labor, materials, equipment, permit costs, and overhead services. Local sales tax includes the 1.25 percent tax only.

Table 3: Local Economic Impacts

<i>Total Project Cost</i>	<i>Total Local Sales Tax Revenue</i>	<i>Total Local Spending</i>
\$498.5 Million	\$2.9 Million	\$189.7 Million

Source: JEDI analysis for Sonoma County solar installations 2003 to 2016.

¹³ JEDI is used by public and private entities to evaluate the economic impacts of new electricity generation projects.

Greenhouse Gas Emission Reductions

Greenhouse gas (GHG) emission reductions resulting from locally installed kW were estimated using annual kW installed totals and a California Air Resources Board GHG methodology that includes the current solar *capacity factor* (17.7 percent), and *efficiency factor* for the annual local electricity power mix, which includes Renewables Portfolio Standard clean energy sources (ARB 2008, I-31), as shown in Figure 8 below.

The capacity factor measures the predicted first-year generation capacity as a percentage of the total amount of electricity the system would generate if it operated on a 24-hour, 7-days a week basis at full equipment, or *nameplate*, capacity.

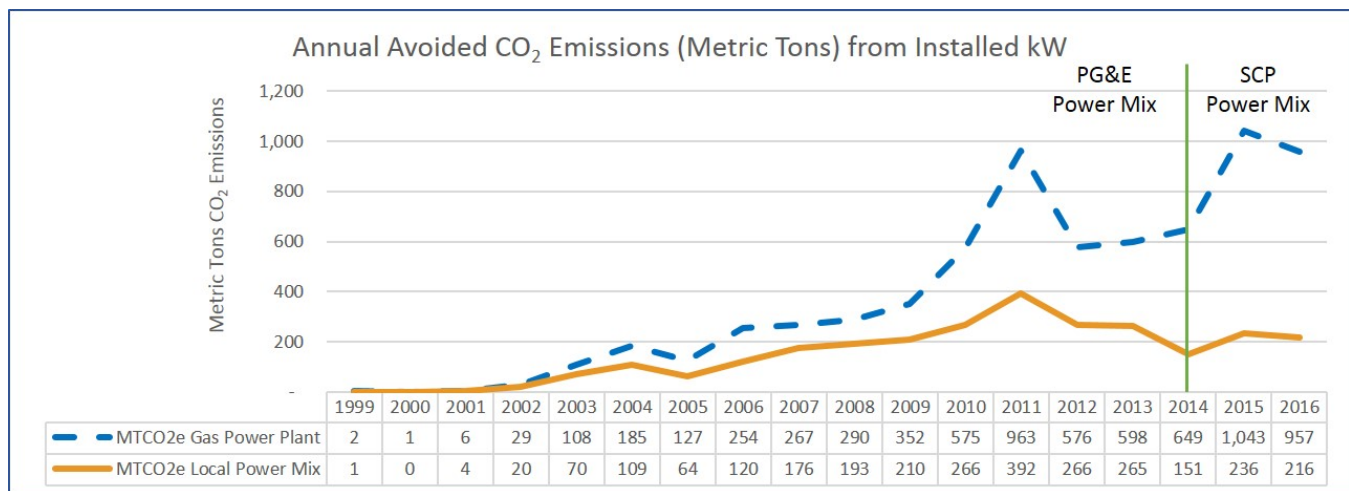
The power mix emissions factor measures how many pounds of CO₂ are emitted per MWh of electricity across an electricity provider's entire generation portfolio. Power mix emissions factors for the years 1999 to 2013, when PG&E was the primary electricity provider, were obtained from the *Greenhouse Gas Emissions Factors: Guidance for PG&E Customers* (PG&E 2015).

On May 1, 2014, Sonoma Clean Power (SCP) became the primary electricity provider in Sonoma County. On that day, the power mix emissions factor, which had been 427 pounds/CO₂ per MWh with PG&E, dropped 48 percent to 224 pounds CO₂ per MWh, as a result of a higher percentage of cleaner electricity resources in the SCP portfolio. In 2015, the SCP power mix emissions factor dropped again to 218, according to the 2016 SCP annual report (SCP 2016).

In Figure 8, the blue dotted line represents the GHG emissions avoided when installed solar kW are compared to generation from natural gas peak power plants only. The natural gas emissions factor (963 pounds/CO₂ per MWh) is used to estimate GHG emissions for electricity sources that are not part of the state's Renewables Portfolio Standard, providing a benchmark for evaluating GHG benefits.

The orange line represents the GHG emissions avoided when solar kW installed are compared to the electricity provider's power mix emissions factor. (Note: The amount of avoided CO₂ shown in Figure 8 changes from year to year with the total annual installed solar kW. In years when solar kW installed goes up, the avoided GHG emissions will also rise; in years when solar kW installed goes down, the annual avoided GHG emissions will drop. In addition, as the electricity provider's power mix reduces its carbon content, the avoided GHG emissions will per solar kW installed will be less.)

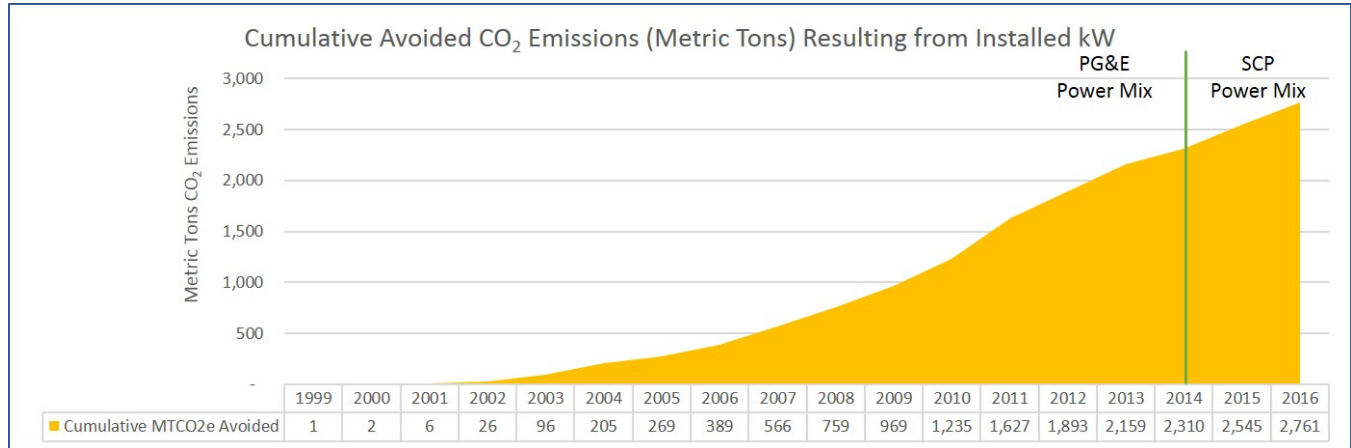
Figure 8: Annual Avoided CO₂ Emissions from Installed Solar kW



Source: NEM Currently Interconnected Data Set; California Air Resources Board, *Climate Change Scoping Plan 2008, Volume 2: Analysis and Documentation, Appendix I: Measure Documentation* (ARB 2008, Appendix I, I-31)

Over time as solar systems continue to operate, there is a cumulative increase in avoided GHG emissions. Figure 9 shows an estimate of that cumulative reduction; note Figure 9 has not been adjusted to account for decreases in solar system efficiency over time.

Figure 9: Cumulative Avoided CO₂ Emissions Resulting from Installed Solar kW



Source: NEM Currently Interconnected Data Set; California Air Resources Board, *Climate Change Scoping Plan 2008, Volume 2: Analysis and Documentation, Appendix I: Measure Documentation* (ARB 2008, Appendix I, I-31)

Policy Drivers

Federal

Solar technology first gained national interest as an energy resource in the 1970s because of two shocks to the global energy market: (1) The 1973 oil embargo in which the Organization of Arab Petroleum Exporting Countries reduced oil supply to the United States in response to the Israeli Yom Kippur War, resulting in a 400 percent increase in the price of oil (OTH 2017) and (2) a 7 percent drop in world supply in 1979 during the Iran Revolution (Graefe 2013).

Seen as a promising solution to address the increasing volatility of the global energy market, Congress passed a series of solar-related bills (1974–1978) that established key agencies to develop renewable energy sources (i.e., Department of Energy, National Renewable Energy Laboratory), allowed independent energy producers to interconnect with the local grid (Public Utility Regulatory Policy Act of 1978), launched the Million Solar Roofs Initiative (1997), and created the solar Investment Tax Credit (Energy Tax Act of 1978) for residential and commercial installations, which continues to this day (IER 2016).

In the early 2000s, as domestic oil production decreased and demand increased, Congress passed the Energy Policy Act of 2005, to address domestic energy production, including renewable energy and efficiency (EPA 2017), and the American Recovery and Reinvestment Act of 2009, providing subsidies and loan resources for the solar industry (IER 2016).

State

In 1978, the California legislature passed its first solar laws to protect consumer rights to solar technology and in 1980 amended the state constitution to exclude the value of a newly installed solar system from the property tax baseline.

Between 1996 and 2006, the California electricity market experienced an economic crisis due to demand outstripping supply (IER 2016) and other factors. The experiment in electricity deregulation that was initiated by Assembly Bill 1890 (1996)¹⁴ and that culminated in the electricity crisis of 2000–2001 laid the groundwork for the passage of Assembly Bill 117 (2002), the law that established Community Choice Aggregation in California.

During this same time, the state legislature pursued a series of initiatives to develop a “self-sustaining market for ‘emerging’ renewable energy technologies in distributed generation applications” (Go Solar 2017b). This included Net Energy Metering (NEM) incentives for grid-connected photovoltaic (PV) systems (1996), grant programs, a state solar tax credit (2001–2006), loan guarantee programs, the Renewables Portfolio Standard program (2002), and a 10-year Million Solar Roofs initiative. In 2006, Senate Bill 1 launched the California Solar Initiative (CSI) (2007–2016), an incentive program based on the metered performance of grid-connected solar systems (Go Solar 2017a), and Assembly Bill 32 established the Global Warming Solutions Act, a comprehensive greenhouse gas reduction initiative (Go Solar 2017b).

Subsequent California solar-related legislation included several updates to the property tax exclusion, which was extended to 2024; increases in the Renewables Portfolio Standard (now set at 50 percent by 2030); incentive programs for multi-family and single-family low income sectors; updates to the NEM program;

¹⁴ Assembly Bill 1980 text is available at: http://www.leginfo.ca.gov/pub/95-96/bill/asm/ab_1851-1900/ab_1890_bill_960924_chaptered.html

financing through Property Assessed Clean Energy assessments; local electricity services via Community Choice Agencies; and Assembly Bill 2188 requiring cities and counties to adopt an online streamlined solar project permitting process. In addition, the 2014 California Building Energy Efficiency Standard, Title 24, includes a “solar-ready roofs” requirement for new construction to ensure there is room to install solar at a later date.

Local

In May 2013, the City of Sebastopol became the second of only two jurisdictions in the nation to enact local solar requirements.¹⁵ Just two months after the City of Lancaster, California, adopted a solar zoning ordinance, Sebastopol took a different tack, establishing a new building code, the Mandatory Solar Photovoltaic Requirements Ordinance (15.72), with the stated purpose of reducing greenhouse gas emissions.

The Sebastopol ordinance applies to new commercial and residential buildings and to alterations, additions, and remodels of existing buildings, including existing residential buildings adding 75 percent-or-more square feet and commercial buildings adding 1,800 or more square feet or whose project involves demolition, repair, or remodel of more than 50 percent of the commercial structure (Schainblatt 2013).

The 2015 *Solar Building Standards* report published by the Green Energy Institute, praised the Sebastopol ordinance for the range of compliance options it offers developers and property owners. For residential, these include two solar system sizing options (2-watts per square foot or offset 75 percent of annual energy use). Commercial new construction developers may install community-scale solar to meet the aggregated requirements for the property. Properties with solar access challenges may receive conditional exceptions and contribute to the GHG goal with energy efficiency measures. Finally, compliance may be obtained with an in-lieu payment equivalent to 90 percent of the installed value of a compliant solar system (Lawton 2015).

In April 2016, the City of Santa Monica debuted a mandatory solar ordinance (Kaplow 2016) and in January 2017, the City of San Francisco’s Better Roofs ordinance went into effect requiring all new buildings 10-stories or less to install a solar system. State Senator Scott Wiener, who authored the San Francisco ordinance when he served on the San Francisco Board of Supervisors, is leading an effort to adopt the approach statewide (Spector 2017).

Following the 2005 adoption of a countywide greenhouse gas reduction target,¹⁶ local governments collaborated on a series of initiatives to guide local policy and outcomes.

The Regional Climate Protection Authority (RCPA) in collaboration with all ten local governments published the 2016 *Climate Action 2020 and Beyond* plan, which calls for requiring solar for new construction (Goal 2, L1 and L3); providing incentives to install solar on existing buildings (Goal 2, L2 and L4); and initiatives to encourage residents to switch from natural gas to renewable electricity via appliance replacement and electric vehicle adoption (Goal 7, R1 and L1) (RCPA 2016).

The Sonoma County Energy Independence Program (SCEIP) provides financing for solar PV, solar thermal space heating, and solar thermal domestic water and pool heating improvements (SCEIP 2015).

The Sonoma County Energy and Sustainability Division (ESD) serves as a clearinghouse for information on solar energy improvements, energy efficiency, and water conservation. ESD also provides free solar

¹⁵ The City of Santa Monica

¹⁶ Reduce local GHG emissions by 25 percent below 1990 levels by 2015.

consultations for residential and commercial projects;¹⁷ hosts Home Energy Workshops providing education on energy efficiency, water conservation, and solar PV systems; and facilitates the streamlined solar permitting program for solar systems ≤ 10 kW in size (ESD 2017).

In 2013, the County of Sonoma adopted Ordinance 6046 updating the county's zoning code for renewable energy uses and special use standards; adding a new Renewable Energy Combining District for large-scale renewable energy facilities (e.g., geothermal, solar thermal, solar PV, bioenergy, and wind); and providing renewable energy project incentives in the form of density bonuses and reducing parking requirements "by ten (10) percent when at least ten (10) percent of the total spaces are provided as covered by solar panels" (County of Sonoma 2013a, 2013b).

The Sonoma County Water Agency (SCWA) launched its Carbon Free Water initiative in 2006 to achieve a carbon-free water system by 2015 by decreasing energy use and increasing renewable energy sources, in alignment with the countywide GHG target. SCWA met its goal, announcing carbon neutral status in 2015 and demonstrating a replicable model for other water utilities (SCWA 2017a).

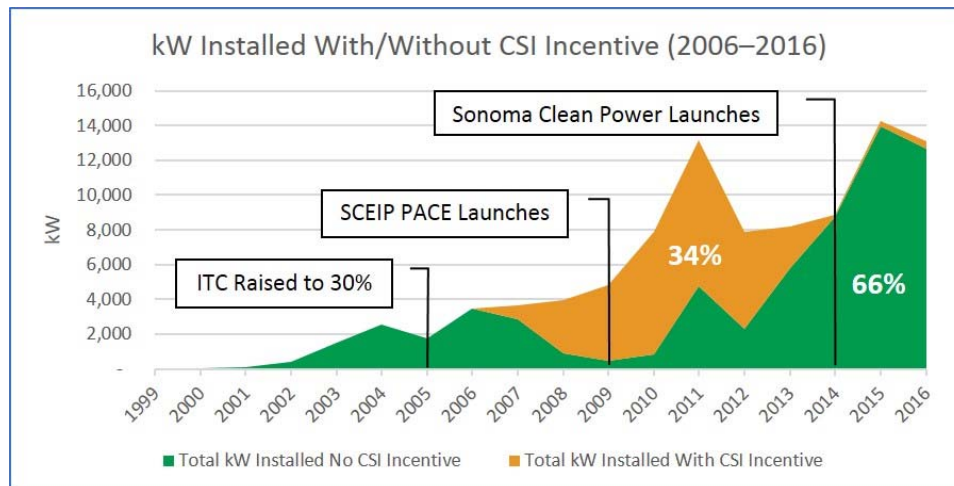
Key Policies

Key state and federal policies driving the exponential growth in California distributed solar generation are:

- Investment Tax Credit (1978 to Present)
- Net Energy Metering (1996 to Present)
- Community Choice Aggregation (CCA) (2002 to Present)
- California Solar Initiative (2007–2016)
- Property Assessed Clean Energy (PACE) financing (2009 to Present)

As the federal ITC and state California Solar Initiative and PACE resources entered the market, the local solar industry experienced a market transformation effect and steady growth in the residential and commercial sectors as shown in Figure 10 below. Since Sonoma Clean Power began operations in 2014, there has been a 3.74 percent increase in installed kW over the projected compound annual growth rate.

Figure 10: Solar Policy Impact on Sonoma County Market



Source: Net Energy Metering Currently Interconnected Data Set.

¹⁷ The Sonoma County Energy and Sustainability Division solar consultations are available at the beginning of the project planning to learn the basics of solar or during the project evaluation process and include assistance with comparing equipment and costs between proposals, and evaluating terms for multiple financing options (ESD 2017).

Local solar vendors credit the California Solar Initiative (CSI) as a major driver for the growth of Sonoma County's solar market.

According to the 2016 *California Solar Initiative Annual Program Assessment*, "the market for solar generating equipment in California has grown at a rapid pace since the beginning of the CSI program. Through increasing annual rates of new solar installations and cumulative installed capacity over the life of the program, California has already installed enough solar capacity to achieve the CSI General Market Program goal" (CPUC 2016c).

As a ratepayer-funded market transformation program administered by the California Public Utilities Commission (Go Solar 2017a), CSI is designed to produce "significant drops in equipment prices" to support solar market growth (CPUC 2017a). CSI based its incentives on system performance in order to produce maximum results and uses a gradual incentive step-down approach to promote solar PV and solar thermal projects and supports research to improve solar technologies.

The CSI program includes four offers:

- CSI General Solar Market provided incentives for residential and non-residential PV projects ranging in size from 1 kW to 1 MW. The CSI GM program ran from 2007 to 2016 with the goal to install 1,750 MWs of new capacity.
- CSI Single-family Affordable Solar Homes (SASH) provides incentives to qualified low-income households, and includes a job training component.
- CSI Multi-family Affordable Solar Housing (MASH) provides incentives to multifamily low-income housing facilities and a Virtual Net Energy Metering (VNEM) tariff that enables building owners to share bill credits with their tenants.
- CSI New Solar Homes Partnership (NSHP) provides incentives to home builders who build new residential housing featuring solar systems and energy efficiency measures.
- CSI Thermal provides incentives for three subprograms: Single family residential, multifamily/commercial, and solar pool heating. The CSI Thermal program promotes installation of solar thermal technologies that replace natural gas or electric water heating equipment. The program runs from 2010 to 2017 with the goal to install 200,000 solar thermal systems.

Community Drivers

The local solar industry has benefited from a 16-year tradition of community and solar vendor advocacy; a proactive and collaborative countywide culture mobilizing climate change solutions that feature renewable energy technologies like solar; innovative local government initiatives for financing, climate change, and local electricity services; and a series of market analysis reports that provide a range of perspectives and locally-based solution options designed to increase local clean energy resources.

For more details, see Appendix B: Solar-Related Sonoma County Studies and Appendix C: Community Partners.

Solar Advocacy

Local solar vendors and government agencies first joined forces in 2002 founding the nonprofit Solar Sebastopol, which set solar installation goals and promoted local solar installation and consumer education.

In 2008, the group received a grant from the Bay Area Air Quality Management District to partner with the City of Santa Rosa and expand to include the entire county under the banner of Solar Sonoma County. A recipient of a U.S. Department of Energy Solar America Cities grant, Solar Sonoma County led a number of solar initiatives including the Clean Energy Advocate program for consumer education; a solar contractor quality assurance program; a countywide streamlined permitting and building code effort to reduce soft costs; joint training events for solar installers and building officials; community education events such as the Solar Fair; and advocacy for renewable energy programs such as the Sonoma County Energy Independence Program providing Property Assessed Clean Energy (PACE) financing for solar, efficiency, and water conservation projects. Additionally, Solar Sonoma County published the 2010 *Sonoma County Solar Implementation Plan*, outlining a series of opportunities within the jurisdictions of local governments to expedite solar adoption.

Solar Sonoma County set a target to install 25 MW of new solar capacity by 2011, achieving a total of 29.8 MW. The nonprofit membership organization received the 2011 DOE Steel on the Roof award for the most solar installed per capita in the nation from among the 25 Solar America Cities grant recipients.

In 2015, Solar Sonoma County decided to come under the umbrella of the Center for Climate Protection as a program. With this structure, it continues to provide member services, Clean Energy Advocate support for property owners, and the Qualified Vendor program.

Countywide Collaboration

In 2001, the nonprofit Center for Climate Protection (CCP) launched a local Cities for Climate Protection initiative based on the ICLEI — Local Governments for Sustainability program. CCP sought countywide participation among all ten local governments, as well as businesses, schools, and the community at large. A collaboration between CCP and local governments led to a series of steps including conducting inventories of greenhouse gas emissions for local jurisdictions; setting a countywide GHG reduction target; developing a countywide *Community Climate Action Plan* (CCP 2008); and advocating for a series of precedent-setting innovations including the founding of the Sonoma County Energy Independence Program (SCEIP), Regional Climate Protection Authority (RCPA), and local Community Choice Agency, Sonoma Clean Power.

The County of Sonoma, its cities, and associated agencies, such as the Sonoma County Water Agency (SCWA) and Regional Climate Protection Authority, have long been committed to the countywide approach, devoting funding and planning resources to pursue local renewable energy projects and GHG-reduction goals.

For example, the SCWA set and met a goal to have a Carbon Free Water system by 2015 that includes three solar installations providing nearly 2 MW of power (see Appendix A: Sonoma County Case Studies); provided \$150,000 in funding and facilitated a 2011 feasibility study and steering committee process to form the Sonoma Clean Power CCA joint powers authority in 2014; and provided \$15 million to the initial PACE fund for the Sonoma County Energy Independence Program.

