**Sustainable Systems Research Foundation, Inc.**
2861 Mission St., Suite 247
Santa Cruz, CA 95060
Phone: 831-708-5836
sustainablesystemsresearch@gmail.com
https://sustainablesystemsfoundation.org/

# Designing the Santa Cruz Westside Microblock: A Strategy and Call for Renewable Community Energy Systems

Ronnie D. Lipschutz
September 14, 2020

## Executive Summary

It is high time that California begins a serious transition from the investor-owned utility (IOU) power grid of the early 20th century to distributed energy community-controlled systems based on solar photovoltaics and battery storage. In recent years, California's IOUs—Pacific Gas & Electric (PG&E), Southern California Edison (SCE), and San Diego Gas & Electric(SDG&E)—have demonstrated repeatedly their inability to operate their grids in a safe and effective manner. Current efforts by the utilities and California Public Utilities Commission (CPUC) to patch the holes in the grid are no more than bandages on an obsolete and unstable monopoly. Supporters of Community Choice Aggregation (CCA) hoped that these local authorities would take on the task of moving California toward community energy systems but, for the most part, the CCAs have become intermediate distributors of electricity from remote independent generators.

A major obstacle to development of community energy systems is a state regulatory framework that imposes severe and costly restrictions and requirements on non-utility generation, distribution and sale of electricity. Indeed, these limitations increase the costs of community energy generation so much as to render them financially impractical: a kilowatt-hour of solar photovoltaic costs about 10 cents to produce, but distribution and other charges imposed by the IOUs and CPUC on solar PV bring the retail cost to the customer up to the level of power from those selfsame IOUs. The sabotage is deliberate.

What is to be done? The Sustainable Systems Research Foundation (SSRF) and its partners believe that, within five to ten years, many of these regulatory restrictions will be removed, allowing community energy systems to flourish. In order to be "shovel ready" when that future arrives, we are designing and planning a 10-megawatt solar pilot plant for a commercial block on the west side of Santa Cruz. The Santa Cruz Westside Microblock (or SWIM) will be built in phases, starting with individual buildings and adjacent structures (2021-25), then linked into a single system (2026-28) and, finally, connected to the grid (2028-30). Our proposal, and the background to it, are provided in this SSRF Policy Brief.

## I. Introduction

Sixty-six million years ago, an 8-mile wide asteroid slammed into the Gulf of Mexico, near Chicxulub in the Yucatan. That impact abruptly ended the 180 million year-long Age of Reptiles, forever eliminating large dinosaurs from the Earth (the small ones evolved into birds). Today, private monopoly electrical utilities are the dinosaurs, and an asteroid is on its way to wipe them out. By the middle of the 21st century—or perhaps sooner—these utilities will disappear, replaced by much smaller, more resilient, flexible and reliable smart renewable energy microgrids and battery storage, operated by public entities based in the communities that they serve.[1]

Right now, the nation's investor owned utility power system is fragile and held together with regulatory duct tape. And even duct tape wears out eventually. Rather than trying to save a broken system, there is a strategy available that will cost less, be more reliable and resilient, and reduce carbon emissions, all at the same time: community- based, renewable energy microgrids that serve localities and are locally controlled but can also connect with other microgrids to provide power regionally and farther afield, if needed.[2]

As the cost of renewable electricity, especially from solar photovoltaics, declines, communities and customers will no longer need to rely on large, far away, mostly carbon-powered utilities and generating plants. In place of a monolithic, top-down utility, linked microgrids offer a bottom-up solution that is far more stable, resilient, and compatible with widespread development of renewable energy resources and the necessary transition away from fossil fuels. A key benefit of renewable microgrids connected through a large distribution network is that they can disconnect from the grid, if necessary, continuing to deliver safe, reliable power and avoiding arbitrary blackouts of millions of people. The well-being of tens of millions of people will no longer be in the hands of a distant, profit-oriented utility but, rather, local decision-makers committed to their communities' well-being.[3]

The City of Santa Cruz is an especially appropriate location for a community energy system. It sits at the end of PG&E's high voltage transmission lines and, as a result,

---

[1] Matthew Bandyk, "2020 Outlook: Utilities will be pushed to further embrace distributed energy resources, *UtilityDive*, January 17, 2020, at: https://www.utilitydive.com/news/2020-outlook-utilities-will-be-pushed-to-further-embrace-distributed-energ/569613/ (accessed August 2, 2020); Lorenzo Kristov, "The Bottom Up (R)evolution of the Electric Power System," *IEEE power & energy Magazine*, March/April, 2019, DOI: 10.1109/MPE.2018.2885204

[2] Russell Ray, "Are Electric Utilities in a Death Spiral?" *Energize Weekly*, September 26, 2018, at: https://www.euci.com/are-electric-utilities-in-a-death-spiral/ (accessed September 10, 2020).

[3] David Roberts, "The radical reform necessary to prepare California's power system for the 21st century," *Vox*, November 1, 2019, at: https://www.vox.com/energy-and-environment/2019/11/1/20934452/california-pge-power-system-21st-century (accessed August 2, 2020).

experiences more than its share of power fluctuations and outages. The wildfires and power blackouts of 2019 and 2020, and the rolling outages during the 2020 August and September heat waves, made clear that much of Northern California is at risk from such events.


*Figure 2: High-voltage power lines feeding the Santa Cruz Area*[4]

While the State of California and its IOUs are making serious efforts to address the unreliability of the power grid servicing their territories, these do not at present extend beyond provision of emergency, diesel-powered generators for "resilience."[5]

Solar photovoltaic microgrids with battery storage offer a local solution to these and other problems with our regional monopoly IOU. This policy brief explores the potential for such microgrids to address the City's power vulnerabilities, reduce greenhouse gas emissions locally and contribute to the State's electrification plans. The Sustainable Systems Research Foundation and its partners are developing proposals for the design of a 10-megawatt solar PV microgrid on the West side of Santa Cruz—the **SC Westside Microblock** (SWIM).[6] This brief focuses on SWIM, which will proceed in four stages, beginning with (1)the two proximate buildings on the south side of the Mission Street extension, followed by connection to an adjacent produce cooler; (2) construction of several independent systems on the north side of

---

[4] Pacific Gas & Electric, "Economic Development Site Tool," generated July 16, 2020, at https://www.pge.com/en_US/large-business/services/economic-development/opportunities/sitetool.page

[5] "PG&E Strengthening Community Resilience with Comprehensive Microgrid Solutions," PG&E Press Release, June 11, 2020, at: https://www.pge.com/en/about/newsroom/newsdetails/index.page?title=20200611_pge_strengthening_community_resilience_with_comprehensive_microgrid_solutions (accessed August 28, 2020).

[6] We are beginning to explore a similar system to service the Santa Cruz Beach Boardwalk and the adjacent Beach Flats neighborhood.

mission to be linked together as possible, (3) joining of the north and south side systems and, eventually, (4) integration of the whole microgrid into the utility grid. This would allow the owners of the microgrid to wheel power to other properties in Santa Cruz or sell surplus electricity to the local community choice aggregator. This microgrid could also be pressed into service during power emergencies and blackouts.

*Figure 1: SWIM Schematic & Phases*

As we shall discuss later in this brief, it is not possible to build such as system at the present time; that will require changes in state regulations and utility attitudes. It will require several years to bring SWIM into service and now is an opportune time to lay the groundwork for a community energy future.

## II. Why private monopoly utilities are on a path to extinction

The coming extinction of investor owned utilities (IOUs) will be driven by at least three factors: climate change, technological obsolescence and financial exigencies. First, as the cascading impacts of climate change grow, adverse weather events, combined with decades of fire suppression policies, will increase the frequency of deadly conflagrations—whether utility-caused or not. Moreover, given the size and scale of many utilities' service territory and the complexity of their distribution network, even intentional outages to prevent fires will not prevent failures in vulnerable parts of their systems.[7] These risks and the liabilities they entail are leading institutional shareholders to pressure IOUs to increase dividends and short-

[7] David Roberts, "Wildfires and blackouts mean Californians need solar panels and microgrids," *Vox*, October 28, 2019, at: https://www.vox.com/energy-and-environment/2019/10/28/20926446/california-grid-distributed-energy (accessed August 2, 2020).

term returns, leaving the utilities short of capital to repair and maintain their increasingly fragile distribution grids.[8]

Second, a massive transition to renewable energy sources is underway and cannot be stopped. New energy sources take time to penetrate deeply into societies, and coal and natural gas will remain mainstays of electricity generate for decades to come. But the costs of solar and wind power continue to decline and are, in many instances today, cheaper than fossil fuels. Most U.S. states have developed "renewable energy portfolios" that require growing fractions of energy use come from solar, wind and water and, while most utilities are purchasing power from large-scale, centralized wind and solar farms, high grid distribution and maintenance costs are likely to make such sources less economical over time.[9]