These community partners developed two climate action plans: 2008 *Sonoma County Community Climate Action Plan* published by the Center for Climate Protection, which provided a science-based roadmap for local climate protection initiatives and priorities, and the subsequent 2016 *Climate Action 2020 and Beyond* climate plan published by the Regional Climate Protection Authority, which established a California Environmental Quality Act–compliant analysis and action framework for local government climate planning.

Climate Action Champions

Over the past 16 years, Sonoma County public and private stakeholders have established a culture of collaboration that has garnered national recognition. In 2014, Sonoma County was one of 16 communities recognized as Climate Action Champions for Leadership on Climate Change by the Obama White House for communities that “have considered their climate vulnerabilities and taken decisive action to cut carbon pollution and build resilience” (White House 2014).

Sonoma Clean Power

On May 1, 2014, Sonoma Clean Power (SCP) started serving most Sonoma County business and residential customers with clean and cost-competitive electricity.

As the most powerful, cost-effective climate protection strategy under local control, Sonoma Clean Power expedites the shift to clean energy resources through the purchase of electricity from cleaner renewable sources and promotion of local renewable energy deployment. SCP offers two solar programs:

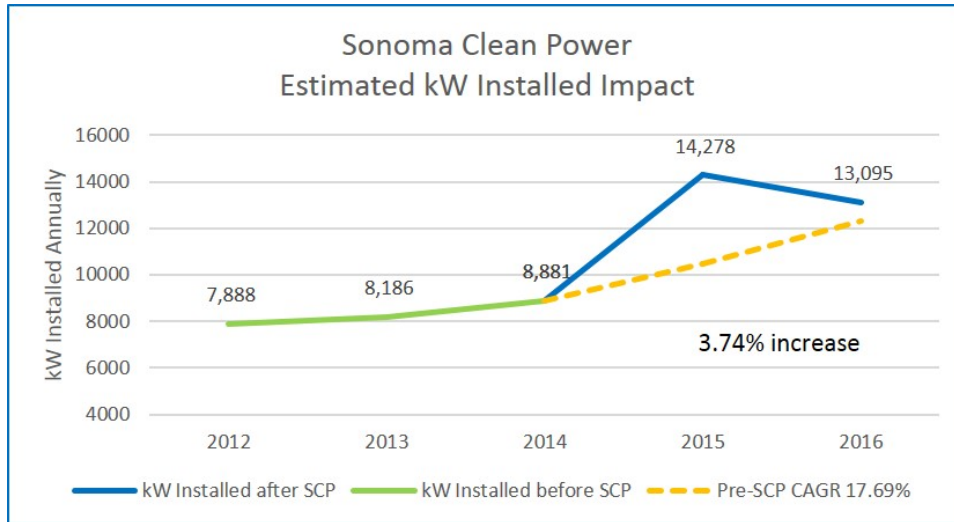
- **NetGreen:** SCP’s net energy metering program measures how much electricity is generated by the customer’s solar system and how much grid electricity the customer used to determine a monthly net production or consumption. SCP pays the retail kWh price plus 1-cent for net electricity production, which is tallied on an annual basis (SCP 2017d).
- **ProFIT:** A Feed-in-Tariff program for wholesale solar production, ProFIT offers small-scale solar producers a standard-offer (9.5-cents per kWh base) contract to provide solar power over a 10- or 20-year period. Qualifying projects may apply for additional bonuses for the first five (5) years on the contract for certain desired project attributes. Solar projects must be new, less than 1 MW, located in SCP territory, be compliant with the California Renewables Portfolio Standard, be part of the PG&E Wholesale Distribution Tariff, be legally permitted, and willing to sign a standard, non-negotiable, long-term contract (SCP 2017c).

Since 2014, the NetGreen program has provided a local premium to new net-energy-metering customers and the ProFIT program has contracted for five local, near 1-MW solar systems, all of which are currently in the development phase. Since SCP began operations, local kW installed has increased 3.74 percent over the historical pre-SCP compound annual growth rate, as shown in Figure 11 below.

In addition to the two programs noted above, SCP also engages with counterparties on unique bilateral contracts for local or remote solar in contractual arrangements that do not necessarily fit into the program parameters of the standard NEM or ProFIT programs. An example would be the “floating solar” projects currently in development with both SCWA and with private agricultural property owners in Sonoma County.

Note: 2015 showed a spike in kW installed mostly likely due to market concerns about pending decisions at the state level regarding continuation of the retail-rate tariff for the NEM 2.0 program¹⁸ and at the federal level regarding extending the Investment Tax Credit.¹⁹

Figure 11: Sonoma Clean Power Estimated Impact on Solar Adoption



Source: Net Energy Metering Currently Interconnected Data Set.

For more details about Sonoma Clean Power, see Appendix C: Community Partners.

¹⁸ On January 26, 2017, the California Public Utilities Commission approved NEM 2.0, which retains the retail-rate but also integrates a Time-of-Use (TOU) rate structure “that charges different prices during different times of the day, to better match real-time costs of generating and transmitting energy across the grid at large” (St. John 2016).

¹⁹ The 2015 Omnibus Appropriations Act included an extension of the residential and commercial ITC through 2023 (SEIA 2017a).

Industry and Policy Trends

Market Growth

Within the 12 months of 2016, the national solar industry grew 97 percent, according to the *U.S. Solar Market Insight: 2016 Year in Review* (SEIA 2017d), because of solar generation capacity from utility, commercial, and residential installations.

The utility-scale solar sector accounted for 72 percent of the national and 75 percent of the California 2016 installed capacity, while distributed generation (i.e., residential and small- to mid-scale commercial projects) represented 28 and 25 percent respectively. Currently California leads the nation in solar installations with more than 17,000 solar installations. Nationally, solar represented 39 percent of new capacity in 2016, more than wind or natural gas (SEIA 2017d).

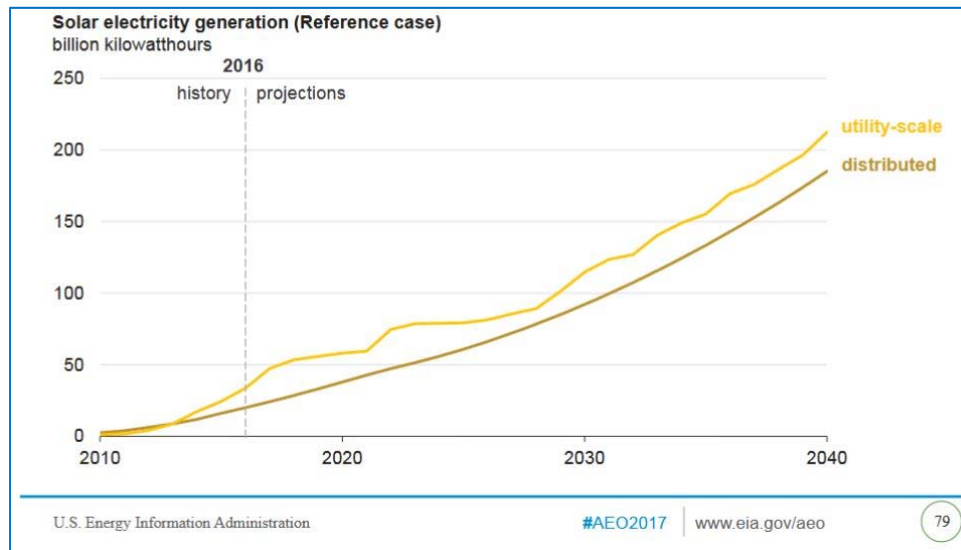
In addition, California's Community Choice Agency (CCA) programs are slated to add as much as 3 GW of wholesale offsite solar by 2020, according to Utility Dive (Trabish 2017).

Community solar projects provide electricity and financial benefits for multiple community members serving renters; properties not suited to onsite solar; and others who, for financial or other reasons, are not able to install an onsite solar system (DOE 2012). Nationally, community solar projects are expected to add more than 200 MW in 2017 as pipeline projects move forward resulting from improvements in regulations; Utility Dive notes that utilities generally seem to view community solar as an effective customer engagement tool that serves all income levels while diminishing the trend toward installation of rooftop solar (Trabish 2017).

According to the U.S. Energy Information Administration's (EIA) *Annual Energy Outlook 2017* report, national utility-scale solar industry is predicted to grow 44 percent between 2016 and 2018, as shown in Figure 12 below, while the California solar industry is on track for a steady 5 percent compound annual growth rate over the next 35 years as a result of declining capital costs, better performance, and tax credit programs (EIA 2017).

Note: Since it first started projecting the growth of utility-scale renewables such as solar and wind, the EIA has underestimated the performance of these power sources. Additionally, according to *PV Magazine*, the EIA has only recently begun to include distributed solar capacity in its calculations. Capacity figures provided by GTM Research, a reliable industry research group, have routinely shown greater industry performance than EIA projections (Roselund 2017).

Figure 12: Projected National Solar Industry Growth through 2040



Source: U.S. Energy Information Administration (EIA 2017).

Market Transformation Policies

Policies supporting growth include market transformation programs such as the federal Investment Tax Credit (extended through 2023), though it may be subject to review in the forthcoming comprehensive tax reform bill, and the California Solar Initiative for Thermal Solar, scheduled to sunset at the end of 2017 pending passage of Assembly Bill 2460, which would extend the program to 2022 (CALSEIA 2017c).

Another significant growth factor is the availability of a variety of financing options including power purchase agreements, solar leases, PACE assessments, and unsecured solar home loans.

Installed Costs

The DOE SunShot Initiative reports that from 1998 to 2015, the median price per installed watt has declined by 6 to 12 percent each year depending on the customer sector. Despite an acceleration in lower costs beginning in 2009, attributed to dropping global module prices, since 2014 the reduction in dollar-per-watt installed has slowed; reasons cited include origination fees association with loan products, increased use of module-level power electronics, and the impact of high-priced markets such as California (Barbose 2016).

The report goes on to note that during the same period, modules and non-module components (referred to as “balance of system” components including inverters, racking, wiring, conduit, shut-off switches, electrical panels) represented 53 percent and 47 percent respectively of the drop in the installed price in the residential sector. In addition, a 16.1 to 16.7 percent increase in module efficiency has led to larger residential system sizes, which contributes to additional reductions in non-module costs (20 percent from inverter/racking equipment and 80 percent from soft costs). Soft costs include marketing and customer acquisition, system design, installation labor, permitting and inspection costs, and installer margins (Barbose 2016).

Soft Cost Reduction Policies

The California Solar Energy Industries Association (CALSEIA) cites inefficient local permitting, utility interconnection barriers, solar-prohibitive homeowner association policies, and a slow solar salesperson licensing process as key challenges for lowering soft costs.

Passed in 2014, Assembly Bill 2188 “requires local governments to create an expedited permitting process by September 31, 2015, that includes electronic submittal of applications and only one inspection. It requires all jurisdictions to align their streamlined permitting processes with the *California Solar Permitting Guidebook* published by the Office of Governor Brown” (CALSEIA 2017b). The bill also includes protocols for homeowner association impacts on solar installations and cost. To-date, the County of Sonoma and City of Cotati have adopted the Assembly Bill 2188 protocols.

Working with the California State Licensing Board, CALSEIA facilitated the passage of Senate Bill 561 (2015) that shortens the timeline and simplifies the process for qualifying for a Home Improvement Salesperson license.

CALSEIA Policy Director Brad Heavner noted that local government partners are uniquely positioned to help reduce soft costs by implementing streamlined permitting (especially for complex commercial solar projects) and on-bill repayment programs targeted to solar and related storage and electric vehicle technologies that offer grid management features.

Financing Options

Tax credit policies designed to promote solar market transformation have shaped financing strategies providing early advantages but also leading to complex financing structures designed to monetize tax benefits. Developed in response to the federal Investment Tax Credit program, the tax-equity approach has fostered third-party ownership (TPO) options for residential and non-residential solar projects, including power purchase agreements (PPAs) and solar leases, that represented 75 percent of the residential financing market in 2012 (SEIA 2012).

Concurrently, Property Assessed Clean Energy (PACE) assessment programs have proliferated, initially in the commercial sector, and since 2016 in the national residential sector after the U.S. Department of Housing and Urban Development (HUD) approved residential PACE (with a short list of conditions) for use with Federal Housing Administration (FHA) mortgage programs (HUD 2016). The County of Sonoma has provided residential PACE since the Sonoma County Energy Independence Program launched in 2009, while taking a lead role in legal actions to obtain HUD approval for residential PACE assessments.

In addition, the FHA offers solar financing through the PowerSaver program (first mortgage rehab, second mortgage) up to \$25,000 (DOE 2014).

A recent Utility Dive solar industry analysis cited a shift in residential solar financing from TPO agreements toward loan and cash purchases driven by small local solar companies whose kitchen-table sales experience indicates system purchases offer their customers more financial advantages. This trend has led to a rise in solar-specific lender companies that work with the full range of solar install companies; these lenders include Mosaic, EnerBank, DividendSolar, Sungage, Green Sky, and Blue Wave.

In addition to TPO, PACE, and solar lender options, residential solar projects may also obtain home equity and solar loans offered by local banks. According to Utility Dive, solar loan products are being developed by utilities in Texas, Colorado, and New Jersey (Trabish 2017). They are also offered by local banks and credit unions, including in Sonoma County.

Another factor affecting financing is the future of the Investment Tax Credit. Citing the eventual end of the tax credit and the exponential growth of the solar market, the DOE SunShot program predicts the development of simpler solar financing structures that can access a wider variety of lower-cost capital sources. “From a financing perspective, utility-scale solar could look much more like conventional generation assets, non-residential solar could look much like other capital improvements such as a new roof or an efficiency upgrade, and residential solar could look much like an expensive appliance” (Feldman 2016).

Smart Grid Modernization

With the passage of the Energy Independence and Security Act of 2007, Title XIII, the federal government committed to implementing “Smart Grid advancements [that] will apply digital technologies to the grid, and enable real-time coordination of information from generation supply resources, demand resources, and distributed energy resources (DER)” (FERC 2016) — and create, in effect, a kind of digital nervous system capable of managing the exponential growth of distributed generation sources such as solar and storage.

To that end, DOE launched the Grid Modernization Initiative (GMI) to “frame new architecture elements, develop new planning and operations tools platforms, provide metrics and analytics, and enhance state and industry capabilities in designing the physical and regulatory models for successfully grid modernization” (DOE 2017).

In 2008, the California Public Utilities Commission (CPUC) initiated rulemaking R.08-12-009, to consider Smart Grid issues and DER integration and, in 2009, Senate Bill 17 added statutory requirements for Smart Grid development (CPUC 2016b). By 2011, the California Energy Commission published its Smart Grid roadmap featuring “integrated communications [that] will enable this smart power grid to continuously send, receive, and process data on system conditions, component health and power flows, as well as pass information among intelligent electronic devices, generators, independent system operators, marketers, and consumers — and allow for the integration of increased levels of renewable generation resources, accommodate increased loads associated with electric vehicle transportation, and provide increased protection from cyber security attacks and customer privacy concerns” (CEC 2011), in accordance with state climate protection goals.

Both the federal and state initiatives reflect the rise of the Internet of Things (IoT),²⁰ a cloud-based platform composed of increasing numbers of Wi-Fi-enabled devices reporting data in real time to inform big data analytics and systems communications.

Key to grid modernization is *smart meter* technology, also known as Advanced Metering Infrastructure (AMI), which consists of onsite digital utility meters that “measure and record electricity usage data hourly, or more frequently, and allow for two-way communication between the electric companies and their customers.” This technology supports Time-of-Use rates that reflect the cost to deliver electricity during high, medium, and low demand periods throughout the day, and provides a data communications framework to support distributed solar and other DER deployment.

Despite public controversy over the safety of the Wi-Fi meter technology, smart meters have been deployed in over 50 percent of U.S. households, including 5,209,000 in the PG&E utility territory (Cooper 2016).

²⁰ “The Internet of Things is a suite of technologies and associated business processes that imbues devices of all types with an ability to communicate information about their status to other systems, creating the opportunity to evaluate and act on this new source of information” (DUP 2016).

Wholesale Distributed Generation

While California's Distributed Energy Resources Roadmap (see below) includes wholesale markets for aggregated grid resources like energy storage and demand response, wholesale generation provides an opportunity for locally sited, commercial-scale solar deployment.

Distributed generation locates grid-connected solar, or wind, installations near demand centers, bypassing the transmission system entirely. Consisting of larger systems (1 MW to 5 MW), distributed generation serves local load, avoids line losses from long-distance transmission, can be deployed more quickly than utility-scale generation, and gives local stakeholders an opportunity to enter the energy industry as a clean energy provider (Clean Coalition 2017c).

A global solar leader, Germany used a Feed-in-Tariff to enable distributed solar systems to connect to the grid under a long-term, standardized, guaranteed contract to sell electricity to the utility at a fixed rate, while streamlining its procurement and interconnection processes. Since 2000, Germany has contracted for 38 GW of distributed solar PV, giving it the most solar capacity in the world.

Distributed Energy Resources

Climate change goals set forth in Senate Bill 350;²¹ flexible, efficient, and price competitive renewable energy generation; measurable energy efficiency; and smart technology capable of coordinating multiple grid resources have set the stage for a transformation of the electricity system through the deployment of distributed energy resources (DER).

The 2016 *California Distributed Energy Resources Action Plan: Aligning Vision and Action* defines DER as “distribution connected distributed generation resources, energy efficiency, energy storage, electric vehicles, and demand response technologies.”

The net societal benefits of effective DER deployment in California could be as high as \$1.4 billion annually by 2020, according to *A Pathway to the Distributed Grid* white paper (SolarCity 2016).

The state DER Action Plan was developed to: (1) provide a long-term vision for DER; (2) identify continuing efforts; (3) assess and direct needed near-term actions; (4) establish a DER steering committee; and (5) coordinate multiple CPUC rulemaking proceedings with a focus on strategies that provide grid operator control and target locational value within the grid system (CPUC 2016a).

DER Deployment Policies

Informed by the CPUC's Integrated Resource Plan proceeding (R.16-02-007), the DER action plan addresses rates and tariffs; distribution planning, infrastructure, interconnection, and procurement; and wholesale DER market integration and interconnection.

Rates and Tariffs

Current CPUC proceedings affecting DER rates and tariffs include: Time-of-Use (R.15-12-012) rates; Residential Rate Design (R.12-06-013); General Rate Case Phase 2 and Rate Design Window; and Net Energy Metering successor (R.14-07-002).

²¹ Senate Bill 350 establishes a GHG target of 40 percent below 1990 levels by 2030, mandates that 50 percent of electricity be obtained from renewable sources by 2030, doubles the targets for energy efficiency, and encourages widespread electrification of the transportation system.

Distribution Planning

The goal is a transparent, seamless planning and sourcing process for DER deployment including utility or affiliate ownership of DERs to achieve state goals. Current CPUC proceedings affecting DER distribution grid needs include:

- Distribution Resource Plans (DRP) (R.14-08-013) including DRP pilots to determine integrated capacity and locational net benefit analysis methods;
- Integrated Distributed Energy Resources (IDER) (R.14-10-003) including competitive solicitation and DER valuation frameworks;
- Rule 21 Interconnection (R.11-09-011) including evaluating interconnection reforms and pilots for cost certainty and data collection performance. This proceeding has closed but the CPUC is expected to open a similar proceeding very soon.
- Energy Efficiency (R.13-11-005) including targeting congested grid circuits to defer upgrades and metering of efficiency performance.

Wholesale Distributed Energy Resources

The goal is greater visibility, dispatchability, and profitability of DERs in wholesale grid operations. Current CPUC proceedings affecting wholesale DER opportunities include: Storage (R.15-03-011) and Demand Response (R.13-09-011).

Residential Rate Design

Assembly Bill 327 (2013) initiated revisions of residential rate policy that are affecting the solar market. In its 2015 decision, the CPUC noted the rate reforms are intended to optimize the Advanced Metering Infrastructure (AMI), or smart meter, system. The CPUC called for a narrowing, or flattening, of existing residential usage tiers; consideration of fixed charges; and the eventual adoption of TOU rates as enabled by smart meters (CPUC 2015b). These rate reforms were undertaken in part to lower air conditioning costs for families living in areas with high summer temperatures and to address the impact of DER on Investor Owned Utility (IOU) business model.

These rate design changes pose challenges for the residential solar industry as a result of the consolidation of electricity tiers from four to two, which lowers the per kilowatt-hour (kWh) retail rate, and the adoption of Time-of-Use (TOU) rates for residential accounts, which will affect the value proposition for Net Energy Metering customers depending on which hours are selected for the TOU rate.

TOU rates “create a direct linkage between the cost of generating electricity and the prices customers pay,” according to Greentech Media (St. John 2015). The IOUs will conduct TOUs pilots and residential TOU rates are expected to become the default rate option for residential customers by 2019 (St. John 2015).

The CPUC did opt to use a minimum bill approach over a fixed charge, which GTM Research has determined has less impact on NEM customers.

Net Energy Metering

California's Net Energy Metering (NEM) program began as a metering/billing arrangement that allowed utility customers with ≤ 1 MW solar systems to receive retail-rate credit for any net surplus of electricity their system feeds into the grid over one year's time. Established in 1995, the original NEM program was a key resource to promote customer investment in grid-connected distributed energy generation systems; within the three large Investor Owned Utility (IOU) territories, more than 90 percent of solar PV systems are enrolled in the NEM tariff. Each IOU is required to accommodate up to 5 percent of its aggregate customer peak demand through July 1, 2017 (CPUC 2017e).

Launched in 2011, the Virtual Net Energy Metering (VNEM) program enables multi-meter property owners to allocate a solar system's energy credits to tenants. Developed through the Multi-family Affordable Solar Housing (MASH) program, VNEM uses a generation meter to monitor the amount of total solar generation and allocates a percentage of the solar energy credit based on the metered electricity consumption of each unit and common area, as predetermined by the building owner or manager. VNEM is also available for multi-meter properties that do not participate in MASH.

Launched in 2014, the Net Energy Metering Aggregation (NEM-A) program allows a single customer with multiple meters on the same property, or on adjacent or contiguous properties, to use a solar photovoltaic system to serve the aggregated load behind all eligible meters. Originally developed to serve the agricultural sector, NEM-A customers are not eligible to receive compensation for net surplus energy fed into the grid, only net usage (PG&E 2017).

In July 2014, the CPUC also opened Rulemaking 14-07-002 to develop a successor to existing NEM tariff (CPUC 2017f)

NEM 2.0 Policies

On January 26, 2017, the CPUC adopted a NEM Successor Tariff (known as NEM 2.0), which continues the existing retail-rate based NEM design while incorporating some changes to "align the costs of NEM successor customers more closely with those of non-NEM customers" (CPUC 2015a). These changes include:

- **One-time interconnection fee:** Previously NEM customers were exempt from paying interconnection application fees. The IOUs now have fees of \$75 for SCE, \$132 for SDG&E, and \$145 for PG&E.
- **Non-bypassable charges:** For each kilowatt-hour NEM 2.0 customers draw from the grid, they will pay a 2- to 3-cent per kWh fee to fund low-income and energy efficiency programs equivalent to the public purpose program charge non-NEM customers pay. Previously, NEM customers paid these fees on monthly net consumption; they now pay based on all electricity consumed from the grid.
- **Time-of-Use (TOU) Rate:** NEM 2.0 customers will be required to be on a TOU rate, including residential customers affected by the Residential Rate Design proceeding (R.12-06-013), to align customer use with grid conditions. Rates will be higher during hours of peak demand and lower when demand drops.

Because of these changes, NEM 2.0 customers will likely pay a \$5 to \$10/month public purpose program fee and residential customers moving to a TOU rate could experience a similar drop in monthly NEM credit, according to CALSEIA. Other NEM-related factors affecting the solar market are the final selection of "peak hours" for the TOU rate structure and grandfather protocols for current projects.

Distribution Resources Plan Proceeding

In the Distribution Resources Plan (DRP) proceeding (R.14-08-013), IOUs were required to file proposals to develop methodologies for identifying optimal locations for DER deployment by July 1, 2015.

Track 1 of the proceeding addresses protocols for Integration Capacity Analysis (ICA) and Locational Net Benefit Analysis (LNBA) and approval of utility-designed demonstration projects to test streamlined and iterative data analysis approaches (December 31, 2016). The proceeding also called for two working groups to develop ICA and LNBA procedures.

The IOU demonstration projects for ICA and LNBA were recently completed, along with the associated working group reports. A Proposed Decision is being prepared.²² A third working group on locational forecasting of DER growth is currently convened, and the next phase of work from the ICA and LNBA working groups will begin soon.

In Track 2 the CPUC evaluates the utility demonstration proposal applications and authorizes pilots to be implemented in 2017. The pilots will address grid needs and costs that may be deferred or avoided with the application of DER; opportunities on the grid to increase renewable energy deployments; and building and operating microgrids.²³

In Track 3, the CPUC considers policy issues raised during the proceeding and in comments on DRP applications. It will consist of three sub-tracks: Distributed energy resources adoption and distribution load forecasting; grid modernization investment guidance; and distribution investment deferral process. A Proposed Decision is expected by early fall 2017.²⁴

While the DRP proceeding is focused primarily on grid issues and IOU planning and pilots, in Track 3 the CPUC proposes to address: "The role of community choice aggregators (CCAs) and electric service providers and the utilities' responsibilities for competitive neutrality with respect to other wholesale electricity providers" (CPUC 2016e). CCAs can contribute to the Track 3 discussion as parties to the rulemaking.

A deliverable of this effort will be publicly-accessible online maps with downloadable data, which are expected to be available in 2018. Examples of the ICA and LNBA maps from PG&E's Chowchilla demonstration project are provided below.

Integrated Capacity Analysis

The ICA working group identified two objectives: (1) improve DER interconnection by determining how much DER can be added at any given point in the distribution system and (2) identify suitable DER sites to facilitate integration of DERs into annual grid planning (PG&E 2016b).

The ICA Working Group set a goal to include all the following data in the ICA maps (see example in Figure 13 below): circuit; section ID; voltage (kV); substation; system; customer breakdown percentage (e.g., agriculture, commercial, industrial, residential, other); existing generation (MW); queued generation (MW); total generation (MW); ICA with uniform generation (MW); ICA with uniform load (MW); and integration capacity of a generic PV system (MW). The working group is developing a common mapping structure and functionality, and access to downloadable data sets. Some issues still under development include: real-time

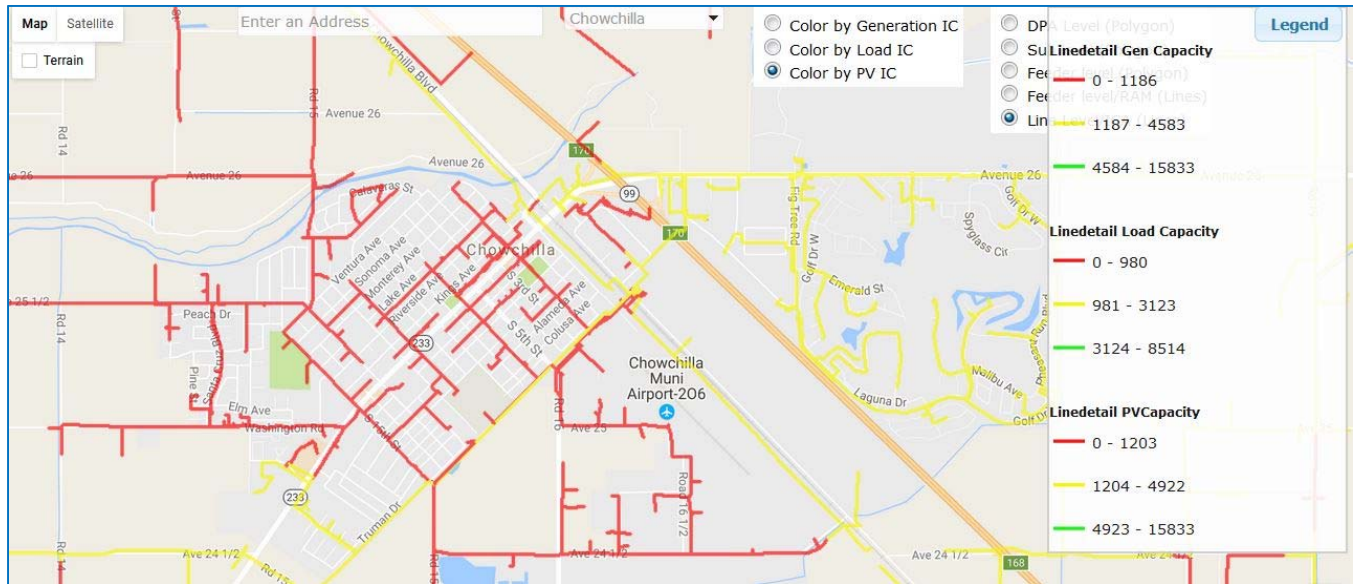
²² Mark Monbouquette, Energy Division Lead Analyst, California Public Utilities Commission, in discussions with Woody Hasting, Renewable Energy Implementation Manager, Center for Climate Protection, June 2017.

²³ Mark Monbouquette, Energy Division Lead Analyst, California Public Utilities Commission, in discussions with Woody Hasting, Renewable Energy Implementation Manager, Center for Climate Protection, June 2017.

²⁴ Mark Monbouquette, Energy Division Lead Analyst, California Public Utilities Commission, in discussions with Woody Hasting, Renewable Energy Implementation Manager, Center for Climate Protection, June 2017.

capacity verification, standardized PV generating profiles to support interconnection approval, incorporation of color-coded single-phase line sections, and how to bridge the gap between desired map metrics, data definitions, and available source datasets (PG&E 2016a).

Figure 13: PG&E's Integrated Capacity Analysis Demo A Map



Source: California IDER and DRP Working Groups (DRPWG 2017)

Locational Net Benefits Analysis

The LNBA working group was tasked with developing a “unified locational net benefits methodology consistent across all three IOUs that is based on the Commission approved E3 Cost-effectiveness Calculator, but enhanced to explicitly include location-specific values and to include certain additional avoided cost components,” according to the *Locational Net Benefit Analysis Working Group Final Report* (SCE 2017). The goal is to establish an LNBA mapping platform that has a consistent visual format, provides standardized data across utility service territories, and is accessible to all stakeholders.

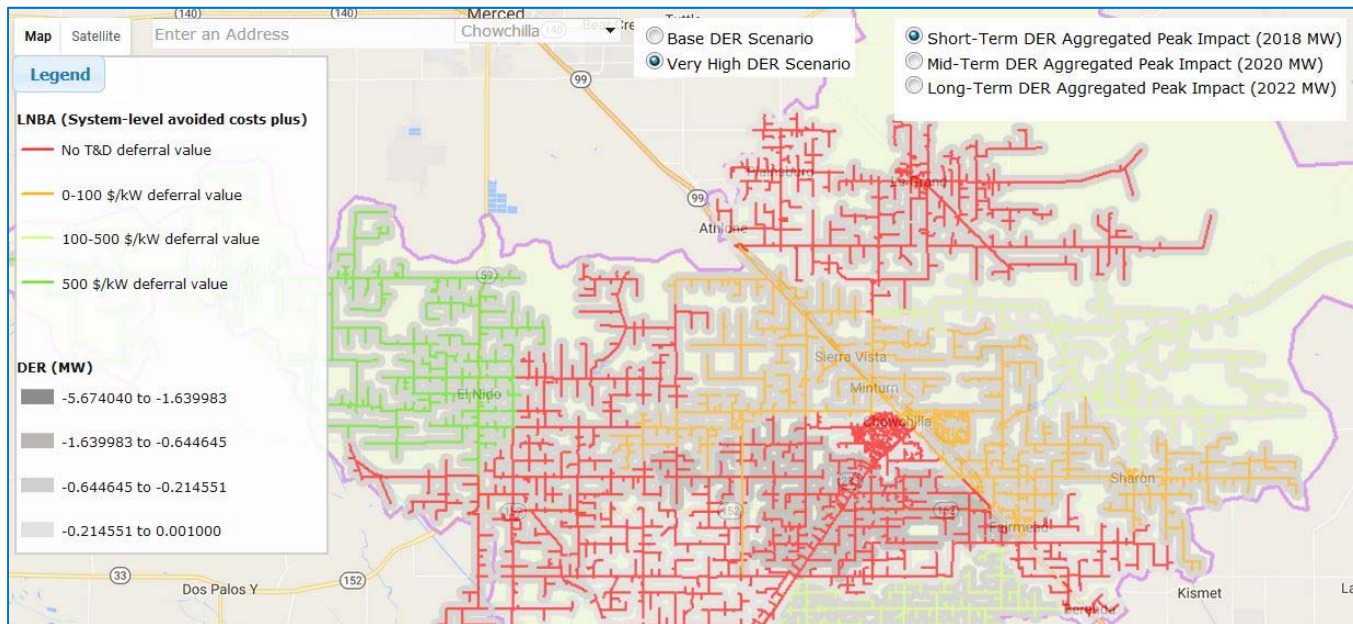
The demo maps (example shown in Figure 14 below) use a color-coded heat map approach to indicate the locational value of system level avoided cost and T&D deferral value in four stages from no avoided cost value per kW (red) to over \$500 per kW avoided cost value (green) (see Table 4). The report notes that “the LNBA tool is designed as a public tool and heat map utilizing public indicative values. The tool and heat map does not provide market-sensitive information, nor does it provide confidential data from utilities.”

Table 4: Locational Net Benefit Analysis Key to Heat Map

\$	Indicates only system-level avoided costs and no T&D deferral value
\$\$	Indicates system-level avoided costs plus 0 to < 100 \$/kW deferral value
\$\$\$	Indicates system-level avoided costs plus 100 to < 500 \$/kW deferral value
\$\$\$\$	Indicates system-level avoided costs plus > 500 \$/kW deferral value

Source: Locational Net Benefit Analysis Working Group Final Report (SCE 2017)

Figure 14: PG&E's Locational Net Benefit Analysis Demo B Map



Source: California IDER and DRP Working Groups (DRPWG 2017)

Together, the two working groups are defining protocols that provide detailed analysis in a timely and affordable manner; and will provide online DER planning tools to quickly understand where cost-effective DERs can be added to the grid and the economic value they provide.

Energy Storage

Energy storage received official federal recognition as a DER in 2013, when the Federal Energy Regulatory Commission (FERC) adopted Order 792 directing transmission system providers to accept electric storage devices as “generation facilities;” the order is supported by a series of federal storage incentive and research grant programs (CAISO 2014).

California led the way with passage of Assembly Bill 2514 (2010), which officially mandated the integration of energy storage onto the electric grid, and led to the CPUC's requirement to install 1,325 MW of IOU storage by 2020. California also has provided rebates through the Self-Generation Incentive Program (SGIP) to customers installing energy storage since 2009. A 2014 California energy storage roadmap, co-authored by the CPUC, California Energy Commission (CEC), and California Independent System Operator (CAISO), provides action steps to address grid and market value barriers.

“The state has seen explosive growth in renewable energy in the past several years, particularly with solar installations more than doubling in recent years. The next step in this fast-moving shift toward a more sustainable grid is energy storage technology,” according to the roadmap report (CAISO 2014).

As of the date of this report, the California Legislature was considering Senate Bill 700, which would create a 10-year rebate program to encourage installation of local storage capacity, modeled on and using the step-down approach of the successful California Solar Initiative for solar PV (CALSEIA 2017a).

Retail Electricity

On May 19, 2017, CPUC President Michael Picker convened an CPUC/CEC Joint En Banc Hearing with Commission members, experts, and stakeholders to discuss “Customer Choice in Electricity in California” and the exponential growth of non-IOU electricity providers including rooftop solar, CCAs, and Direct Access, who currently provide electricity for 30 to 40 percent of Californians, and are expected to increase their market share to 85 percent by the mid-2020s.

Noting that economics and technology are driving this trend, the CPUC issued a staff white paper to establish a context for the discussion. Entitled *Consumer and Retail Choice, the Role of the Utility, and an Evolving Regulatory Framework*, the paper acknowledges the role of solar in the reshaping of the electricity industry:

“Among the many new trends reshaping the California electricity landscape is the continued growth of net energy metering, largely driven by technology innovation and cost reduction in solar PV manufacturing and financing. Since 2007, over 4,500 MW and 550,000 customers have ‘gone solar.’ Programs like the Self-Generation Incentive Program (SGIP) have furthered market transformation for additional technologies like fuel cells, thermal storage, and lithium ion battery storage, allowing customers to produce their own power and/or to reduce their peak energy consumption. On top of these trends, energy efficiency programs and changes in California’s economy have sharply reduced the growth rate in the use of electricity here” (CPUC 2017c).

The paper also notes that, in addition to addressing the shifting risks and costs arising from DER deployment, stakeholders must “lay out elements of a path forward to ensure that California achieves its reliability, affordability, equity, and carbon reduction imperatives while recognizing important role that technology and customer preferences will play in shaping this future.”

Energy Industry Transformation

As the California Public Utilities Commission (CPUC), California Energy Commission (CEC), and energy industry stakeholders work to design a policy and regulatory framework for the new distributed energy system, new opportunities are opening for communities to actively participate in the process.

The distributed nature of clean energy technology makes Community Choice Agencies (CCAs), local governments, and associated agencies vital partners that possess resources and expertise necessary to a successful transition. Understanding how local energy resources and priorities can align with the electricity grid will be key to forging a strong and productive partnership with regulators, the Investor Owned Utility, and state grid operator, and to creating market conditions that encourage robust local clean energy investment.

Distributed Energy Resources and Grid Performance

Facilitating a smooth transition from the 90-year-old centralized regulated-monopoly system to an optimized digitally managed distributed system is dependent on the ability to successfully manage electricity supply and demand on the transmission-and-distribution (T&D) grid — the interconnected network of electricity generation plants, high-voltage transmission lines serving local demand hubs, and distribution lines serving utility customers. The transition will include updating T&D policies and regulations as well as the physical grid infrastructure.

Ensuring every home and business has uninterrupted access to electricity is the role of the nonprofit California Independent System Operator (CAISO), which manages the flow of electricity from generation plant to electricity customer across the high-voltage power lines that make up 80 percent of the California T&D grid (CAISO 2017).

Over the course of any 24-hour period, the demand for electricity can spike for a variety of reasons; to meet that *peak demand*, CAISO deploys dispatchable generation (or *peaker plants*) that can quickly generate extra electricity, typically using natural gas turbines. Each utility or load-serving entity (such as a CCA) is required to buy a set amount of stand-by generation capacity called “resource adequacy” annually to serve peak demand events²⁵ — and ensure reliable supply.

Aligned with the *California Distributed Energy Resources Action Plan*, CAISO’s strategic plan states: “To meet carbon reduction goals, we will continue work to integrate renewable generation and distributed energy resources, increase energy efficiency standards, and encourage investment in the infrastructure necessary to support millions of zero-emission vehicles on our roads” (CAISO 2015).

Duck Curve Challenge

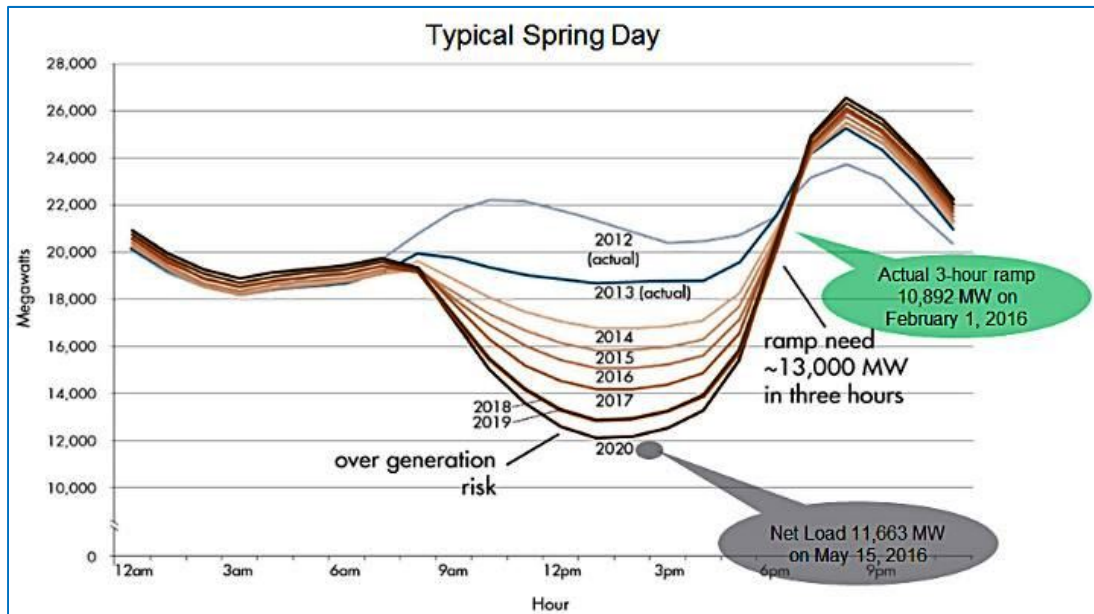
State clean energy policies, such as the Renewables Portfolio Standard and California Solar Initiative, have prompted the addition of an estimated 17,084 MW of solar power (SEIA 2017d) flowing into the grid during daylight hours. This new generation capacity has led to a phenomenon known as the *duck curve*, a daily period during which solar electricity is meeting a significant portion of the electricity demand, but also creating steep *ramping periods* when non-solar generation sources must quickly ramp up or down to meet

²⁵ This stand-by generation capacity is called for by Resource Adequacy policy, which requires every utility or load-serving entity to procure 15 percent more generation capacity than the forecasted load to they can meet the occasional period of peak demand.

real-time electricity demand outside of the prime solar hours, represented by the net load curves in Figure 15.

According to CAISO, “The net load curves represent the variable portion [of demand] that ISO must meet in real time. To maintain reliability, the ISO must continuously match the demand for electricity with supply on a second-by-second basis” (CAISO 2016).

Figure 15: Duck Curve Showing Steep Ramping Needs and Over-Generation Risk



Source: California ISO: Fast Facts — What the duck curve tells us about managing a green grid (CAISO 2016).

The duck curve challenge²⁶ requires that new solar generation deliver electricity during high or “peak demand” periods, be paired with daytime electric vehicle charging, and include sophisticated grid-performance characteristics²⁷ including round the clock flexibility in supply to meet changes in demand, oversupply mitigation with electricity storage for later deployment, and the ability to automate frequency responses in order to stabilize system frequency during emergency or other disruptive events (CAISO 2016).

Solar and Integrated DER

Where many traditional fossil-fuel power plants can respond to grid conditions by simply increasing or decreasing its electricity output, Integrated DERs²⁸ (IDER) respond with a *virtual resource* approach that aggregates resources, combines services, and coordinates activities to deliver comparable and increasingly more affordable grid performance.

²⁶ According to CAISO, the duck curve challenge includes: “Short, steep ramps — when the ISO must bring on or shut down generation resources to meet an increasing or decreasing electricity demand quickly, over a short period of time; oversupply risk — when more electricity is supplied than is needed to satisfy real-time electricity requirements; and decreased frequency response — when less resources are operating and available to automatically adjust electricity production to maintain grid reliability” (CAISO 2016).

²⁷ These grid-performance characteristics include the ability to: Sustain upward or downward ramp; respond for a defined period of time; change ramp directions quickly; store energy or modify use; react quickly and meet expected operating levels; start with short notice from a zero or low-electricity operating level; start and stop multiple times per day; and accurately forecast operating capability (CAISO 2016).