Third, electrical utilities face the specter of rising costs and declining revenues—the so-called utility death spiral—which can be remedied by higher tariffs for only so long. Rising costs come from maintenance of extensive distribution grids—and liabilities from network failures—and the labor required to keep those grids operating, among other things. Declining revenues arise as more and more customers decide they can do better by generating their own electricity and public utility commissions come under political pressure to limit tariff increases, especially those left behind. Shareholders will pressure utilities to economize, thereby increasing hazards and risks, or they will abandon them to seek higher returns elsewhere, depriving utilities of critical capital.[10]

The state's three large IOUs—Pacific Gas & Electric, San Diego Gas & Electric and Southern California Edison—are being dragged kicking and screaming into this future, and are resisting as much as possible, for obvious reasons. First, it is much easier to conduct business-as-usual than to adapt to new conditions. Second, community-based distributed energy resources (DERs) in the form of microgrids threaten the business model of the IOUs and investor earnings. Third, DERs transfer much of the oversight of power systems from centralized to local bodies and authorities. It is too soon to tell whether extinction is in the cards, but it cannot be ruled out.

---

[8] PG&E's "exit" from bankruptcy shortchanges fire victims to the benefit of shareholders and is premised on target share prices that appear impossible to achieve. More generally, see Jeff St. John, "4 Things PG&E Must do to Survive and Thrive as It Exists Bankruptcy," *Greentechmedia.com*, July 2, 2020, at: https://www.greentechmedia.com/articles/read/four-hurdles-pge-must-clear-to-survive-post-bankruptcy (accessed September 10, 2020).

[9] Amol Phadke, et al., "2035—The Report," Goldman School of Public Policy, June 2020, at: https://www.2035report.com/ (accessed July 15, 2020).

[10] Steve Corneli & Steve Kihm, "Electric Industry Structure and Regulatory Responses in a High Distributed Energy Resources Future," Lawrence Berkeley Bal Future Electric Utility Regulation Report No. 1, November 2015, at: https://eta-publications.lbl.gov/sites/default/files/lbnl-1003823.pdf (accessed August 2, 2020).

## II. So what, exactly, is a microgrid?[11]

The Department of Energy's Microgrid Exchange Group defines a microgrid as

> A group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode.[12]

This is a rather opaque; what does it mean? First, a *microgrid* should be compared to a *macrogrid*. The latter is either the sum total of an electric utility's generation, transmission and distribution system or the sum total of all such electricity generation, transmission and distribution systems, with interconnections, in the United States. By contrast, a microgrid is a relatively small electricity generation operation along with the wires and controls that distribute power to nearby customers.

Second, the original energy source and generating technology of the microgrid is not fixed; it could be fossil fuels, small dams, biomass, waste or renewables (even, in theory, a small nuclear reactor). A microgrid can also include batteries to store surplus electricity and make it available when the sun or wind are not available (e.g., at night).

Third, the "service area" of a microgrid is usually limited to one or several adjacent consuming sites and its distribution system is often separated, or "islanded," from the macrogrid, even as the latter may also providing power to those same sites on separate circuits.[13] But—and this is a key point—a microgrid can also be connected to the macrogrid and send its power out into the larger world, if the rules permit it.[14]

Many operating microgrids are islanded and are not designed or permitted to send electricity offsite into the distribution system and transmission network or, if they are, incorporate complex arrangements for ensuring that this cannot happen during power outages. In some instances, utilities control the interconnection hardware and

[11] An excellent place to learn about all things microgrid-related is "Microgrid Knowledge" at: https://microgridknowledge.com/

[12] This definition, attributed to the "Microgrid Exchange Group," appears in hundreds of documents, but the original source does not seem to exist anywhere.

[13] See, for example, Redwood Coast Energy Authority, "Airport Solar Microgrid," https://redwoodenergy.org/community-choice-energy/about-community-choice/power-sources/airport-solar-microgrid/ (accessed August 2, 2020).

[14] One of the convenient fictions of power transmission and distribution is that "packages" of moving electrons can be distinguished from one another for purposes of buying and selling. In reality, of course, this is merely a bookkeeping device, since the microgrid's electrons disappear into the sea of electrons coming from other generators. The practice of "moving" such packages of electrons from a site of generation to a site of consumption is called "wheeling."

software, and can limit how much electricity is sent into the grid and how much they pay for that power. A growing number of microgrids are being put into operation for the purposes of "resilience," to operate when the macrogrid has been shut down, especially at sites such as hospitals, emergency responders and police stations that do not have backup generators and must have power during blackouts and natural disasters.[15]

Microgrids are attractive because they can generate electricity at a cost that is usually below the retail price charged by a monopoly utility. This is a sore point for utilities who must cover not only the wholesale price for the power they purchase from independent generators[16] but also pay for the cost of maintaining and operating the transmission and distribution network. As a result, customers of microgrids are required to pay additional charges to cover the cost of disconnection from the macrogrid (called the "Power Charge Indifference Adjustment," or PCIA). Solar generator who rely on macrogrid power in lieu of on-site battery storage for off-peak power are also charged for "using" the transmission and distribution networks. We will return to the financial aspects of microgrids later in this brief; suffice it here to say that, at the present moment it is not so easy to make a macrogrid-connected microgrid attractive to those looking for high returns on their investments. By the same token, relying wholly on an islanded microgrid can reduce customers' utility bills, but those savings do not represent cash-in-hand for the owner (who are only allowed to sell their electricity to immediately adjacent neighbors; see below).

Notwithstanding these, and other obstacles (described below), there is a great deal of excitement about the potential for solar microgrids becoming the default source of power as the 21st -century proceeds. In particular, localized solar photovoltaic microgrids appear especially attractive, for several reasons. First, they emit no greenhouse gases (although they are not wholly "carbon" and "pollution-free," because manufacture, transport and disposal require materials and processes that are both carbon-intensive and toxic). Second, solar panels are modular and solar generation is much less reliant on economies of scale than are other power sources.[17] That is, while large fossil fueled and nuclear generators and turbines produce electricity at a lower marginal cost than smaller ones, while there is no cost

[15] See, for example, California Community Choice Association, "CCA Resilience Initiatives," August 2020, at: https://cal-cca.org/wp-content/uploads/2020/05/CCA-Resilience-Iniatitives-August-2020.pdf (accessed September 6, 2020).

[16] In California, the electricity market is "deregulated" and private utilities no longer generate most of the electricity they provide to retail customers. Instead, they obtain power through long-term contracts with "independent" generators and short-term buys through an Independent System operator.

[17] An "economy of scale" means that the marginal or additional cost of producing each additional unit of something is less than the previous one, so it makes economic sense to mass produce large numbers of goods in large factories and generators, at least up to a point. While operating and servicing costs of a large solar farm are probably lower than for a comparably sized set of much smaller microgrids, this is as much a result of accounting as real differences in operating and servicing costs.

differential between power from a single PV panel and 100,000. Third, community based distributed energy sources offer the potential to utilize roofs, parking lots and undeveloped spaces, controlled by local governments and authorities, rather than far-off IOUs. Microgrids can also offer a number of ancillary services that increase their value to customers, communities and the grid (see below).[18]

**III. The regulatory environment as obstacle**

But, if solar microgrids are so great, why are there not more of them? As of this writing, there are close to 10,000 megawatts of solar PV distributed energy capacity across California, most of that being individual rooftop installations.[19] Of this, there are perhaps 1,000 megawatts (1 gigawatt) of solar microgrid capacity planned and in operation. The potential for microgrids is considerably larger, by some estimates, upward of several dozen gigawatts or more (current total state generating capacity is slightly less than 80 gigawatts while peak demand is around 50 gigawatts).[20]

There are two major regulatory hurdles that stand in the way of growth in microgrids, compared to which technical issues are relatively simple. The first of these is the bane of all innovative and transformative projects: business as usual (BAU). Those who benefit from BAU have no incentive to change or disrupt things or, at least, give up control of something (this is sometimes called "bureaucratic" or "regulatory inertia"[21]).

In the present case, beneficiaries of BAU include the IOUs, their regulatory overseers and speculative markets. On the supply side, disruption is potentially destabilizing to long-established infrastructures and ways of doing things. On the demand side, most customers are not concerned about *how* their electricity is generated; they only care that it be delivered reliably and at the lowest cost possible. So public demand for change is limited. Indeed, if microgrids do threaten the hegemony of monopoly IOUs, as the asteroid did the dinosaurs, we should expect that all tools and obstacles at the IOUs' disposal will be thrown at the former to obstruct and slow down deployment of alternatives, and delay IOUs' extinction, with the public doing little to intervene.

---

[18] These are sometimes called the "value stack." See Elke Klaassen, et al, "Flexibility Value Stacking," Universal Smart Energy Framework, October 18, 2018, at: https://www.usef.energy/app/uploads/2018/10/USEF-White-Paper-Value-Stacking-Version1.0_Oct18.pdf (accessed August 5, 2020).