²⁸ IDER is a strategy that seeks to provide comprehensive building energy management solutions via the integration of technologies, programs, and strategies to facilitate customer behavior changes that reduce load and grid inefficiencies (CPUC 2017b).

Nicknamed Solar+ by the local solar industry, this emerging virtual resource business model is built on solar generation²⁹ whose beyond-on-site-demand output is captured by stationary and mobile battery technology tied to energy-management software that facilitates energy flow between the building, smart meter, and grid — delivering grid performance that meets or exceeds that of a traditional power plant.

At the heart of a virtual resource is a distributed energy resource management system that coordinates IDER components in real time. Virtual resources can be deployed on the supply side (with small-scale solar projects such as are popular in Europe), with aggregated demand response resources (that can lower load during peak demand events), and a generation/demand response combo that can provide both services. Virtual resources can be deployed at utility scale (over 1000 MW capacity) or in smaller commercial, industrial, residential, or microgrid applications.

Yale Environment 360 notes that the U.S. market for virtual resource services (i.e., renewable generation, storage, and energy management platform) could reach \$3.7 billion by 2023 driven in part by advancements in battery technology (Yale 2016).

Meanwhile, California regulators and stakeholders are working to establish a regulatory framework for IDERs (R.14-10-003). The CPUC has also set electricity storage targets pursuant to Assembly Bill 2514 and other storage-related legislation for all CCAs. For example, to meet peak demand and provide flexibility, Sonoma Clean Power is tasked to procure storage capacity for 1 percent of its peak demand load by 2020 (SCP 2015).

Whether administered by the load-serving-entity (such as a CCA), utility, or third-party, the virtual resource approach provides the technological framework to ensure renewable energy can deliver reliable, affordable, and controllable grid services.

Solar and Fuel Switching

According to the RCPA 2016 report *Climate Action 2020 and Beyond*, 53 percent of local GHG emissions come from gasoline-powered vehicles and another 16.6 percent from natural gas used for space and water heating (RCPA 2016). Since 2014, Sonoma Clean Power has continued to reduce the GHG footprint of the electricity supply, but burning fossil fuel still comprises more than 80 percent of local energy demand.

Electric Transportation

Electrifying the transportation system is a complex endeavor that has been the focus of CPUC rulemaking since the 2009 Alternative Fuel Vehicle proceeding (R.13-11-007) to address the policy, infrastructure, and technology issues for widespread adoption of electric vehicles. More recently the CPUC launched the Zero Emission Vehicles (ZEV) program to provide incentives, rebates, and charging station infrastructure for plug-in and hydrogen vehicles to put 1.5 million ZEVs on the road by 2025.

Estimates for global EV growth range from 20 percent of vehicles by 2025 to 50 percent by 2030. In addition, EVs can provide demand response and storage supply services to the grid.

Smart charging technology that uses Wi-Fi to adjust the charging speed to grid conditions (lower speed during high grid demand; higher speed when solar supply is available) turns an EV into a basic DER. As EV technology and grid integration evolve, EVs will eventually become a two-way mobile Vehicle-to-Grid-Integration (VGI) resource that can be aggregated to increase charging load when renewable sources are available and decrease load when grid demand is high.

²⁹ Other applicable renewable generation facilities include technologies such as wind, geothermal, and biomass.

As an aggregated VGI resource, “EVs could pump electricity back onto the grid at times of high demand and participate in the ancillary services markets, providing services like frequency and voltage regulation, reactive power for power factor correction, and reserve capacity,” according to a recent report from the Rocky Mountain Institute (Fitzgerald, Nelder, and Newcomb 2016).

The RMI report also notes that managing when and where EVs plug into the grid is key to their DER value, and that local partners can play a lead role in shaping that flexibility through incentives and market structures.

According to the National Renewable Energy Laboratory (NREL), “installing solar in proximity to EV charging infrastructure can reduce or eliminate demand spikes and increases in peak load caused by daytime charging. In some locations, encouraging daytime charging with solar may displace fossil fuel generation.” Among the approaches cited by NREL is to “co-locate solar with EV charging at the workplace or in public parking lots” where onsite solar resources, such as solar parking canopies, could be deployed (NREL 2014).

NREL cites several policy recommendations to promote co-located PV and EV charging projects including: Rebates to co-locate EV charging stations with solar technology; special rate structures or bill credits for PV plus EV projects; allow utilities to count EV charging load that is offset by co-located solar as an eligible measure to meet efficiency targets; streamline interconnection for PV plus EV projects; identify sites on the grid where PV plus EV projects can deliver optimum benefits; waive demand charges at PV plus EV project sites when solar production is reduced due to weather conditions; provide community recognition for businesses that install PV plus EV projects at the workplace or in public parking lots; and provide project developers with technical assistance for PV plus EV project planning.

CleanCharge

Electric vehicles already perform as a demand response resource when coupled with smart charging technology that lowers the charging speed during hours of peak grid demand and raises the charging speed when solar and wind energy is available.

For example, Sonoma Clean Power’s CleanCharge program provides customers with JuiceNet smart-charging equipment from eMotorwerks that communicates with the power grid demand using the customer’s Wi-Fi network and automatically adjusts the charging rate to grid conditions, ensuring the vehicle is fully charged when needed. The program also allows EV customers to manage their charging system with a smart phone app while automatically earning “Juice Points” that are redeemable via Pay Pal (SCP 2017b).

Solar Space and Water Heating

Solar technology can easily serve new onsite demand resulting from the conversion of natural gas³⁰ water and space heating equipment.

Solar photovoltaic (PV) systems use solar panels and generate electricity to run high-efficiency technologies like heat pumps that deliver hot water and space heating/cooling, as shown in Table 5 below. Solar Heating and Cooling (SHC) systems use solar collectors and capture thermal energy to provide hot water, space heating/cooling, and pool heating — delivering services while displacing both natural gas and electricity.

³⁰ Solar technology can replace other fossil fuels like propane.

Table 5: Solar Options to Replace Natural Gas

TECHNOLOGY	SECTOR	DESCRIPTION
Water Heating		
PV (electric)	Res / Com	PV system + high efficiency heat pump water heater
SHC (thermal)	Res / Com	Solar collector, piping, large storage tank
Space Heating		
PV (electric)	Res / Com	PV system + high efficiency heat pump space heating system
SHC (thermal)	Res / Com	Solar collector, heat transfer medium (air, water, or non-toxic liquid), heat distribution system; passive collectors tied to distribution system
Space Cooling		
PV (electric)	Res / Com	PV system + high efficiency air conditioning system
SHC (thermal)	Res / Com	Solar collector provides heated fluid for thermal/chemical sorption process like a refrigerator but without the compressor
Pool Heating	Res / Com	Solar collector and filtration system
Process Water and Steam Heating	Industrial	Hot water and steam for industrial processes such as food processing, pasteurization, sterilization, beer and wine production, and water desalination
Air Heating	Industrial	Air heating for industrial preheating processes, crop drying, laundry drying, or dehumidification applications

Source: Solar Energy Industries Association (SEIA 2013a)

According to the Solar Energy Industries Association (SEIA), residential SHC systems typically cost between \$6,000 and \$10,000 while commercial and industrial systems cost between \$20,000 and \$1 million with a payback period of 4 to 8 years. SEIA goes on to note that while installation costs are more than convention fuel systems, operating costs are significantly lower; in addition, solar thermal equipment is made from recyclable materials; and SHC emits zero greenhouse gas (GHG) emissions. (SEIA 2013b)

Community Choice and DER Integration

CCA Potential to Deliver Added Value

In eligible IOU service territories, Community Choice Agencies (CCAs) are forecast to be available to 60 percent of California electricity customers by 2020 (CCP 2016). As not-for-profit local entities serving the public interest, CCAs bring added value to the integration of DERs.

At the February 1, 2017, CPUC En Banc Hearing on Community Choice Aggregator Issues,³¹ CPUC President Michael Picker challenged CCAs to bring innovative locally-based solutions to the IDER process, stating “land use and local transportation planning and other tools that are specifically reserved to local government — [this] is where the CCAs appear to be best positioned to add value” (CPUC 2017b).

³¹ An *En Banc Hearing* is a meeting at which all Commissioners are present to hear presentations on specific topics from a variety of parties for informational purposes, and no action is taken.

Later at the May 2017 Business of Local Energy Symposium in Long Beach, President Picker reiterated his challenge, asking CCAs to show how they can bring added value that the IOUs cannot (CCP 2017b; 14:40 minutes).

Within the IDER R.14-10-003 rulemaking, a sub-group of the Competitive Solicitation Framework Working Group examined potential challenges to creating robust DER markets in CCA territories. Finding CCAs eligible to participate as market participants providing non-wire DER services in a competitive solicitation progress,³² the sub-group offered two proposals:

1. **Incremental Improvement Proposal 1:** Resolve DER implementation issues on a case-by-case basis in accordance with CPUC decisions and resolutions, modeling IOU/CCA partnerships on precedent set by a settlement between Marin Clean Energy and Sonoma Clean Power with PG&E regarding the Charge Smart and Save program.
2. **“Enhanced” Proposal 2:** Form new partnerships between IOUs and CCAs for mutual benefit to enhance local reliability and resiliency, and address local community GHG goals. Public benefits that CCAs are uniquely positioned to deliver include community stakeholder engagement based on local priorities, targeting and facilitation of DER projects at key grid locations to enhance customer value, and integration of local resources such as land use planning, demographic data, and local GHG policy.³³

While the sub-group noted that Proposal 2’s general language means that details to the partnership model will need to be negotiated for each partnership, they did recommend the following:

“The Commission should authorize CCAs and IOUs, should they so wish, to voluntarily form an umbrella partnering entity, unique to each composite aggregation, for purposes of optimizing mutual benefit and achievement of efficiencies in implementing state and commission policies relating to GHG goals, robust proliferation of DER markets, and the implementation of certain other policy objectives of PUC Code Sections 769 and 381.1 as well as Senate Bill 350, for the purposes of coordinating efforts including but not limited to Integrated Resource Planning, resiliency efforts, and energy efficiency goals.

“The partnership agreement for this entity would contain terms intended to maximize public benefit from the strengths of both entities (CPUC 2016d).”

Currently CAISO and the IOU/POUs that operate the transmission and distribution grids are working to resolve structural barriers such as the inability of CAISO, which manages the transmission grid and wholesale markets, to see conditions on the distribution grid that might interfere with a specific IDER’s ability to respond to CAISO instructions; the growing number of non-wholesale market, self-dispatching IDERs that make it challenging for CAISO and grid operators to forecast load; and other structural interconnect issues.

As “market participants providing non-wire services,” CCAs can lead the development of IDER projects that mitigate grid challenges, address local priorities, and anticipate transmission/distribution grid improvements that will allow projects to receive full market value for their investment over time (More Than Smart 2017).

³² *Non-wire alternatives* are local generation and demand response services that mitigate grid congestion and defer T&D upgrades.

³³ Challenges that will need to be addressed include ensuring the CCA and IOU do not duplicate efforts and identifying a means for CCAs to use Evaluation, Verification, and Monitoring protocols to confirm results against business as usual.

Replicable Model for IDER Deployment

California's clean energy policy states: "IDER is a strategy that seeks to provide comprehensive building energy management solutions via the integration of technologies, programs, and strategies to facilitate customer behavior changes that reduce load and grid inefficiencies" (CPUC 2017d).

This idea can be implemented in a single home or business; across a group of similar buildings (functioning as a virtual resource); or within a locale involving a variety of DER partners, such as a microgrid.

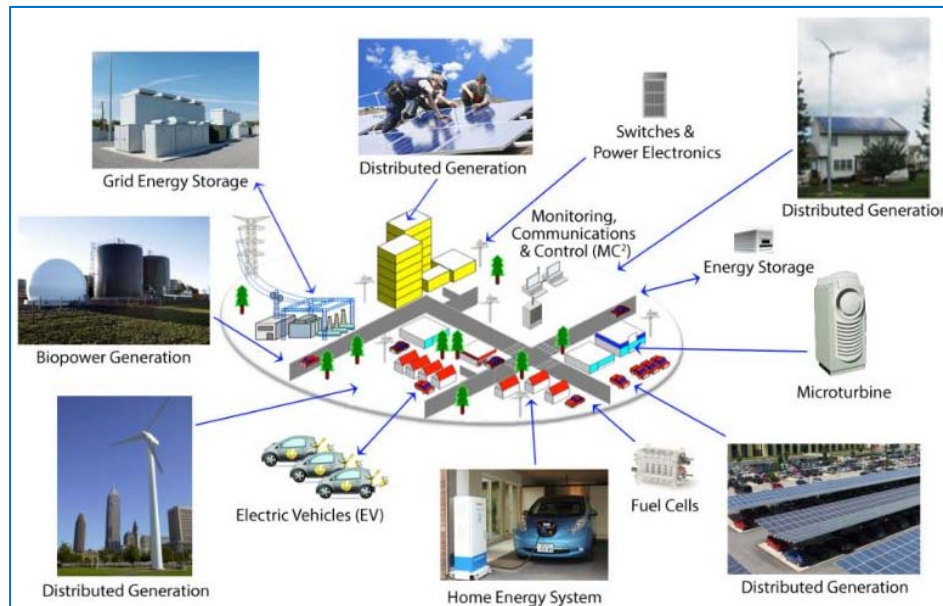
Community Microgrid Initiative

An important concept for local leadership in IDER deployment is the *community microgrid*, as shown in Figure 16 below, which is defined as "a coordinated local grid area ideally served by an entire distribution substation and supported by high penetrations of local renewables and other DER," according to Clean Coalition, sponsors of the Community Microgrid Initiative (Clean Coalition 2017a).

This approach uses substation areas as building blocks to implement a load-centered design that includes load balancing and load flattening to reduce grid costs caused by peak demand and transmission charges. Encompassing an entire substation grid area (including thousands of customers), a community microgrid can provide power backup for prioritized loads and deliver grid-quality load balancing services to manage power, voltage, and frequency.

This community approach is different from behind-the-meter and utility-scale microgrids because it allows jurisdictions to target locations prioritized by public benefit or grid cost reduction in a modular way to gradually deploy a series of grid-quality community microgrids (Clean Coalition 2017a).

Figure 16: Community Microgrid Landscape



Source: Clean Coalition (Clean Coalition 2017b)

The community microgrid is a platform that enables customers, communities, and local governments to become partners in building an IDER energy system, while bringing local investment, policy, and planning resources to bear. In such a community-based endeavor, land use planning, zoning rules, local ordinances, regional coordination to lower soft cost from permitting and building codes, long standing relationships with

public and private stakeholders, and historical collaboration on public interest issues (such as climate change) comprise a suite of local tools that can deliver added value to the grid, and the community.

Community Benefits of IDER

Enhance Public Safety

Living in earthquake country, it is not a matter of *if*, but *when* the big one will hit. In addition, increasingly extreme weather caused by climate change has heightened the threat from heat, wildfires, and flooding.

At these times, access to emergency services is critical. CCAs with local partners can use IDER to facilitate microgrid projects that can, when needed, run independently of grid power to maintain critical services including: police and fire stations, emergency operations centers, hospitals, emergency shelters, grocery stores, gas stations, water systems, and government offices as well as to support vulnerable populations at schools and nursing homes.

In 2012 when Hurricane Sandy hit New York City, microgrids like those at New York and Princeton universities provided the only light in a dark and devastated city. This emergency performance prompted New York State to make microgrids a key strategy in its Reforming the Energy Vision initiative and launch the NY Prize Competition to help communities create microgrids (New York State 2017).

Lower Grid Costs

Currently in Sonoma County, 59 percent of the average residential electricity bill pays for the maintenance and upgrade of the transmission and distribution system owned by the incumbent IOU as well as the 7.8 percent of electricity that is lost during the transmission of power from a remote generation plant to the customer.

Future increases in demand from electric vehicles and conversion of appliances from natural gas to electricity; the addition of local generation and storage resources; and the integration of “smart,” cloud-based, big-data, real-time communication capacity are putting pressure on an aging grid infrastructure designed for centralized power system.

Working with the incumbent IOU, CCAs can engage public and private partners with facilities on congested or otherwise challenged grid circuits in IDER projects (single building to microgrid scale) that would eliminate or defer T&D costs, and provide locally generated electricity with no line losses.

Grow Local Economy

CCAs already facilitate local economic growth in several ways: Lower electricity rates for customers mean savings can be spent locally; tariff programs to encourage solar system and electric vehicle investment mean more local financing and energy and transportation savings for participating customers; and incentive programs for non-utility large-scale solar installations drive long-range local investment decisions.

IDER deployment and investment is coming, and with it the opportunity to expand local economic benefits that meet environmental goals and protect customer rates. Technology, electricity markets, and investment opportunities will likely move faster than federal and state policy. More than ever, local policy and local leadership will influence how quickly private sector investors engage in game-changing IDER opportunities such as coordinated multi-property grid-performance projects.

Bringing Added Value

Single- and multiple-jurisdiction CCAs, drawing on their close relationship to local government, are uniquely positioned to match community needs and resources with IDER solutions and work with the incumbent IOU to align local IDER solutions with T&D cost-reduction opportunities.

As technology and innovation push energy systems to the local level, CCAs are called to a new role — that of guide and visionary — to ensure that IDER delivers a locally-based, resilient, secure, and cost-effective energy system that meets the community's needs and priorities.

Findings and Recommendations

Within the market, technological, policy, and regulatory context described in this report, several key findings and related recommendations are presented for consideration.

Findings

Sonoma County Solar Industry

The Sonoma County solar industry is robust, versatile, and growing. Since 1999, local efforts have resulted in the installation of 95.6 megawatts (MW) of solar power³⁴ on residential, commercial, and industrial behind-the-meter projects³⁵ that range in size from an average residential system of 5 kilowatts (kW) to large commercial systems nearing 1 MW. Thirty-eight of these MW were installed by solar vendors headquartered in Sonoma County who employ nearly 100 percent local staff and primarily source materials from local distributors. From 2003 to 2016, solar installation in Sonoma County has grown at an annual compound growth rate of 18.26 percent.

Sonoma County ranks 22nd in the state, and second among Bay Area counties, for kW installed per person under California's Net Energy Metering program,³⁶ with 0.19 installed kW per person, which is 33 percent higher than the state average. In addition, Sonoma County was ranked 13th in the nation for 2016 solar job growth by The Solar Foundation's Solar Job Census, with a 44 percent increase in jobs created over 2015.

This market growth is the result of progressive state solar policy, the California Solar Initiative incentive program, and strong local solar advocacy in collaboration with local government partners to innovate market barrier solutions such as uniform permitting and building code processes and Property Assessed Clean Energy (PACE) financing.

Sonoma County can expect continued success as solar technology improves, component costs drop, the market matures, and solar generation incorporates IDER technologies such as storage and smart control services that can coordinate solar generation with grid conditions, turning a Solar+ system into a versatile plug-and-play grid resource (see Recommendation #13).

However, the local solar industry still faces challenges such as regulatory, legislative, and other policy-related decisions affecting market growth that will require ongoing vigilance to respond to threats and support opportunities and increasing public awareness about the benefits of solar and solar-related programs.

Positioned as it is at the nexus of the IDER technological revolution, the solar industry needs to develop competitive Solar+ IDER services that meet and exceed customers' expectations.

³⁴ The 95.6 MW total represents all Sonoma County projects enrolled in the Net Energy Metering program since 1999.

³⁵ *Behind the meter* means a renewable energy system designed and installed to meet the energy needs of a specific property.

³⁶ Net Energy Metering is a utility billing system that tracks and pays the solar system owners for excess solar energy they contribute to the grid.

Community Choice Agencies, the County, Cities, and Associated Agencies

Think “Added Value”

In the current turbulent energy environment, electricity industry stakeholders (e.g., providers, regulators, customers, and workers) are challenged to reinvent themselves. Technology is increasingly pushing state policy toward a market-based, IDER energy services approach that is rewriting business models across the industry. According to a 2017 CPUC staff white paper on consumers and retail choice: “California may well be on the path towards a competitive market for consumer electric services” (CPUC 2017c).

In this context, Community Choice Aggregation agencies (CCAs), the county, cities, and associated agencies³⁷ have a temporary window of opportunity to redefine their roles and show they are uniquely qualified to lead the creation of robust, local IDER markets that deliver new economic and technological benefits for the community and the grid (CPUC 2016d).

This theme was echoed at the May 5, 2017, Business of Local Energy Symposium, where California Public Utilities Commission (CPUC) President Picker challenged CCAs to innovate locally-based solutions to the IDER process with “land use and local transportation planning and other tools that are specifically reserved to local government,” asking CCAs to show how they can bring added value that the Investor Owned Utilities (IOUs) cannot (CCP 2017b; 14:40 minutes).

Innovate Integrated Distributed Energy Resource Planning

To do so, Sonoma County cities, the county itself, and associated agencies can draw on their proven track record of collaboration with local solar professionals to accelerate solar adoption as a key means to meet climate action targets. These precedent-setting efforts have already created added value for the local solar market and piloted effective market barrier solutions that have served as policy models, such as countywide streamlined solar permitting, which pre-dates Assembly Bill 2188 (2014) that “requires local governments to create an expedited [solar] permitting process.”³⁸

As new CPUC-funded tools for distribution grid mapping become available, CCAs, the county, cities, and associated agencies can collaborate to identify, map, and develop IDER strategies and projects that align with community priorities, such as installing Solar+ systems at emergency preparedness facilities, including solar in affordable housing developments, helping disadvantaged communities access solar resources, and innovating land use and planning strategies and local incentives for IDER investment, building on local examples (e.g., the County of Sonoma’s Renewable Energy Combining District and the City of Sebastopol’s solar ordinance for new and existing properties) to create incentives for IDER developers (see Recommendations 3, 4, and 5).

Reimagine CCA Business Model

The shift to a distributed energy system is also disrupting the traditional electricity provider business model. Entities that depend primarily on kilowatt-hour sales revenue will experience increasing challenges as renewables, energy efficiency, and demand response shift or remove customer demand, and regulators and

³⁷ Associated agencies include entities such as the Sonoma County Water Agency, Regional Climate Protection Authority, Sonoma County Energy and Sustainability Division, and Sonoma County Energy Independence Program.

³⁸ These solar policy and planning solutions include establishing countywide streamlined solar permitting that pre-dates current state law, participating joint-trainings for solar vendors and building officials on solar-related building and fire codes and industry best practices to improve the inspection process; adopting uniform countywide building codes; participating in community education events such as the Solar Sonoma County Solar Fairs; collaborating with the solar industry on clean energy initiatives from the founding of the Energy Independence Program to the launch of Sonoma Clean Power; and including solar as a solution in climate action planning.

stakeholders decide how grid costs associated with the shift will be addressed. At the same time, new roles are emerging, including as a value-add IDER services partner with the distribution grid IOU (see Recommendations 1 and 3).

This position is supported by CPUC President Picker's comments at the May symposium (CPUC 2017b) and in a CPUC working group report recommending that CCAs and IOUs form new partnerships to capture "public benefits for which CCAs are uniquely positioned to deliver," such as community engagement based on local priorities, development of IDER projects at key grid locations to enhance customer value, and integration of local resources such as land use planning, demographic data, and local greenhouse gas (GHG) policy (CPUC 2016d).

As electricity-only providers, CCAs have additional added-value opportunities, such as targeting fuel switching initiatives for all electric buildings and vehicles, providing on-bill repayment services to support local clean energy investment, and focusing on shifting excess afternoon solar generation to high demand hours with a Solar+ retrofit strategy to add energy storage and smart controllers to existing solar systems (see Recommendations 6, 7, 8, 9, 10, 11, and 12).

Developing aligned and expanded services that fill the market niche for targeted local IDER investment will help CCAs adapt to and thrive in a dynamic market with a diverse suite of competitive energy services.

State Policy and Regulations

By 2020, it is estimated that as much as 60 percent of California electricity customers in eligible service territories will have the option to obtain their electricity from a CCA (CCP 2016). Yet the role of CCAs in the emerging IDER market has only just started to be examined, and ultimately defined, by the CPUC.

As noted above, CCAs, their local city and county partners, and associated agencies constitute an invaluable alliance of local expertise and resources that vital to the successful shift to a distributed energy system.

As a load serving entity, CCAs have an opportunity to lead the policy and regulatory dialogue and show how they, along with their local partners, can and do add value to the new distributed energy future (see Recommendation 2).

Dynamic Fast-Paced Global Market

Solar is a dynamic global industry that is changing daily as technology advances; market forces; and international, national, state, and local policies move toward a distributed clean energy model. The CPUC alone has more than eight rulemaking proceedings in progress dealing with IDER topics ranging from rate setting to distribution resource planning. The California Independent System Operator (CAISO), which manages the electricity transmission system, is pursuing multiple initiatives relating to wholesale IDER markets. The state legislature continues to develop clean energy bills, such as Senate Bill 700 that would create a 10-year rebate program to encourage installation of local energy storage. While the new federal administration has stopped supporting global climate action and clean energy goals, states, counties, and cities are stepping up to lead the way. This fast-paced complex situation requires vigilance to stay apprised of new opportunities and threats as the new distributed clean energy and economic systems are being built.

Recommendations

The successful acceleration of Solar+ IDER requires a team of local partners.

- In its role as a public electricity provider, the Community Choice Agency (and/or its statewide association) is uniquely positioned to represent community interests at the legislative and regulatory table as IOU liaison, technical advisor, public project developer, distribution grid coordinator, and public advocate.
- Local governments (i.e., cities and county) can lead land use and planning innovation and priority setting to identify locations and IDER project types that best meet local needs.
- Associated agencies,³⁹ including the Sonoma County Water Agency, Regional Climate Protection Authority, Sonoma County Energy and Sustainability Division, and Sonoma County Energy Independence Program, can champion Solar+ IDER deployment by leading a regional approach to clean energy development and self-sufficiency; facilitating local government collaboration and communications with regional, state, and national entities; educating residents and businesses about Solar+ IDER economic and environmental benefits; and providing competitive financing for local investment.
- The local solar industry can explore new business models and customer services that incorporate Solar+ features and collaborate with government partners to address market barriers and develop public awareness.
- Community stakeholders and customers can serve as a market sounding board to ensure that programs and resources are delivering value that leads to Solar+ IDER adoption.

While government partners may provide the platform, enacting the following recommendations will call on all team members and the culture of collaboration that has distinguished Sonoma County as a clean energy leader.

CCA Role in Solar+ IDER Market

#1 — Business Model Innovation: Identify opportunities for CCA business model innovation and new IDER-related services, such as: (1) serving as a liaison between IOU/CAISO and local governments, representing local government priorities and applicable local IDER deployment resources (e.g., land use tools, code enforcement); (2) serving as consultant on community project designs that address local needs (e.g., establishing community microgrids at fire stations and other emergency preparedness sites); and (3) developing wholesale distributed generation projects and other aggregated IDER services that will provide CCA revenue from IDER deployment and distribution grid services to create an ongoing robust IDER market (e.g., Community Solar programs such as Marin Clean Energy's Local Sol or a behind-the-meter or utility side-of-meter power purchase agreement [PPA] or equity service where CCA owns the installation).

³⁹ Sonoma County's associated agencies are effective allies providing leadership in distinct and complementary areas. The Sonoma County Water Agency consistently leads efforts to increase reliable local clean energy generation through projects and programs that deliver energy independence and protection against market fluctuations, grid challenges, and natural disasters. The Regional Climate Protection Authority provides a unique forum for local governments to develop coordinated climate action strategies and coordinate with regional, state, and national partners to find effective solutions; the Sonoma County Energy and Sustainability Division leads community education on solar and other clean energy opportunities through its customer service program and its role facilitating initiatives within the county government to deploy clean energy strategies; and the Sonoma County Energy Independence Program serves as a clearinghouse for a range of PACE financing options and access to qualified local contractors for energy efficiency, solar, and water conservation, providing the financial resources to grow local clean energy investment.

Stakeholders include: CCA, county, cities, associated government agencies, and the California Community Choice Association (CalCCA).

#2 — State IDER Advocacy: Engage in direct advocacy with State legislators and CPUC IDER and related regulatory proceedings (with assigned regulatory staff) in coordination with CalCCA to ensure CCAs lead the discussion and definition of their role in IDER deployment.

Stakeholders include: CCA, associated government agencies, and CalCCA.

Local Solar+ IDER Deployment Strategy

#3 — Incumbent Utility Partnership/IDER Map: Collaborate with incumbent IOU to: (1) map optimal IDER sites and assess their grid and local government value; (2) integrate priority local government IDER sites; (3) identify ways to reward developers who pursue projects that deliver grid performance and community benefits; and (4) identify how CCA can bring added value, capacity, and speed to the building of a robust distribution grid within its service territory.

Stakeholders include: CCA (lead) and the county, cities, associated government agencies, and incumbent IOU.

#4 — Local IDER Priorities: Initiate a process among local government and agency partners to: (1) identify land use and other local tools that can be harnessed to expedite IDER deployment by building on existing solar protocols to identify best practices and ordinance strategies (e.g., City of Sebastopol solar ordinance), zoning rules, and general plan elements related to solar, and determine how these can be expanded to include Solar+ IDER features; (2) establish new Solar+ IDER protocols for affordable housing, disadvantaged communities, and the New Construction Solar Policies called for in *Climate Action 2020 and Beyond* (RCPA 2016); (3) evaluate IDER applications for emergency preparedness sites, such as fire stations, hospitals, emergency centers, nursing homes, etc.; and (4) identify IDER-friendly zoning options based on the enterprise zone model that would offer property owners within its boundaries a suite of government incentives (e.g., free permitting, fast-track permitting, and clean energy/grid performance bonus) to participate in projects or microgrid programs that include Solar+ IDER installations and apply the IDER-friendly zone model to aggregated infill projects.

Stakeholders include: CCA, the county, cities, and associated agencies.

#5 — Local IDER Deployment Plan: Prepare an IDER development plan using the aforementioned IDER map as an overlay to existing community plans (e.g., general plans; *Climate Action 2020*) to dramatically improve the “institutional and technological capacity to integrate distributed energy resources” (RCPA 2016). Working with member jurisdictions, the CCA could conduct a countywide evaluation to identify and prioritize promising local IDER sites, aided by forthcoming CPUC grid analysis tools. The CCA could use standard processes, such as Requests for Proposal, to initiate local IDER projects in member jurisdictions in partnership with associated agencies such as Regional Climate Protection Authority and Sonoma County Water Agency.

Stakeholders include: CCA, the county, cities, and associated agencies.

#6 — Evaluation/Monitoring Platform: Collaborate with the California Community Choice Association (CalCCA) to establish a metering platform (e.g., free open-source Open Energy Efficiency Meter)⁴⁰ to monitor performance of IDER projects, support IDER mapping, and assist in planning and use of tactics such as aggregated PV generation.

Stakeholders include: CCA, the county, cities, associated agencies, CalCCA, and project developers.

#7 — Solar+ IDER Retrofit Incentive: Incentivize adding grid-performance equipment to existing solar systems to create Solar+ resources, including the addition of bi-directional inverters, updated circuit boards, storage batteries, EV charging, and Wi-Fi enabled smart controllers that can make stored solar power available during peak grid hours.

Stakeholders include: CCA, the county, cities, and associated agencies.

Fuel Switching Opportunities

#8 — Building Electricity Conversion: Establish a comprehensive fuel switch program to: (1) provide incentives for high-efficiency electric appliances and systems that are not eligible for, and/or are in addition to incentives, under CPUC IOU ratepayer program rules.

Stakeholders include: CCA, the county, cities, and associated agencies.

#9 — Vehicle Electricity Conversion: Administer a comprehensive program for electric vehicles (EVs) and EV charging with information and tools to help customers charge their EVs when solar electricity is readily available or overall demand is low (e.g., Sonoma Clean Power's CleanCharge that shifts charging load to off-peak hours and includes free consultation with qualified vendors, web-based EV information, web-based application forms to EV programs offering smart-charging station equipment and other incentives).

Stakeholders include: CCA, the county, cities, and associated agencies.

#10 — Workplace EV Charging: Collaborate to site and fund daytime workplace EV charging stations at employer and business centers and co-locate charging stations with Solar+ IDER energy storage.

Stakeholders include: CCA, the county, cities, and associated agencies.

#11 — Solar Parking Canopy Initiative: Establish a solar parking canopy initiative, collaborating with prospective host sites, project developers, equipment manufacturers, and others to expedite the deployment of solar parking canopies throughout the county, enabling solarized parking areas to provide EV charging station power, additional solar electricity to support the host site, serve daytime EV demand that mitigates the high demand periods in the morning and evening, and provide shaded parking for vehicle owners.

Stakeholders include: CCA, the county, cities, and associated agencies.

⁴⁰ The Open Energy Efficiency Meter is a free open-source, meter platform that uses utility smart meter data to monitor energy use on individual and aggregated customer meters (OEEM 2017). The Open Energy Efficiency Meter uses CalTRACK methods developed by the CPUC to import and clean smart meter data, evaluate the actual load shape impact of individual and aggregated properties, and enable electricity providers to apply research protocols to proposed solutions while developing market strategies; the meter platform is currently being tested by the CPUC in its Pay-for-Performance pilot (PG&E 2016c).

Financing Platform

#12 — On-Bill Repayment Platform: Establish a CCA on-bill repayment platform in collaboration with incumbent IOU and financial institutions to host a range of qualified financing providers with the option to tie payments to grid-performance results of Solar+ IDER measures; CCA could also host independent meter service based on IOU smart meter data (e.g., customized meter software such as the Open Energy Efficiency Meter) to monitor and support CCA supported Solar+ IDER projects.

Stakeholders include: CCA, Sonoma County Energy Independence Program, additional financing entities, and the incumbent IOU.

Solar+ IDER Value Proposition

#13 — Solar+ Business Model: Customers rely on solar vendors to translate technical and economic details into a simple value proposition that meets their need. Residential Time-of-Use electricity rates will come into effect over the next 18 months and include higher rates for peak-hour use. The Solar+ package of technologies allows the customer to draw on stored energy during peak hours providing rates savings benefits. Solar vendors have an opportunity to expand their business model and apply their proven sales approach to a new value proposition offering Solar + services to new customers and revisiting former customers with Solar+ enhancements.

Stakeholders include: Solar companies with support from CCA, the county, cities, and associated agencies.

Appendix A: Sonoma County Case Studies

At the time of the writing of this report in 2017 there are approximately 95 megawatts (MW) of installed solar capacity in Sonoma County. Presented here are brief summaries of just a few of the hundreds of solar projects, selected to show the range, variety, and scale of solar installations in Sonoma County.

Project hosts reported they were motivated to “go solar” by benefits such as prospective energy cost savings and greenhouse gas (GHG) reductions. In the public and commercial sectors achieving pre-determined sustainability goals was also a factor.

This set of case studies offers a sampling of ways in which solar is being used to meet a variety of needs for residences, businesses, and public agencies. Information contained in the case studies was compiled from interviews with project host representatives and information available online.

Projects are included in six categories:

- Public (municipalities, agencies, schools, etc.)
 - Los Guilicos Center
 - Sonoma County Water Agency (three locations)
- Commercial and Industrial
 - Labcon
- Small Business
 - Woodfour Brewpub
- Residential — Single Family
 - Ferguson Residence
- Residential — Multi-Family
 - Altamont Apartments
- Agricultural
 - Jackson Family Wines
- Innovative
 - Stone Edge Farm Microgrid
 - Kunde Family Winery Floating Solar

Case Study: Public — Los Guilicos Center



Photo Credit: Google Earth

Los Guilicos Center is a Sonoma County complex including a juvenile hall, courtrooms, and Valley of the Moon children's home. The center installed two solar systems: A 3,500-panel, 750 kW rooftop solar system on the center and additional complex buildings and 2,400-panel, 706 kW ground-mount system on three acres, which together comprise 1.5 MW generation capacity (enough to power 350 homes).

The county-owned rooftop system was built for \$4.6 million including \$3.4 million in low-interest, clean energy bonds overseen by the federal government and issued by the county and was installed by Aircon Energy. The ground-mount system is leased under a 20-year power purchase and lease agreement with Colorado-based Spear Point Energy (which acquired the agreement from system installer SPG Solar). Both systems are part of the Sonoma County Comprehensive Energy Project.

Location: 7425 Rancho Los Guilicos Rd, Santa Rosa, California

Solar Capacity: 1.5 MW

Solar Vendors: Rooftop: Aircon Energy; Ground Mount: Spear Point Energy, SPG Solar

Estimated Lifetime CO₂ Reduction: 324 metric tons

System Type: Photovoltaic

Estimated Lifetime Bill Savings: \$4.6 million

Campus Demand: The two-part system was designed to meet 100 percent of campus electrical demand

Case Study: Public — Sonoma County Water Agency, Headquarters



Photo Credit: Google Earth

The Sonoma County Water Agency (SCWA) has installed solar systems at three different SCWA-owned properties.

This installation is at SCWA's headquarters.

The administration building has a 465 kW system with a total of 2,752 panels mounted on the building roof and on a solar shade canopy in the parking lot.

The SCWA installed the three solar PV systems with the goal to achieve carbon free water by 2015, which was achieved. SCWA is constantly investigating additional opportunities to deploy solar power generation.

Over the system lifetime, the solar installation will help SCWA to reduce their carbon dioxide emissions by 17,000 tons, which is equivalent to planting 5,000 acres of trees or removing 3,000 cars from California roadways.

Location: 404 Aviation Blvd,
Santa Rosa, California

Completion: 2006

Solar Capacity: 465 kW

Average Annual Output:
670,000 kWh

Solar Vendors: SunPower

Estimated Lifetime CO₂ Reduction:
17,000 tons

System Type: Photovoltaic

Estimated Lifetime Bill Savings:

For all three SCWA systems:
\$2.3 million in reduced energy costs
over the ~25-year life of the systems
(Approx. \$92,000 to \$115,000
annually)

Innovations/Integrations:

Electric vehicle charging
Solar parking shade canopy

Information:

<http://www.scwa.ca.gov/carbon-free-water/>

<http://www.scwa.ca.gov/photovoltaic-systems/>

<https://us.sunpower.com/commercial-solar/case-studies/sonoma-county-water-agency/>

Case Study: Public — Sonoma County Water Agency, Airport



*Solar panels are visible along the southern outside edge of the water containment berm.
Photo Credit: Google Earth*

The Sonoma County Water Agency has three solar photovoltaic systems integrated into its operations. This installation is located at SCWA's Airport/Larkfield/Wikiup Wastewater Treatment Plant.

The innovation here is the use of an existing sloped berm for the ground-mounted system that offsets the treatment plant's power requirements.

Location: Northeast edge of Sonoma County Airport, Santa Rosa, California

Completion: 2007

Capacity: 498 kW

Solar Vendor: SunPower

System Type: Photovoltaic

Estimated Lifetime Bill Savings:

For all three SCWA systems:
\$2.3 million in reduced energy costs over the ~25-year life of the systems (Approx. \$92,000 to \$115,000 annually)

Innovations/Integrations:

Ground-mounted on the sloped berm of a water containment pond

Information:

<http://www.scwa.ca.gov/carbon-free-water/>

<http://www.scwa.ca.gov/photovoltaic-systems/>

<https://us.sunpower.com/commercial-solar/case-studies/sonoma-county-water-agency/>

Case Study: Public — Sonoma County Water Agency, Sonoma Valley Wastewater Treatment Plant



Ground-mounted photovoltaic panels are visible in the upper right in this photo. Photo Credit: Google Earth

The Sonoma Valley Wastewater Treatment Plant is home to a 929 kW ground-mount installation with a sun-tracking system in a field adjacent to a storage pond. The tracking system increases overall system efficiency.

Approximately 33 percent of the water treatment plant's power needs are met by the solar system. The system includes 5,208 ground-mounted solar panels covering nearly 5 acres. A seasonal wetland is also protected on the site.

The water treatment plant service area covers approximately 4,500 acres and includes the City of Sonoma and the unincorporated areas of Agua Caliente, Boyes Hot Springs, Eldridge, Fetta's Hot Springs, Glen Ellen, Schellville, Temelec, and Vineburg. The plant treats wastewater from approximately 17,027 equivalent single-family dwellings.

Location: 22675 8th Street East,
Sonoma, California

Completion: 2007

Solar Capacity: 929 kW

Solar Vendor: SunPower

System Type: Photovoltaic

Estimated Lifetime Bill Savings:

For all three SCWA systems:
\$2.3 million in reduced energy costs
over the ~25-year life of the systems
(Approx. \$92,000 to \$115,000
annually)

Innovations/Integrations:

Sun-tracking

Information:

<http://www.scwa.ca.gov/carbon-free-water/>

<http://www.scwa.ca.gov/photovoltaic-systems/>

Case Study: Commercial Industrial — Labcon North America



Photo Credit: Labcon

In addition to sourcing remote renewables via the grid, Labcon is committed to onsite energy generation. Due to continuing improvements in efficiency, the energy embedded in each case of Labcon's medical device products has been reduced by more than 50 percent since 2000.

An 800 kW rooftop solar system installed in 2011 was expanded with another 70 kW in late 2013 and now produces 33 percent of Labcon's electricity needs. The goal is to be over 50 percent solar powered by 2020.

Total renewable energy including onsite solar and remote renewables purchased via Sonoma Clean Power (geothermal, wind, solar, biogas and hydroelectric) now make up 54 percent of Labcon's 2017 energy portfolio. Labcon's goal is to operate with 70 percent renewable energy by 2020.

Location: 3700 Lakeville Hwy,
Petaluma, California

Completion: 2011/2013
(two phases)

Solar Capacity: 869 kW

Solar Vendor: SunPower

**Estimated Lifetime CO₂
Reduction:** N/A for PV system
but overall campus: 80 percent
since 2000

System Type: Photovoltaic

**Innovations and/or
Integrated features:**

Efficiency: An advanced closed-loop cooling system for molding machine water uses significantly less energy than other methods.

Efficiency: Nearby "E-Beam" sterilizer uses less energy than other methods.

EV Charging: Four dedicated EV charging spaces are connected to the solar array.

Information:

<http://www.labcon.com/energy.htm>

<http://www.labcon.com/emissions.html>

Case Study: Small Business — Woodfour Brewing Company



Photo Credit: Woody Hastings

Founded in 2013, Woodfour Brewing Company is a microbrewery and brewpub located in the Barlow, a former apple processing facility, in Sebastopol, California.

The installation is a Cogenra (acquired by SunPower in 2015) solar co-generation system that produces both clean electricity and hot water from sunshine.

The system is designed to provide ~180°F water directly and during peak times offsets nearly 90 percent of hot water demands, greatly reducing dependence on natural gas.

Seth Wood, owner of Woodfour, states that “Our main interest in the system is to offset our hot water demands and the system does this well while also producing solar-electric energy, enough to operate the system as well as feed surplus power to the grid.”

Location: 6780 Depot St. #160
in The Barlow, Sebastopol,
California

Solar Vendors: Cogenra/SunPower

System Type: Thermal/Photovoltaic

Innovations/Integrations:
Integrated photovoltaic and solar
thermal application

Information:
<http://woodfourbrewing.com/>

Case Study: Residential — Single Family, Ferguson Home



Photo Credit: Google Earth

The home of Andy Ferguson is a typical 2,100 sq. ft. two-story home with a 100-amp electrical panel adequate for all measures taken. It has an average energy consumption for the home and vehicles and has the typical insulation found in tract homes from 1960 to 2000.

Chronology of energy makeover:

2010 was a baseline year with no improvements to the house or vehicles, which matched the area average in household energy consumption and GHG emission of ~28,503 lbs. CO₂/yr.