[19] California Distributed Energy Statistics, "Statistics and Charts," at: https://www.californiadgstats.ca.gov/charts (accessed August 30, 2020).

[20] California Energy Commission, "Electric Generation and Capacity," April 29, 2020, at: https://www.energy.ca.gov/data-reports/energy-almanac/california-electricity-data/electric-generation-capacity-and-energy (accessed August 30, 2020). It is important to distinguish here between *capacity* in mega- or gigawatts, a measure of peak power potential, and output, in kilowatt or megawatt-hours, a measure of electricity generation.

[21] Antoine Faure-Grimaud & David Martimort, "Regulatory inertia," *RAND Journal of Economics* 34, #3 (Autumn 2003): 413-37.

Why is BAU so entrenched, especially if there are better ways of accomplishing the same goals? Explanation of this paradox requires a brief lesson in what is called "political economy," that is, the ways in which holders of forms of power, wealth and influence are able to shape law and regulation in their favor. Under BAU, *playing* the game according to written rules is for suckers, whereas *writing* the rules that shape the structure of the game can ensure victory without having to throw a single ball into play. IOUs have the concentrated wealth and influence to shape the structure of the game, and they also have many friends in positions of wealth and political power who can help them do this. By contrast, customers are small fry, dispersed and have only limited resources to bring to bear on policy and politics.[22] The California Public Utilities Commission (CPUC) often seems to be an especial friend of the three IOUs, who can get pretty much whatever they request in the way of restrictions on microgrids and independent power generation. And they have not been shy in asking for restrictions. As a result, efforts to level the regulatory field for community-scale microgrids have proven slow and difficult.[23]

There are three major regulatory obstacles put in place of small power generators by the CPUC. These were originally developed in the interest of efficiency and controlling monopolies but now serving to benefit the IOUs.

First, who qualifies to be an electrical utility? Section 218[24] of the California Public Utilities Code is very explicit. An

> "Electrical corporation" includes every corporation or person owning, controlling, operating, or managing any electric plant for compensation within this state, except where electricity is generated on or distributed by the producer through private property solely for its own use or the use of its tenants and not for sale or transmission to others (Section 218a).

Second, to whom can a microgrid generator send electricity?

---

[22] This is sometimes called "socialism for the rich; capitalism for the poor" and explained by the "logic of collective action," whereby it is very difficult to build coalitions among a large number of individuals and much easier to do so if there is a dominant power willing to pay the costs of coalition-building. For the moment, there exists no such dominant power on the side of challengers to BAU. See also: Matt Roberts, "Multi-Customer Microgrid Projects: Rare, Difficult and the Future," *Microgridknowledge.com*, September 11, 2020, at: https://microgridknowledge.com/multi-customer-microgrid/ (accessed September 11, 2020).

[23] The reader interested in such regulatory proceedings should consult the following web site: California Public Utilities Commission, "Resiliency and Microgrids," at: https://www.cpuc.ca.gov/resiliencyandmicrogrids/. Additional information can be found an the SSRF's Microgrid Resources Page at: https://sustainablesystemsfoundation.org/microgrid-resources/.

[24] California Public Utilities Code, "Chapter 1: General Provisions and Definitions, at: http://leginfo.legislature.ca.gov/faces/codes_displayText.xhtml?lawCode=PUC&division=1.&title=&part=1.&chapter=1.&article= (accessed June 19, 2020).

> "Electrical corporation" does not include a corporation or person employing cogeneration technology or producing power from other than a conventional power source for the generation of electricity solely for any one or more of the following purposes:
>
> (1) Its own use or the use of its tenants.
>
> (2) The use of or sale to not more than two other corporations or persons solely for use on the real property on which the electricity is generated or on real property immediately adjacent thereto, unless there is an intervening public street constituting the boundary between the real property on which the electricity is generated and the immediately adjacent property… (Section 218b).

In other words, anyone generating electricity for their own use is not permitted to transmit surplus farther than their next-door neighbors and absolutely not across "an intervening public street," because that is part of the definition of an "electrical corporation."[25] In effect, this turns a public street into a form of limited private property. A utility can grant a generator an easement to cross a public street but it is under no obligation to do so (and it can charge handsomely for the privilege, if it so desires).[26]

Third, to whom can a microgrid generator sell electricity? The subsections of California Public Utilities Code Section 218(2) stipulate limits "when one or more of the following applies:"

> The real property on which the electricity is generated and the immediately adjacent real property is not under common ownership or control, or that common ownership or control was gained solely for purposes of sale of the electricity so generated and not for other business purposes… (Section 218b 2A).