2012 Purchase of a Nissan Leaf (approximately 16,500 lbs. CO₂/yr.)

2013 Installation of 24,000 BTU mini-split heat pump system and 4 kW rooftop solar array. Began using rooftop solar to charge the Leaf (approximately 9,000 lbs. CO₂/yr.)

2015 became a full Sonoma Clean Power (SPC) Community Choice Energy customer (approximately 5,000 lbs. CO₂/yr.)

2016 became SCP Evergreen customer (GHG was reduced to 4,672 lbs. CO₂/yr.)

Location: Sonoma County, California

Solar Vendor/s: North Coast Solar

Completion: 2013

Solar Capacity: 4 kW

Estimated Lifetime CO₂

Reduction: Total GHG reductions in the household through 2016 is approximately 84 percent over a five-year period; Total household GHG reduction from 2010 at 28,503 lbs. CO₂/yr. to 2016 at 4,672 lbs. CO₂/yr.

System Type: Photovoltaic

Estimated Lifetime Bill Savings:

Return on investment for solar and heat pump systems in less than 10 years; roughly \$25,000 savings over 10 years.

Onsite Demand: ~500 kWh/month

Innovations/Integrations:

Electric Vehicles

Electric Heat Pump for space conditioning

Efficiency improvements

SCP Evergreen customer

Case Study: Residential — Multifamily, Altamont Senior Apartments



Photo Credit: Google Earth

Altamont Apartments is a four-story 230-unit apartment complex designed for senior living. The complex includes opportunities for low-income residents and offers many amenities including air conditioning, pool, spa, elevators, movie theatre, and fitness room.

All common areas, including lighting, pool, spa, elevators and the movie theater are powered by the PV system.

The project consists of 509 SunTech 240-watt solar panels spanning 9,043 square feet of rooftops on multiple buildings. The total system generates approximately 189,760 kilowatt-hours of electricity annually.

Each of the 509 solar modules is controlled by an Enphase microinverter. Microinverters greatly reduce impacts of shade from nearby trees or structures and generate about 7 percent more power than conventional inverters. Overall system efficiency is increased by 10-12 percent.

The system generates enough electricity each day to power over 53 average homes.

Location: 300 Enterprise Dr.
Rohnert Park, California

Completion: 2012

Solar Capacity: 122 kW

Solar Vendor: SolarCraft

Estimated Lifetime CO₂

Reduction: It will avoid 77 tons of GHG annually and over its 30-year life its emission reduction will be roughly equivalent to eliminating over 5 million miles of driving.

System Type: Photovoltaic

Innovations/Integrations:

Multiple roof surfaces
Enphase microinverters

Information:

<http://solarcraft.com/pr-solar-energy-apartments-rohnert-park-altamont/>

Case Study: Agricultural — Jackson Family Wines



Photo Credit: SunWorksUSA (La Crema Location)

When installed, the solar/thermal system at Jackson Family Winery (JFW) La Crema location was one of the largest rooftop solar/hot water cogeneration facilities in the nation. The company estimates annual savings of \$30,000 and 700,000 kWh of electricity, equivalent to 44 average American homes' energy use for one year. The system provides electricity for lighting and cooling systems as well as the hot water required in the winemaking process.

In 2015, JFW installed 21 Tesla Energy stationary energy storage systems for a total of 4.2 MW of storage capacity. JFW was among the first companies in the nation to collaborate with Tesla on this initiative designed to reshape the way energy is managed for more sustainable operations.

JFW has also built a 280 kW solar system at its Carneros Hills Winery, and a 162 kW solar system at its Hartford Family Winery. These onsite systems allow JFW to source approximately 60 percent of their electricity from onsite resources, company-wide.

Location: 425 Aviation Boulevard,
Santa Rosa, California

Completion: 2012

Solar Vendor: SunWorksUSA

System Type: Photovoltaic/Solar
Thermal

Estimated Bill Savings:
~\$30,000 annual

Information:

Jackson Family Wines:
http://www.jacksonfamilywines.com/sites/default/files/jfw_sustainabilitycasestudy.pdf

SunWorksUSA:
<https://sunworksusa.com/>

Case Study: Unique Mixed Residential/Agricultural — Stone Edge Farm Microgrid

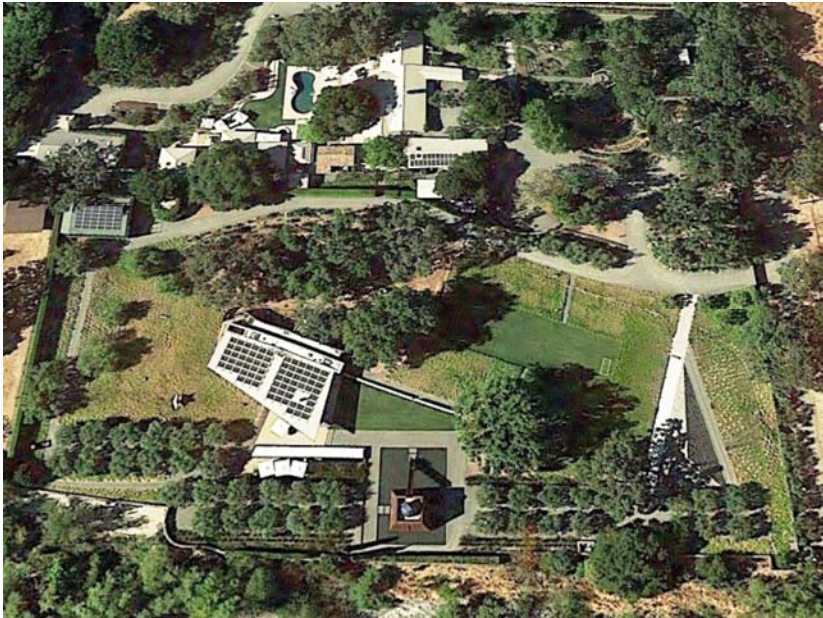


Photo Credit: Google Earth

Stone Edge Farm is a 16-acre working farm and residence just west of the City of Sonoma, California. The farm produces vegetables, fruit, wine grapes, olives, herbs, eggs, and honey. Organic and sustainable best practices are enhanced by technology in an integrated approach to the natural world. This is a demonstration farm for soil, water, and energy conservation. The farm's microgrid produces two self-sustaining energy products: electricity and hydrogen. The Stone Edge Farm microgrid is an ongoing project with some unusual characteristics:

Prototype – Experimenting and embracing mistakes as learning experiences

Overbuilt – Deliberately to test how multiple components integrate, to identify trade-offs and economics

Retrofitted – Purposely to determine the costs and challenges of upgrading outmoded infrastructure

Invisible – Mostly buried underground or hidden within plain metal boxes

Unfinished – An evolving work in progress at year 3.5 on a timeline from July 2013 to June 2018.

Unique – Capable of exporting electricity to the grid while operating in island mode

Open source – Without restrictions on intellectual property.

Location: 5700 Cavedale Rd,
Glen Ellen, California

Completion: 2013 to 2018

Solar Capacity: 32 kW

Estimated Lifetime CO₂

Reduction: The aim was to reduce CO₂ emissions by 50 percent. That goal was reached within a year; now aiming to achieve zero emissions using renewable energy and storage.

System Type: Photovoltaic+

Innovations/Integrations:

Multiple energy storage technologies

Microturbine generator with goal of hydrogen fueling

Islandability

Automation

Systems integration

Solar/hydrogen production/fueling system

Information:

<http://sefmicrogrid.com/>

In the news:

<https://cleantechnica.com/2016/05/03/california-winery-uses-solar-power-energy-storage/>

<http://www.solarpowerworldonline.com/2016/08/installation-notes-microgrid-reduces-california-winerys-carbon-footprint/>

Case Study: Innovation — Kunde Family Winery Floating Solar



Photo Credit: Ciel et Terre

This is a 10 kW floating solar deployment at the Kunde Family Winery in southeast Sonoma County. The winery has long been a leader in sustainable farming and was one of the first wineries in the county to become certified sustainable by the Certified Sustainable Winegrowing Alliance.

The system consists of 34 260-watt solar panels at a 12-degree angle that snap together like LEGO® pieces, which makes them easy to assemble as well as expand in the future. Enphase microinverters on the back of each panel convert the DC current to AC. Two panels operate a solar powered aerator that creates circulation in the pond during the day and adds dissolved oxygen to the water.

Floating PV systems are naturally kept cooler by the water, reducing the need for a dedicated cooling system and improving power efficiency. North Coast Solar plans to compare the performance between the floating and landlocked panels and believe that the panels on the water will be 10 to 20 percent more efficient due to the cooling effect of the water. Lastly, floating systems are less susceptible to damage from earthquakes.

Location: 9825 Sonoma Hwy,
Kenwood, California

Completion: March 2016

Solar Capacity: 10 kW

Solar Vendors: Ciel et Terre
(float system); North Coast Solar
(installation)

**Estimated Lifetime CO₂
Reduction:** 1.93 lbs/kWh

System Type: Photovoltaic

Innovations/Integrations:
Floating solar

Information:

<http://www.kunde.com/winegrowing>

<http://www.ciel-et-terre.net/>

Kenwood Press Story:

<http://www.kenwoodpress.com/pub/a/8813?full=1>

Appendix B: Solar-Related Sonoma County Reports

The Sonoma County solar market was the subject of four research reports: 2010 *Sonoma County Solar Implementation Plan*, 2013 *Sonoma County Renewable Energy Based Secure Communities (RESCO) Final Project Report*, 2014 *Planning Concepts for Sonoma Clean Power's Local Energy Resources Development*, and 2017 *Data-Driven Path to Economic and Ecological Sustainability: A Roadmap for Community Choice Innovation*.

In addition, the community has produced two Climate Action Plans that include analysis of solar potential to provide greenhouse gas (GHG) free electricity on a countywide basis: 2008 *Sonoma County Community Climate Action Plan* and 2016 *Climate Action 2020 and Beyond*.

This collection of reports offers insights into opportunities and challenges in the deployment of local solar and other renewable energy and energy efficiency resources.

2008 *Sonoma County Community Climate Action Plan*

Following the setting of a countywide GHG reduction target in 2005, the Center for Climate Protection facilitated a community collaboration to produce a precedent-setting climate action plan designed to meet the 25 percent below 1990 levels by 2015 goal. The action plan engaged business, community, and government stakeholders to identify four key solutions: Energy efficiency, smart transit and land use, power up locally, and conserve and capture (CCP 2008).

The “cool plan” estimated Sonoma County could meet 67 percent of its 2008 energy needs with a diverse portfolio of local renewable resources, including distributed solar. Proposed solar-related solutions included increasing utility-scale renewable energy under the California Renewables Portfolio Standard, establishing a Community Choice Aggregation to provide local control over electricity sources, and providing financing options such as Property Assessed Clean Energy (PACE) assessments and incentives to encourage local investment in solar and other renewable generation technologies. The *Sonoma County Community Climate Action Plan* provided a roadmap for subsequent climate action initiatives and planning efforts.

2010 *Sonoma County Solar Implementation Plan*

Part of the 2008 DOE Solar America Cities grant, the 2010 *Sonoma County Solar Implementation Plan* provides strategies that foster collaboration between local governments and the private sector to reduce market barriers to the installation of solar electric (PV) systems, solar thermal systems, and energy efficiency measures through advances in policy, financing, education, and market transformation. The report was “designed to encourage the installation of solar electric and solar thermal systems to offset countywide peak energy demand [and] achieve GHG emissions reductions” by promoting new solar capacity and market transformation (SSC 2010).

The report called for installing 25 new MW by 2011 and replacing 250 MWs of peak demand with solar generation and energy efficiency. Market transformation goals included removing financial, regulatory, and educational barriers to property owner participation; facilitating countywide collaboration among government, business, and community partners; standardizing regional policies and regulations, such as permitting and

building codes, to reduce solar project “soft costs”;⁴¹ and identifying local code and planning opportunities to expedite solar adoption.

In collaboration with a 50-member working group composed of stakeholders from government, business, nonprofits, and the community, the *Sonoma County Solar Implementation Plan* presented six key strategies:

- **Regional Standards:** Adopting regional solar-focused policies and regulations for permitting, code compliance, municipal building code scope, zoning ordinances, and general plan design
- **Redevelopment/Community Development/Enterprise Fund Programs:** Seeking opportunities within existing dedicated public planning programs to include solar and efficiency projects
- **Training for Government Staff/Officials and Solar/Efficiency Vendors:** Hosting integrated solar code joint training for government and solar/efficiency vendor stakeholders
- **Education for the Community:** Delivering the solar message through existing community outreach channels
- **Clean Energy Advocate Program:** Providing unbiased consumer assistance and support on a countywide basis to assist property owners in implementing solar and efficiency projects
- **Request-for-Proposal/Bid Clearing House:** Advocating for the creation of a countywide online request-for-proposal clearinghouse for government solar projects

Implementation Outcomes

In 2010, following the release of the state's mandatory green building codes, nine of the ten local jurisdictions adopted the CalGreen Tier 1 code, unifying the building code compliance process (Snyder 2010).

In 2011, the City of Santa Rosa founded the free Clean Energy Advocate program with funding from a DOE grant to assist property owners in planning solar, energy efficiency, and water conservation projects with unbiased information on rebates, incentives, and financing (Ruiz 2011).

In 2013, a collaboration between building inspectors, fire safety officials, and solar vendors produced a uniform solar project permitting protocol and application process that is used in jurisdictions throughout the county. (Houston 2013).

2013 Sonoma County RESCO Final Project Report

In 2009, the Sonoma County Water Agency received a \$1 million Renewable-Based Energy Secure Communities (RESCO) grant from the California Energy Commission (CEC) that included a detailed analysis of three prototype portfolios that could provide an “economic and environmental integration of solutions that enable multiple individual renewable energy conversion technologies to serve a community’s energy needs” (SCWA 2009).

“The ultimate goal of this [RESCO] project is to develop and partially demonstrate a model for a locally owned, cost-effective renewable energy portfolio that helps Sonoma County meet its greenhouse gas reduction goals” (CEC 2013, 7).

⁴¹ *Soft costs* include items such as financing, customer acquisition, permitting, installation, labor, and inspection (DOE 2016a).

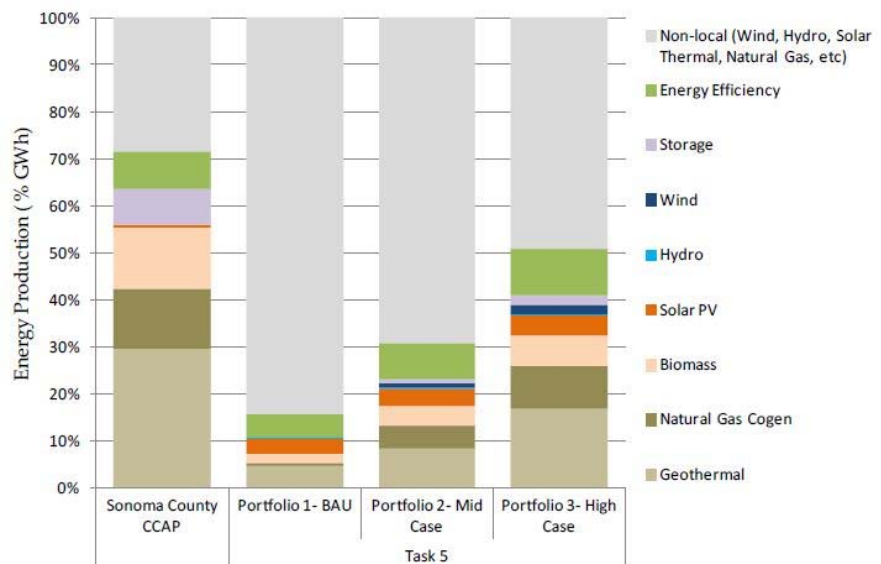
The *Sonoma County RESCO Final Project Report* (RESCO) analysis sought to refine the renewable energy portfolio proposed in the *Sonoma County Community Climate Action Plan* (CCP 2008) to calculate “price competitiveness and carbon impacts” across business-as-usual (15 percent local renewable resources), mid-case (30 percent), and high-case (50 percent) scenarios for solar PV, efficiency, natural gas combined heat-and-power, geothermal, biomass, wind, hydro, and storage (see Figure 17 below) (CEC 2013).

The RESCO analysis estimated that distributed solar generation could, on an annual basis, provide 102 GWh for the business-as-usual scenario; 118 GWh for mid-case; and 134 GWh for high-case. All this capacity is estimated to come from “smaller and mid-sized distributed generation behind-the-meter projects on the order of 1 to 1,000 kW;” with no utility-scale solar PV installations (CEC 2013, 90).

Analysis of Sonoma County’s annual solar resource (called *insolation*) showed 60 to 65 percent of commercial and 22 to 27 percent of residential rooftop area provided good opportunities for solar development. The report notes: “the highest amount of solar photovoltaics in the three portfolio scenarios reaches 85 megawatts in 2020, which is only 17 percent of the estimated technical rooftop potential” (CEC 2013, 91).

The report also found that Sonoma County residents use about 35 percent less electricity than the national average, allowing property owners to install smaller systems at less cost.

Figure 17: RESCO Prototype Portfolios



Source: Sonoma County RESCO FINAL PROJECT REPORT (CEC 2013)

Among the 2013 RESCO report recommends are: “Establishing a community choice aggregation program to provide planning and financial tools for implementing portfolios with high penetration of cost effective local resources; and implementing financial tools, such as on-bill financing, feed in tariffs based on market conditions not flat or average rate, and low interest loans, to expand deployment of energy efficiency and onsite distributed generation behind the meter.”

The RESCO report concludes: “Sonoma County can meet a large portion of its forecasted electricity demand through development of local distributed and small-scale renewables, combined heat and power, biomass, and demand reduction resources such as energy efficiency, with substantial participation from the private sector and application of the right financing structures.

“Local renewable-based energy resources could be developed through a more comprehensive locally controlled community choice aggregation program, or other similar program. The cost-effectiveness of meeting this demand is likely to improve over time as the costs of wholesale energy and corresponding retail electric rates increase” (CEC 2013, 2).

2014 *Planning Concepts for Sonoma Clean Power's Local Energy Resources Development*

In 2014, the Center for Climate Protection (CCP) issued *Planning Concepts for Sonoma Clean Power's Local Energy Resources Development*, with the premise “that a community is more energy secure when it controls more of its own energy resources and obtains more of its energy from locally-based generation.”

Built on three prior research publications,⁴² the CCP report presents a recommended set of tools to achieve local energy efficiency, grid intelligence, and behind-the-meter generation that can be deployed to avoid transmission and distribution (T&D) costs as well as avoid ownership and debt risks — in order to achieve 100 percent local renewable energy capacity by 2030.

The planning report provides a summary of local energy resources to inform discussions of near-, mid-, and long-term local programs for the Sonoma Clean Power (SCP) Resources Plan, and that support the founding principles identified in the SCP Joint Powers Agreement, including reducing GHG emissions, reducing energy consumption, stimulating the local economy and promoting long-term electric rate stability.

To acquire 85 MWs of new solar photovoltaic capacity by 2020 as estimated in the RESCO report, the planning report offered 17 recommendations, two of which are currently active solar programs:

- **NetGreen:** SCP's net energy metering program measures how much electricity is generated by the customer's solar system and how much grid electricity the customer used to determine a monthly net production or consumption. SCP pays the retail kWh price plus 1-cent for net electricity production, which is tallied on an annual basis (SCP 2017d).
- **ProFIT:** A Feed-in-Tariff program for wholesale solar production, ProFIT offers small-scale solar producers a standard-offer (9.5-cents per kWh) contract to provide solar power over a 10- or 20-year period. Solar projects must be new, less than 1 MW, located in SCP territory, be compliant with the California Renewables Portfolio Standard, be part of the PG&E Wholesale Distribution Tariff, be legally permitted, and willing to sign a standard, non-negotiable, long-term contract (SCP 2017c). ProFIT currently has five near 1 MW solar systems under contract.

The remaining program ideas included these solar-related strategies:

- **Retail Solar Cooperative:** A retail solar cooperative would consist of one or more local ≤ 1 MW solar installations whose output is made available, as a cooperative member, to SCP customers with properties that are not suitable for onsite solar. Other clean energy technologies, including efficiency, demand response, automation, and storage, could be included in a “Shared Energy Cooperative” program.
- **Behind-the-Meter Energy Installations:** This would consist of SCP contracts to install an optimally sized solar system on the property of a qualified SCP customer, who would then reimburse the installation cost by purchasing the electricity generated for less than the current retail rate over a 20-year period.

⁴² These publications include: 2008 Sonoma County Community Climate Action Plan (CCP 2008), 2013 Sonoma County RESCO Final Report (CEC 2013), and Community Choice Aggregation Feasibility Study (SCWA 2011).

- **On-Bill Repayment:** This would consist of an SCP service to enable customers to pay back efficiency and clean energy generation investments on their utility bill, providing the potential for lower interest rates over a longer term.⁴³
- **Local Renewables Investment Program:** This would consist of a crowdfunded program where investors would invest in local resource development projects in partnership with a crowd-source funding enterprise or clean energy bank.
- **SCP Member Cities/County Engagement Program:** Participating jurisdictions would serve as host sites for distributed energy resource deployment, identifying potential sites, characterizing potential community benefits that might be realized with the project, determining resource types that might be deployed, identifying ideal financing options, and coordinating incentives for the system.
- **SCP Electric Vehicles Integration and Incentives Program:** SCP could deploy and/or incentivize PV shade structures co-located with EV charging stations and offer incentives for fleet conversions and charging stations while monetizing the grid balancing and ancillary services value of EV storage capacity and the generation and load shaping value that storage adds to solar PV.
- **Intelligence/Grid Modernization Program:** The local grid can acquire microgrid-type capabilities by installing communications and information technologies in buildings to coordinate local energy resources and reduce the 45 percent waste of the current centralized grid system. This includes behind-the-meter real time monitoring, assessment, and remote management of energy use; automated demand response; and onsite automated generation control.
- **Local Renewable Energy Certificate Purchase Program:** This strategy would aggregate multiple small PV systems and add intelligence technology to track generation to qualify these systems for Renewable Energy Credits (REC), providing both solar system owners and SCP will access to REC value.
- **Sonoma County Efficiency Financing Program:** Non-residential customers are aggregated to create a single virtual retrofit project that qualifies for bond financing.

“The focus should — be on creating the right framework and contracting strategy,” concludes the planning report, emphasizing that integration of multiple strategies holds the key to a successful transition to a local distributed energy resources system.

2016 *Climate Action 2020 and Beyond*

Published in 2016 by the Sonoma County Regional Climate Protection Authority (RCPA), the *Climate Action 2020 and Beyond* plan (CA2020) was developed in collaboration with all ten local governments, the RCPA Board of Directors, ICF International, community nonprofits and partner agencies, and a Stakeholder Advisory Group composed of community members and organizations, and is compliant with California Environmental Quality Act protocols.

Written for a community audience,⁴⁴ CA2020 presents countywide action steps for GHG reduction and climate adaptation based on jurisdiction-specific GHG inventories, near-term action plans for all ten local

⁴³ “In Sonoma County, the “Pay-As-You-Save®” (PAYS®) On-Bill Repayment program is demonstrating success. After installation of eligible upgrade measures, participants pay a surcharge on their water bill with the assurance that their estimated savings on combined utility bills will exceed the bi-monthly water surcharge. If the bill-payer moves, the payment obligation ends and the next bill-payer at the location gets the remaining savings and makes the remaining payments” (CCP 2014).

⁴⁴ CA2020 was prepared as resource for local governments, regional agencies, community groups, and Sonoma County residents and businesses.

governments, and climate-readiness analysis to support meeting the updated regional GHG reduction goal: 25 percent below 1990 levels by 2020.⁴⁵

The report cites a 2010 countywide GHG inventory that attributes 34 percent of GHG emissions to energy use in buildings, including electricity (50 percent) and natural gas (49 percent) (RCPA 2016, 2-5). Utility-scale solar is one of a range of renewable energy resources local electric load serving entities (i.e., Sonoma Clean Power, Healdsburg Electric, and PG&E) can purchase to meet the California Renewables Portfolio Standard, which calls for 50 percent of electricity sources to be renewable by 2030.

Distributed solar (i.e., onsite rooftop and ground-mount PV installation) is an additional zero-carbon energy source that can reduce or replace local use of non-renewable electricity generation and natural gas.

CA2020 solar-related GHG reduction goals include:

- Increase renewable energy use
 - **Regional:** Sonoma Clean Power complies with state Renewables Portfolio Standard for utility-scale electricity and administering NetGreen and ProFIT programs for distributed solar (Goal 2-R1)
 - **Local:** Implement solar installation requirements for new residential and non-residential buildings (Goals 2-L1 and 2-L3) and incentivize solar installations for existing residential and non-residential buildings (Goals 2-L2 and 2-L4)
- Switch equipment from fossil fuel to electricity (creating more demand for solar)
 - **Regional:** Stationary fuel switching incentive program in development by government partners (Goal 3-R1)⁴⁶
 - **Local:** Replace residential natural gas water and space heating equipment with high-efficiency electric equipment (Goal 3-L1)
- Encourage a shift to low-carbon fuels in vehicles and equipment (creating more demand for solar)
 - **Regional:** Implement Shift Sonoma County, an electric vehicle promotion program (Goal 7-R1)
 - **Local:** Develop local charging stations to support more electric vehicles (Goal 7-L1)
- Increase use of renewable energy for water and wastewater systems
 - **Regional:** The Sonoma County Water Agency, which provides water/wastewater services to most of the county, has already achieved a Carbon Free water system (Goal 14-R1)
 - **Local:** The cities of Healdsburg and Cloverdale are implementing similar strategies for their water systems (Goal 14-L1)

⁴⁵ In 2005, all ten local governments and community stakeholders set a countywide GHG reduction goal of 25 percent below 1990 levels by 2015.

⁴⁶ Government partners include: Sonoma Clean Power, Sonoma County Energy Independence Office, RCPA, Bay Area Air Quality Management District (BAAQMD), and Northern Sonoma County Air Pollution Control District (NSCAPCD) (RCPA 2016, 3-15)

2017 Data-Driven Path: A Roadmap for Community Choice Innovation

In January 2017, the North Bay Clean Energy Forum, a non-partisan civic group composed of persons with technical, business, and public policy backgrounds in the energy industry, published *Data-Driven Path to Economic and Ecological Sustainability: A Roadmap for Community Choice Innovation*. Prepared using a planning from the future method, the white paper presents key strategies tailored to Community Choice Agencies to achieve an ambitious goal:

“Transform Sonoma County into an electricity based economy powered by low or GHG-free renewable and distributed energy resources developed to create local jobs and optimize local investment. Going further, and recognizing our county’s abundant renewable energy potential, we call for Sonoma County to exceed local requirements for renewable energy generation by 20 percent and export the remainder to other regions by 2050 — while seeking to eliminate or sequester GHG emissions across the board.”

The recommended strategies include (NBCEF 2017):

1. **Prioritize Zero Emissions Buildings + Transportation (ZEBT).** Promote ZEBT project outcomes (i.e., whole building efficiency, renewables, and transportation) and implement financing and program solutions that enable whole-building onsite clean energy transformation and use cost barrier tunneling, also known as deep retrofit strategies, to achieve the fastest/best economic payback. In addition, quickly implement innovative Time-of-Use (TOU) residential and commercial electric tariffs that enhance grid stability and that incentivize and optimize deployment of new renewable energy and energy efficiency sources and ZEB+T projects.
2. **Conduct building assessments and pilots.** Undertake detailed assessments of the residential and commercial property building stock in the Community Choice Agency (CCA) service area, and use that data to design programs for reducing GHGs by means of efficiency programs and fuel switching.⁴⁷
3. **Electrify all building functions.** Based on recent scientific consensus regarding the significantly larger short-term climate-forcing effect of methane than was previously assumed, recognize the need to replace natural gas and propane with clean electricity and efficiency. Quickly start pilot programs to research and test highly-efficient electric technologies, especially heat pump technologies, for local residential and commercial space conditioning and water heating.
4. **Mitigate heat events with heat pump air conditioning.** Recognizing the probability of more prolonged and intensive heat events in coming decades due to climate change, promote the adoption of fuel-switching technologies (e.g., electric heat pumps with both heating and cooling capacity powered by renewable energy) to ameliorate related public health problems.
5. **Grow a local clean energy workforce.** To help create the needed local workforce and jobs, fund degree and certificate programs at two-year colleges that provide the technical skills required for solar array, HVAC (heating, ventilation, and air conditioning with heat pump technologies), heat pump water heater, and EV charger installation.
6. **Provide affordable easy-to-use financing.** Develop financial capacity (e.g., municipal H bonds) and financing instruments that make it possible for consumers to improve their cash flow while upgrading their buildings with CCA assistance and guidance.

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7. **Expedite electric vehicle adoption and charging system.** Complementing the leading role played by the private sector, devise programs to encourage wider adoption of electric vehicles (EVs) and electrified mass transit (including TOU tariffs), direct EV purchase incentives, incentivizing “mobility as a service,” and wider EV charging opportunities, especially in homes and at workplaces. Work to exploit the advantages of using local renewable energy for EV charging and EV battery potential for use demand response systems for grid balance.
8. **Partner with CCAs, industry experts, and established research organizations.** Expand collaborative partnerships and political, technical, and administrative alliances with other Community Choice Agencies (CCA) and leading program-development organizations in the clean energy industry (e.g., Northwest Energy Efficiency Alliance) plus scientific and technical solutions groups (e.g., Lawrence Berkeley National Laboratory) to more rapidly develop technical and political solutions that lead to expedited GHG reductions for all customers.

Appendix C: Community Partners

Solar Sonoma County

Solar Sebastopol

The story of solar in Sonoma County begins in 2002 with the founding of Solar Sebastopol, a grassroots coalition of residents, City Council members, and Sonoma State University staff, seeking to “promote the installation of solar, improve the quality and dependability of solar power installations, and provide assistance to residential and commercial building owners” (Solar Sebastopol 2008). The group established a successful model that included community education, collaboration with related industries (i.e., real estate agents, appraisers, and lenders), building inspector/solar installer code training, and capacity analysis to support solar-install target setting.

Solar Sonoma County

By 2008, Solar Sebastopol received a grant from the Bay Area Air Quality Management District to partner with the City of Santa Rosa and expand to include the entire county under the banner of Solar Sonoma County (SSC). This partnership led to a successful bid for a U.S. Department of Energy (DOE) Solar America Cities grant and publication of the 2010 *Sonoma County Solar Implementation Plan* (SSC 2010).



The DOE grantees were “tasked with setting a national example for how to mainstream solar through local grassroots advocacy and policy change” (SSC 2012). SSC co-founder Lori Houston cited a countywide approach involving all ten local governments and a goal to install 25 new MWs within three years (2011) as key to winning the grant.⁴⁸ Between 2008 and 2011, Sonoma County added 29.8 new MW (California Solar Statistics 2017).

Over the next four years, SSC collaborated with local governments, businesses, solar vendors, energy efficiency professionals, nonprofits, and individuals to address market barriers and establish effective solar programs.

Developed with a 50-member stakeholder group, the 2010 *Sonoma County Solar Implementation Plan* provided key strategies for local action (see Appendix B) that informed a series of SSC programs and initiatives including:

- **Clean Energy Advocate Program:** Offers free unbiased expert assistance to residential and commercial property owners seeking to evaluate proposed solar, energy efficiency, or water conservation projects.
- **Contractor Quality Assurance Program:** Pre-qualifies solar vendors according to standards for customer satisfaction, customer service, applicable licenses and certifications, ongoing professional training, commitment to SSC code of ethics, and participation as a dues-paying member of SSC.

⁴⁸ Solar Sonoma County was co-founded by Lori Houston and Marty Roberts in partnership with the City of Santa Rosa under the DOE Solar American Cities grant program, which funded 25 innovative solar programs throughout the nation.

- **Streamlined Permitting Initiative:** A standardized online solar permitting system across all local jurisdictions. (In 2009, all local jurisdictions adopted a uniform solar permit form as developed by the Redwood Empire Association of Building Officials [DOE 2011]; in 2016, the County of Sonoma debuted an online service called Permit Sonoma that includes online solar permit applications [Hart 2016]; in 2011, SSC participated on the Governor's Office of Planning and Research committee to develop the *2012 California Guide to Solar Permitting* [GOPR 2012]).
- **Consumer Events/Workforce Training:** Consumer events include community solar fairs, clean energy workshops, community forums, and webinars to provide citizens with tools to understand and adopt solar technology. SSC also hosted a variety of workforce trainings on permitting, building codes, sales and marketing, and installation best practices (SSC 2012).
- **Advocacy and Community Resources:** SSC supported the founding of the Sonoma County Energy Independence Program (SCEIP), a Property Assessed Clean Energy (PACE) financing program, and worked with elected officials, partner organizations, and solar trade associations on market transformation.

Awards

In 2008, SSC received Special Recognition for Leading the Way to a Clean Energy Future from Congresswoman Lynn Woolsey. In 2011, SSC received the DOE Steel on the Roof Award for the most solar installed per capita in the nation from among the 25 Solar America Cities grant recipients.

Solar Action Alliance

In 2013, SSC expanded its territory to include the counties of Marin and Napa, informally rebranding itself, but not formally changing its name to the Solar Action Alliance. The goal was to replicate SSC's successful solar programs for consumer education, workforce training, and contractor vetting, and help facilitate standardized online solar permitting in these neighboring counties (Go Local 2013). The project was terminated in early 2014.

A New Partnership

In fall 2014, Solar Sonoma County and Center for Climate Protection (CCP) opened discussions about merging. By June 2015, the organizations announced a new partnership in which SSC would become a special program under the CCP umbrella. The move supports CCP's commitment to reducing GHGs by accelerating the switch from fossil fuels to clean renewable energy sources.

Under the new partnership all but one of the former SSC board members stayed on to constitute the newly-formed CCP Solar Committee, with one member also joining the CCP Board of Directors. The Solar Committee oversees and guides policy, program, and project initiatives.

While retaining core services such as the Clean Energy Advocate and Qualified Vendor programs, the new Solar Sonoma County is pursuing renewed efforts to accelerate solar deployment, improve solar vendor and solar customer services, and support Sonoma Clean Power in expanding solar adoption. In addition, SSC continues to advocate for Community Choice Energy (CCE) and market transformation policies, as well as build alliances throughout the state (CCP 2015).

This work is carried out largely in the context of CCP's Clean Power Exchange program,⁴⁹ which serves as a resource for operational CCAs and local governments evaluating Community Choice, as well as other stakeholders and advocates. The Clean Power Exchange article "Solar and Community Choice Energy: How Does One Affect the Other?" addresses the relationship between solar and Community Choice Energy (CPE 2017).

Solar Industry Professionals

Over the years, and many kitchen table conversations, solar vendors have increased customer awareness and market demand — building businesses that deliver value; integrate technology, financing, and incentives; and give customers a competitive alternative to traditional utility energy. They have installed 95.6 MW of solar generation in a wide range of project types from residential to commercial to industrial. Through industry associations such as the California Solar Energy Industries Association (CALSEIA) and the national Solar Energy Industries Association (SEIA), solar vendors have participated in developing national, state, and local solar policies needed to grow into a mature industry with the versatility to support the Solar+ IDER approach to the forthcoming distributed energy system.

Center for Climate Protection

In 2001, Ann Hancock and Mike Sandler co-founded the nonprofit Center for Climate Protection (originally called the Climate Protection Campaign), inspired by the Cities for Climate Protection program whose motto is *local action moves the world*.⁵⁰ They set a goal to enlist all nine Sonoma County cities and the county in climate protection. By August 2002, all ten local governments had pledged by resolution to follow a five-step, two-track program for reducing GHG emissions, the first of many national precedents set by Sonoma County. This collaborative model has fostered unprecedented community engagement and innovation.

In 2003 GHG inventories were completed for the nine cities and in 2005 for the entire county; in 2005, local government, business, and community leaders set and adopted a countywide GHG target of 25 percent below 1990 levels by 2015, which was the boldest target in the U.S. at the time. While preparing the 2008 *Sonoma County Community Climate Action Plan* (see Appendix B),⁵¹ CCP identified a significant climate protection tool, the new public electricity provider model known as Community Choice Energy (CCE),⁵² and facilitated a community campaign to establish a local CCE, resulting in the 2014 launch of Sonoma Clean Power (CCP 2017a).

Sonoma County Water Agency

Established as a special district in 1949 to provide flood protection and manage water resources, the Sonoma County Water Agency (SCWA) serves more than 600,000 residents in Sonoma and Marin counties to ensure that customers "have the water they need, when they need it" (SCWA 2017c).

One of the county's largest energy users, SCWA launched its Carbon Free Water initiative in 2006 to achieve a carbon-free water system by 2015 by decreasing energy use and increasing renewable energy

⁴⁹ For more information on the Clean Power Exchange and solar power visit: <http://cleanpowerexchange.org/resources/solar/>

⁵⁰ The Cities for Climate Protection program is administered by the International Council for Local Environmental Initiatives (ICLEI — Local Governments for Sustainability). Founded in 1990, the program "promotes local action for global sustainability and supports cities to become sustainable, resilient, resource-efficient, biodiverse, low-carbon; to build a smart infrastructure; and to develop an inclusive, green urban economy" (ICLEI 2008).

⁵¹ The *Sonoma County Community Climate Action Plan* was prepared with the participation of 50 business, government, community group, and technical representatives over several years to provide "a blueprint for achieving emission reduction targets in a cost-effective and technically-feasible manner" (CCP 2017a).

⁵² Community Choice Energy became an option in California with the passage of Assembly Bill 117 in 2002.

sources, in alignment with the countywide GHG target. SCWA met its goal, announcing carbon neutral status in 2015 and demonstrating a replicable model for other water utilities (SCWA 2017a).

Three solar projects providing nearly 2 MW of power represent 6 percent of SCWA's carbon-free energy portfolio; geothermal (5 percent), land-fill gas (55 percent), and hydropower (34 percent) comprise the rest of the portfolio — 93 percent of which comes from energy sources within the county. The solar projects include: a 465 kW administration building rooftop system (2006), a 498 kW wastewater treatment plan ground-mount system (2007), and a 929 kW wastewater treatment plan ground-mount system (2007) (SCWA 2017b).

SCWA has played a lead role in a series of local climate protection initiatives. In 2009, SCWA partnered with the County of Sonoma to establish the Sonoma County Energy Independence Program (SCEIP), a PACE financing program, supporting solar, efficiency, and water conservation improvements to residential, commercial, and industrial properties, providing \$15 million toward the PACE program fund (SCEIP 2012). In support of the initiative to create a Community Choice Energy agency, SCWA provided \$150,000 in funding and lead the preparation of the 2011 *Report on the Feasibility of Community Choice Aggregation in Sonoma County* (SCWA 2011) and 2012 *Sonoma Clean Power Draft Implementation Plan* (SCWA 2012). In 2013, SCWA served as grantee and lead author for the California Energy Commission *Sonoma County Renewable Energy Secure Communities (RESCO) Final Report* analyzing Sonoma County renewable energy potential (CEC 2013) (see Appendix B).

Sonoma County Energy Independence Program

With the passage of Assembly Bill 811 (2008), local governments had a new tool for clean energy investment: Property Assessed Clean Energy financing, an assessment attached to the property, not the owner, that is paid back through the property tax system on an annual basis over a 10- to 20-year term.

In 2009, the County of Sonoma Board of Supervisors approved the countywide Sonoma County Energy Independence Program (SCEIP) to provide PACE financing to all residents of the county in coordination with the nine local cities. In October 2014, SCEIP launched the PACE Financing Marketplace, which provides four additional PACE programs and expands the amount of available funding for Sonoma County PACE projects; the marketplace program is currently being expanded (County of Sonoma 2016).

In a May 4, 2017, email, SCEIP Program Manager Jane Elias reported that, as of March 2017, the program had financed 1,513 residential and 48 commercial solar PV projects representing 11,306 installed kW and \$53,732,943 in assessments; in addition, SCEIP financed 71 residential and 9 commercial solar thermal projects with an investment value of \$673,397. The program has 157 participating contractors providing services for over 90 eligible clean energy measures; 88 percent of SCEIP-funded projects are installed by local contractors (County of Sonoma 2016).

Sonoma County Regional Climate Protection Authority

In 2009, the community joined forces again to establish the Sonoma County Regional Climate Protection Authority (RCPA), the nation's first local government agency created specifically to coordinate a response to climate change. Governed by a Board of Directors composed of representatives of all ten local governments, RCPA coordinates initiatives to promote efficient buildings, clean energy investment, alternative transportation, and conservation/adaptation strategies, with member governments and seven local agencies. RCPA provides advocacy, project management, planning, finance, grant administration, and research services and facilitates policy and administrative communications between local governments and regional, state, and national agencies (RCPA 2017).

RCPA's July 2016 *Climate Action 2020 and Beyond* plan calls for increased deployment of solar PV for new and existing residential and commercial properties and for water and wastewater treatment systems.

Sonoma County Energy and Sustainability Division

Established in 2010, the Sonoma County Energy and Sustainability Division (ESD) is part of the county's General Services Department and leads planning, evaluation, and administration of the Countywide Energy Management and Sustainability Program. It oversees strategies for long- and short-range energy and green resource procurement; county energy use and sustainability practices; employee commute reduction planning; and serves as a clearinghouse of information on solar energy improvements, energy efficiency, and water conservation, providing free solar consultations for residential and commercial projects;⁵³ hosting Home Energy Workshops providing education on energy efficiency, water conservation, and solar PV systems; and facilitating the streamlined solar permitting program for solar systems ≤ 10 kW in size (EDS 2017).

Sonoma Clean Power

The most recent and significant community initiative is Sonoma Clean Power, a Community Choice Agency, that began serving customers in May 2014. When energy prices soared in the early 2000s because of illegal market manipulation that bankrupted the Investor Owned Utilities, California communities sought a remedy in Community Choice Aggregation (Assembly Bill 117 / 2002), which allows communities to purchase power for their residents and businesses in order to foster competition, lower prices, and increase local renewable energy development.

Identified as a vital GHG reduction strategy in the 2008 *Sonoma County Community Climate Action Plan*, the Center for Climate Protection began educating local government, business, and community leaders about Community Choice. They were joined in 2011 by the Sonoma County Water Agency, which established a Community Choice Aggregation steering committee comprised of local elected officials, government staff, business representatives, nonprofits, and other stakeholders. A 2011 feasibility study and 2013 implementation plan resulted in eight local cities and the County of Sonoma joining Sonoma Clean Power (SCFB 2016).⁵⁴

To promote distributed solar generation, Sonoma Clean Power offers two programs:

- **NetGreen:** SCP's net energy metering program measures how much electricity is generated by the customer's solar system and how much grid electricity the customer used to determine a monthly net production or consumption. SCP pays the retail kWh price plus 1-cent for net electricity production, which is tallied on an annual basis (SCP 2017d).
- **ProFIT:** A Feed-in-Tariff program for wholesale solar production, ProFIT offers small-scale solar producers a standard-offer (9.5-cents per kWh) contract to provide solar power over a 10- or 20-year period. Solar projects must be new, less than 1 MW, located in SCP territory, be compliant with the California Renewables Portfolio Standard, be part of the PG&E Wholesale Distribution Tariff, be legally permitted, and willing to sign a standard, non-negotiable, long-term contract (SCP 2017c).

⁵³ The Sonoma County Energy and Sustainability Division solar consultations are available at the beginning of the project planning to learn basics of solar or during the project evaluation process and include assistance with comparing equipment and costs between proposals, and evaluating terms for multiple financing options (ESD 2017).

⁵⁴ The City of Healdsburg meets its residents' electricity needs with its own Publicly Owned Utility.

Since 2014, the NetGreen program has provided a local premium to new net-energy-metering customers and the ProFIT program has contracted for five local, near 1 MW solar systems, all of which are currently in the development phase. Since SCP began operations, local kW installed has increased 3.74 percent over the historical pre-SCP compound annual growth rate.

In addition to the two programs noted above, SCP also engages with counterparties on unique bilateral contracts for local or remote solar in contractual arrangements that do not necessarily fit into the program parameters of the standard NEM or ProFIT programs.

A utility-scale example is the Mustang Renewable Solar Energy project, which is under contract with Sonoma Clean Power and Marin Clean Energy. Located in Kings County, California, the 100 MW_{AC} facility began operation on August 13, 2016, and is providing SCP with approximately 70 MW of power. The electricity generated by the 1,000-acre facility will supply approximately 45,000 homes (SCP 2015).

A local, behind-the-meter example would be the “floating solar” projects currently in development with both Sonoma County Water Agency and with private agricultural property owners in Sonoma County.

Resources

Solar Industry Associations

American Solar Energy Society:
<http://www.ases.org/>

California Solar Energy Industries Association:
<http://calseia.org/>

Northern California Solar Energy Association:
<http://www.norcal solar.org/>

Smart Electric Power Association:
<https://sepapower.org/>

Solar Energy Industries Association:
<http://www.seia.org/>

Print and Online Industry Publications and Blogs

CleanTechnica Solar:
<https://cleantechnica.com/solar-power/>

Greentech Media Solar:
<https://www.greentechmedia.com/channel/solar>

PV Magazine: <https://www.pv-magazine.com/>

PV Solar Report: <https://www.pvsolarreport.com/>

Renewable Energy World:
<http://www.renewableenergyworld.com/solar-energy/blog.html>

Solar Industry Magazine:
<http://solarindustrymag.com/>

Solar Wakeup: <http://www.solarwakeup.com/>

Utility Dive Solar:
<http://www.utilitydive.com/topic/solar/>

Governmental

California Distributed Generation Statistics:
<http://www.californiadgstats.ca.gov/>

Go Solar California (California Energy Commission): <http://www.gosolarcalifornia.ca.gov/>

National Renewable Energy Laboratory:
<http://www.nrel.gov/>

Sonoma County

Rahus Institute: <http://rahus.org/>

Regional Climate Protection Authority:
<https://rcpa.ca.gov/>

Solar Sonoma County:
<http://www.solarsonomacounty.org/>

Sonoma Clean Power:
<http://sonomacleanpower.org/>

Sonoma County Energy Independence Program:
<http://sonomacountyenergy.org/>

Sonoma County Water Agency:
<http://www.scwa.ca.gov/energy-sustainability-projects/>

Books

Let It Shine: The 6000 Year Story of Solar Energy:
<http://john-perlin.com/let-it-shine.html>

Annual Events

Business of Local Energy Symposium:
<http://climateprotection.org/our-work/symposium-2017/>

InterSolar North America: <https://www.intersolar.us/>

Solar Power International:
<http://www.solarpowerinternational.com/>

Other

Advanced Energy Legislation Tracker:
<http://www.aeltracker.org/>

Database of State Incentives for Renewables and Efficiency: <http://www.dsireusa.org/>

Solar Living Institute: <https://www.solarliving.org/>

Vote Solar: <https://votesolar.org/>

Glossary

Advanced Metering Infrastructure	An integrated system of smart meters, communications networks, and data management systems that enables two-way communication between utilities and customers.
Alternating Current	An electric current that reverses its direction many times a second at regular intervals; typically used in power supplies.
Balance-of-System	Refers to the components of a solar installation other than the solar panels, including items such as wiring, racking, inverters, etc.
Behind the Meter	Renewable energy systems, usually solar, in which the system is physically located on the owner's property and connected to the owner's electrical panel and utility meter, hence "behind the meter"; does not include renewable energy systems that provide power directly to the electric grid, such as utility-scale renewable power plants.
California Air Resources Board (ARB)	The California agency charged with improving the state's air quality. Established in 1967, the ARB is a department within the cabinet-level California Environmental Protection Agency.
California Community Choice Association (CalCCA)	The 501(c)6 association of operational and emerging Community Choice Agencies in California.
California Energy Commission (CEC)	California's primary energy policy and planning agency, committed to reducing energy costs and environmental impacts of energy use, such as greenhouse gas emissions, while ensuring a safe, resilient, and reliable supply of energy.
California Independent System Operator (CAISO)	An independent, non-profit California entity that oversees the operation of California's bulk electric power system, transmission lines, and electricity market generated and transmitted by its member load serving entities. The primary stated mission of CAISO is to "operate the grid reliably and efficiently, provide fair and open transmission access, promote environmental stewardship, and facilitate effective markets and promote infrastructure development." CAISO is one of the largest ISOs in the world, delivering 300 million megawatt-hours of electricity each year and managing about 80 percent of California's electric flow.
California Public Utilities Commission (CPUC)	The California regulatory agency that regulates privately owned public utilities in the state of California, including electric power, telecommunications, natural gas, and water companies.
California Solar Energy Industries Association (CALSEIA)	A California non-profit organization that works in policy development, advocacy, education, networking, and business services to promote the growth of the solar industry in the state.
California Solar Initiative (CSI)	The ten-year California solar rebate program (2006–2016).
Capacity	The maximum electric output an electricity generator can produce under specific conditions.
Capacity Factor	The ratio of actual electrical energy output over a given period of time to the maximum possible electrical energy output over the same amount of time; or, the average power generated, divided by the rated or "nameplate" peak power (see <i>nameplate</i>).
Carbon Dioxide	Carbon dioxide (chemical formula CO ₂) is a colorless, odorless gas with a density about 60 percent higher than that of air. Carbon dioxide consists of a carbon atom covalently double bonded to two oxygen atoms. It is the second most abundant greenhouse gas in the atmosphere, second only to water vapor.

Clean Power Exchange (CPX)	A program of the Center for Climate Protection focused on the expansion of Community Choice Agencies that include greenhouse gas reduction as a primary goal.
Community Choice Agency or Aggregator (CCA)	A local governmental agency with decision-making authority over sources of energy for electricity, and other statutory powers. California Assembly Bill 117 (2002, Migden).
Community Choice Energy	Another name for a Community Choice Agency or Aggregation.
Compound Annual Growth Rate (CAGR)	A useful measure of growth over multiple time periods. It can be thought of as the growth rate that occurs from the initial investment value to the ending investment value assuming that the investment has been compounding over the time period.
Customer	Occupant of a residential, commercial, industrial, or agricultural property who purchases energy (e.g., electricity, natural gas) from an Investor-Owned, Publicly Owned, or Community Choice Agency (CCA) provider. This term is included to emphasize the changing nature of what it means to be an electricity consumer in California. Customers who install solar systems or choose to receive their electricity from a CCA, whose mission is to provide clean renewable energy, go from being captive ratepayers to customers with a choice (see <i>ratepayer</i>).
Demand	In the context of this paper, <i>demand</i> refers to electrical demand or load.
Demand Response (DR)	A reduction in the power consumption by an electricity customer to better match the demand for power with the supply. Often controlled by automated technology, DR is usually a voluntary program that may compensate end-use customers for reducing their electricity use during periods of high power prices or when the reliability of the grid is threatened.
Deployment	In the context of this paper, deployment refers to all the processes involved in getting energy-related programs, technologies, systems, or hardware up and running properly in its environment, including installation, configuration, running, testing, and making necessary changes. The word <i>implementation</i> is sometimes used to mean the same thing.
Direct Current	An electric current flowing in one direction only. Photovoltaic (PV) panels generate direct current that must be converted to alternating current for most uses (see <i>alternating current</i>).
Distributed Energy Resource (DER)	Energy-related technologies that can be installed locally, including distributed renewable generation resources, energy efficiency, energy storage, electric vehicles, and demand response technologies.
Distribution Resource Plan (DRP)	Major utilities are now required to be produced distribution resource plans pursuant to Assembly Bill 327. According to the Public Utilities Code Section 769, these plan proposals will “identify optimal locations for the deployment of distributed resources,” which includes distributed renewable generation resources, energy efficiency, energy storage, electric vehicles, and demand response technologies.
Electric Vehicle (EV)	Any vehicle that is propelled by an electric motor. It includes battery-electric and fuel-cell electric vehicles.
Emissions Factor (EF)	A representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant.
En Banc	A term used by the California Public Utilities for a meeting at which all Commissioners are present to hear presentations on specific topics from a variety of parties for informational purposes, and no action is taken.
Energy	Energy is the property that must be transferred to an object to perform work on, heat, or move the object.
Energy Efficiency	The function of reducing the amount of energy required to provide identical or equivalent products and services that previously required more energy.

Energy Storage	<p>The capture of energy produced at one time for use later. There are many ways to store energy. The six most common are:</p> <ul style="list-style-type: none"> • Solid State Batteries: a range of electrochemical storage solutions, including advanced chemistry batteries and capacitors • Flow Batteries: batteries where the energy is stored directly in the electrolyte solution for longer cycle life, and quick response times • Flywheels: mechanical devices that harness rotational energy to deliver instantaneous electricity • Compressed Air: utilizing compressed air to create a potent energy reserve • Thermal: capturing heat and cold to create energy on demand • Pumped Hydro: creating large-scale reservoirs of energy with water
Federal Energy Regulatory Commission (FERC)	The U.S. federal agency that regulates the transmission and wholesale sale of electricity and natural gas in interstate commerce.
Footprint	In the context of this report refers to the amount of carbon dioxide and other carbon compounds emitted due to the consumption of fossil fuels by a person or group.
Fuel-switching	Replacing polluting, inefficient energy sources with cleaner and more economical alternatives. In this report, it usually means switching fossil gas and petroleum with electric systems and vehicles, respectively.
Generation	Refers to the production of electricity.
Gigawatt-hour/s	One billion watts of electricity generated or consumed over the course of one hour.
Gigawatt/s	One billion watts of electricity.
Greenhouse Gas	A gas in an atmosphere that absorbs and emits radiation within the thermal infrared range. This process is the fundamental cause of the greenhouse effect. The primary greenhouse gases in Earth's atmosphere are water vapor, carbon dioxide, methane, nitrous oxide, and ozone.
Grid Modernization Initiative (GMI)	A program of the U.S. Department of Energy (DOE) that fosters collaboration among DOE divisions to create the modern grid of the future.
Implementation	In the context of this paper, implementation refers to all the processes involved in getting energy-related programs, technologies, systems, or hardware up and running properly in its environment, including installation, configuration, running, testing, and making necessary changes. The word <i>deployment</i> is sometimes used to mean the same thing.
Institute for Energy Research (IER)	A Washington, D.C.-based non-profit organization that conducts research and analysis on the functions, operations, and government regulation of global energy markets.
Integrated Distributed Energy Resource (IDER)	A strategy that seeks to provide comprehensive building energy management solutions via the integration of technologies, programs, and strategies to facilitate customer behavior changes that reduce load and grid inefficiencies.
Integration Capacity Analysis (ICA)	A tool to specify how much capacity is available for integrating circuits on the distribution grid system to host expanded distributed energy resources.
Interconnection	May refer to the linking of an electricity generation source to the distribution grid, and/or the linkage of transmission lines between two utilities, enabling power to be moved in either direction. Interconnections allow the utilities to help contain costs while enhancing system reliability. In this paper, interconnection usually refers to the former — solar systems interconnected to the distribution grid.

International Council for Local Environmental Initiatives (ICLEI)	An international association of local governments and national and regional local government organizations that have made a commitment to sustainable development.
Internet of Things (IoT)	The inter-networking of physical devices, vehicles, buildings, and other items embedded with electronics, software, sensors, actuators, and network connectivity that enables these objects to collect and exchange data.
Inverter	An electronic device that changes direct current (DC) to alternating current (AC). Solar panels generate DC, which inverters convert to AC.
Investment Tax Credit (ITC)	A 30 percent tax credit for solar systems on residential and commercial properties.
Investor Owned Utility (IOU)	A private sector business organization, providing a product or service regarded as a utility and managed as private enterprise rather than a function of government or a utility cooperative. In California, IOUs are regulated by the California Public Utilities Commission.
Jobs and Economic Development Impacts	A computer modeling system developed by the National Renewable Energy Laboratory used to estimate economic impacts resulting from installation of local renewable energy generation.
Kilovolt/s	One thousand volts.
Kilowatt-hour/s	One thousand watts generated or consumed over the course of an hour.
Kilowatt/s	One thousand watts.
Lawrence Berkeley National Laboratory (LBNL)	A U.S. national laboratory located near Berkeley, California, that conducts scientific research on behalf of the U.S. Department of Energy. It is managed and operated by the University of California.
Load Serving Entity	The industry term for an electric utility or provider. In California, IOUs, Publicly Owned Utilities (POUs), Community Choice Agencies, Rural Electric Cooperatives, and Irrigation Districts that provide electric service, are all load serving entities.
Locational Net Benefit Analysis (LNBA)	An analytical methodology developed pursuant to the Distribution Resource Planning mandate in Assembly Bill 327 aimed at identifying optimal locations for the deployment of distributed energy resources on the distribution grid.
Megawatt-hour/s	One million watts of electricity generated or consumed over the course of one hour.
Megawatt/s	One million watts of electricity.
Microgrid	A group of interconnected loads and distributed energy resources (DER) with clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid (and can) connect and disconnect from the grid to enable it to operate in both grid-connected or island mode (U.S. Department of Energy).
Multi-family Affordable Solar Housing (MASH)	Established in 2008, the MASH Program provides solar incentives on qualifying affordable housing multifamily dwellings.
Nameplate Capacity	The intended or optimal condition full-load sustained output of an electricity generation source. It is also known as the rated capacity, nominal capacity, or installed capacity.
National Renewable Energy Laboratory (NREL)	Located in Golden, Colorado, NREL is the United States' primary laboratory for renewable energy and energy efficiency research and development. NREL is a government-owned, contractor-operated facility, and funded through the U.S. Department of Energy.
Net Energy Metering (NEM)	A billing system that credits solar customers for surplus electricity they feed to the grid from small on-site sources such as residential rooftop solar systems.

Net Energy Metering Aggregation (NEM-A)	Allows a single solar customer with multiple meters on the same property, or on adjacent or contiguous properties, to use their solar system to serve the aggregated load behind all eligible meters and receive the benefits of Net Energy Metering.
New Solar Home Partnership (NSHP)	Part of the California Solar Initiative, the NSHP provides financial incentives and other support to homebuilders, encouraging the construction of new, energy efficient solar homes that save homeowners money on their electric bills and help protect the environment.
Pacific Gas and Electric Company (PG&E)	An investor-owned electric utility with publicly traded stock that is headquartered in the Pacific Gas & Electric Building in San Francisco, California.
Photovoltaic	The conversion of light into electricity using semiconducting materials that exhibit the photoelectric effect. A typical photovoltaic solar system is made up of any number of solar panels, each composed of many solar cells, which generate electrical power.
Power	Most references to power in this report refer to electrical power. Electric power is the rate, per unit time, at which electrical energy is transferred by an electric circuit.
Power Purchase Agreement (PPA)	A financial arrangement in which a third-party developer owns, operates, and maintains the photovoltaic solar system, and a host customer agrees to site the system on its property and purchases the system's electric output from the solar services provider for a predetermined period. This financial arrangement allows the host customer to receive stable and often lower-cost electricity, while the solar services provider or another party acquires valuable financial benefits, such as tax credits and income generated from the sale of electricity.
Property Assessed Clean Energy (PACE)	A financing mechanism that enables low-cost, long-term funding for energy efficiency, water conservation, and renewable energy projects. PACE financing is repaid as an assessment on the property's regular tax bill, and is processed the same way as other local public benefit assessments have been for decades. Depending on local legislation, PACE can be used for commercial, non-profit, and residential properties.
Publicly Owned Utility (POU)	An electric load serving entity that is owned and operated by a not-for-profit entity like a city or a county. Also known as municipal utility districts, MUDs, or munis.
Ratepayer	Persons who pay a regulated monopoly electric utility for service and who are not strictly considered "customers" given that they do not typically have an opportunity to choose the company to whom they pay their bill, an inherent aspect of the definition of <i>customer</i> (see <i>customer</i>).
Regional Climate Protection Authority (RCPA)	A Sonoma County agency formed in 2009 to coordinate countywide climate protection efforts among Sonoma County's nine cities and multiple agencies. The RCPA fosters collaboration, helps to set goals, pools resources, formalizes partnerships, and facilitates coordination among member jurisdictions.
Renewable Energy Credit	A tradable, non-tangible energy commodity in the U.S. that represents proof that one megawatt-hour of electricity was generated from an eligible renewable energy resource and was fed into electric grid.
Renewables Portfolio Standard (RPS)	A California regulation that requires the increased generation of electricity from eligible renewable energy sources, such as wind, solar, biomass, and geothermal. In California, the RPS target is currently 50 percent renewable energy generation by 2030.
Self-Generation Incentive Program (SGIP)	A California program that provides incentives to support existing, new, and emerging distributed energy resources. SGIP provides rebates for qualifying distributed energy systems installed on the customer side of the utility meter. Eligible technologies include wind turbines, waste heat to power technologies, pressure reduction turbines, internal combustion engines, microturbines, gas turbines, fuel cells, and advanced energy storage systems.

Single-family Affordable Solar Homes (SASH)	A program of the California Solar Initiative, administered by Grid Alternatives, that provides solar incentives on qualifying affordable single-family housing.
Smart Grid	An electricity supply and demand network that uses digital communications technology to detect and react to local changes in generation and usage to optimize overall system-wide performance and efficiency.
Soft Costs	A construction industry term, also used in the solar industry, for an expense item that is not considered a direct construction cost. Soft costs include architectural and engineering services, financing costs, legal fees, and other pre- and post-construction expenses.
Solar Energy Industries Association (SEIA)	A national 501(c)6 non-profit trade association representing the U.S. solar energy industry, which was established in 1974.
Solar Heating and Cooling	Technologies that collect thermal energy from the sun and use this heat to provide hot water, space heating and cooling, and pool heating for residential, commercial, and industrial applications. These technologies displace the need to use electricity or natural gas.
Solar Lease	In a solar lease, the customer agrees to pay a fixed monthly payment that is calculated on the estimated amount of electricity the system will produce. The customer agrees to have the system installed on their property, and a third party maintains ownership of the system.
Solar+	A name and concept developed by Solar Sonoma County that defines solar PV technology as a generation platform that can be integrated with electric vehicle charging, energy storage, fuel-switched appliances, and automation for provide a functional Distributed Energy Resource (DER) service.
Sonoma Clean Power	The second Community Choice Agency to launch service to customers in the state of California (2014), Sonoma Clean Power provides electricity to the residents and businesses of Sonoma County, California.
Sonoma County Energy and Sustainability Division (ESD)	A division of Sonoma County's General Services Department that promotes and delivers solutions necessary to mitigate environmental impacts and address climate change. ESD serves as a clearinghouse of information on solar energy improvements, energy efficiency, and water conservation, providing free solar consultations for residential and commercial projects; hosting Home Energy Workshops providing education on energy efficiency, water conservation, and solar PV systems; and facilitating the streamlined solar permitting program for solar systems ≤ 10 kW in size.
Sonoma County Energy Independence Program (SCEIP)	A Sonoma County division that provides PACE financing for energy efficiency, water conservation, and renewable energy generation projects as well as resources, rebates, incentives, and qualified contractors to help property owners save energy, save money, and live comfortably.
Sonoma County Water Agency (SCWA)	A Sonoma County-based agency that maintains a water transmission system that provides naturally filtered Russian River water to more than 600,000 residents and businesses in portions of Sonoma and Marin counties in California. The SCWA has a carbon-free water system.
Southern California Edison (SCE)	An investor-owned utility, and the largest subsidiary of Edison International. SCE is the primary electricity supply company for much of Southern California. It provides 14 million people with electricity across a service territory of approximately 50,000 square miles.
Substation	A part of an electrical generation, transmission, and distribution system. Substations transform voltage from high to low, or the reverse, while performing other important power management functions. Between the generating station and consumer, electric power may flow through several substations at different voltage levels.

SunShot Initiative	A national U.S. Department of Energy initiative to support solar energy adoption by making solar energy affordable for all citizens through research and development efforts in collaboration with public and private partners.
Tariff	A pricing schedule or rate plan that utilities offer to customers. Along with the pricing plan, there may be certain rules for each tariff a utility offers, such as the times or seasons when prices will vary, eligibility for a tariff, when/how a customer can join or leave the tariff, what type of meter must be installed, etc.
Time-of-Use (TOU) Rates	A kind of electricity pricing that breaks up the day into two or three large intervals and charges a different price for each interval. Rates can be divided into off-peak, semi-peak, and peak prices.
Transmission and Distribution (T&D)	The system of poles and wires that deliver electricity. <i>Transmission</i> refers to the high voltage long distance part of the system that brings power from generation plants to local service areas; <i>distribution</i> refers to the lower voltage short distance part of the system that delivers power to customers.
U.S. Energy Information Administration (EIA)	A part of the U.S. Department of Energy, the EIA is a principal agency of the U.S. Federal Statistical System responsible for collecting, analyzing, and disseminating energy information to promote sound policymaking, efficient markets, and public understanding of energy and its interaction with the economy and the environment. EIA produces data on coal, petroleum, natural gas, electricity, renewable and nuclear energy.
Vehicle to Grid Integration (VGI)	A system in which electric vehicles may be connected to and in communication with the electrical grid to sell demand response services by either returning electricity to the grid or by throttling down their charging rate.
Virtual Net Energy Metering (VNEM)	A tariff arrangement that enables multi-meter property owners to allocate a solar system's energy credits to other tenants.
Zero Emission Vehicles (ZEV)	Vehicles that have no tailpipe emissions. Note that some emissions are produced in the manufacture of the vehicles and in the generation of the power/fuel that recharges or refuels them.

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