[25] Except for this section of California Public Utilities Code, it is difficult to find the rationale for the restriction on crossing streets, which does not seem to appear anywhere else in various laws and regulations, and even though permission is given explicitly to telephone and other communication companies.

[26] This was one of the challenges facing the proposed downtown Berkeley microgrid, which would have had to cross city streets to fulfill its proposed function. See: Katie Van Dyke, et al., "Berkeley Energy Assurance Transformation (BEAT) Project—Case Study," City of Berkeley, June 20, 2018, at: https://www.cityofberkeley.info/uploadedFiles/Planning_and_Development/Level_3_-_Energy_and_Sustainable_Development/BEAT_Case_Study.pdf (accessed June 25, 2020).

> Sale or transmission to an electrical corporation or state or local public agency, but not for sale or transmission to others, unless the corporation or person is otherwise an electrical corporation (Section 218b 3).[27]

Section 218e also stipulates that "Electrical corporation" does not include an "independent solar energy producer." These are governed by California Public Utilities Code 2868,[28] which defines such entities as follows:

> (b) "Independent solar energy producer" means a corporation or person employing one or more solar energy systems for the generation of electricity for any one or more of the following purposes:
>
> (1) Its own use or the use of its tenants.
>
> (2) The use of, or sale to, not more than two other entities or persons per generation system solely for use on the real property on which the electricity is generated, or on real property immediately adjacent thereto.
>
> (c) "Real property" means a single parcel of land.

It is not entirely clear how to reconcile the two sections of the code much less fully understand them.

Fourth, how much can a microgrid generator charge for electricity? So long as the generator remains within the restrictions stipulated in the utility code, it would appear that any price is acceptable (although gouging is frowned upon). However, as soon as a microgrid operator tries to send electricity into the distribution grid, the game changes entirely. For the time being, under the policy of "net energy metering" (NEM), any surplus electricity fed into the grid is "sold" to the utility at the going retail price per kilowatt- hour and "bought" back by the generator when the microgrid or PV array is not operating. Under NEM, generators receive a credit on their bills but no monetary remuneration for surplus electricity.[29]

A more complicated situation arises when a microgrid operator contracts with a utility to wheel electricity through the grid to a utility or public agency—and this also applies

---

[27] This is another odd provision, since it seems to allow "sale" to utilities or public entities, which should include CCAs

[28] California Public Utilities Code, "Chapter 9, Article 3. Solar Energy Systems—Independent Solar Energy Producers," at: http://leginfo.legislature.ca.gov/faces/codes_displayText.xhtml?lawCode=PUC&division=1.&title=&part=1.&chapter=1.&article= (accessed August 2, 2020).

[29] Edison Electric Institute, "Solar Energy and Net Metering," January, 2016, at: https://www.eei.org/issuesandpolicy/generation/NetMetering/Documents/Straight%20Talk%20About%20Net%20Metering.pdf (accessed August 2, 2020).

to the price charged to a customer of the microgrid if the latter is connected to the grid. The utility is allowed to impose a service charge per kilowatt- hour of microgrid electricity for use and maintenance of the grid infrastructure. Pacific Gas & Electric, for example, charges generators exactly the right amount to equalize their retail prices, which means that a microgrid customer realizes no savings on its electricity purposes.

For example, Monterey Bay Community Power's electric generation charge on a recent electric bill was 8.2¢ per kilowatt hour. The use charges imposed by the owner of the transmission and distribution grid, PG&E, were 14.1¢ per kilowatt hour.[30] With other charges, CCA power was no cheaper than PG&E's base retail rate (PG&E's generation cost is around 9.5¢ per kilowatt hour). The transmission and distribution charges are intended to cover the capital, operating and maintenance cost of the grid, although this is a bit disingenuous, since the capital cost of that infrastructure were amortized long ago.

But wait, there are more burdens placed on distributed energy generators wishing to wheel power through the grid! Utilities can impose insurance charges on microgrid operators to cover any costs arising from malfunction or damage to the utility's network arising from microgrid transmission. The utility can also demand transfer of ownership to itself of parts of the microgrid's own transmission network and impose the future cost of operation and maintenance of those portions on the microgrid operator.[31]

This is not the end of the regulatory gauntlet facing microgrids and their owners, operators and customers, but it gives a sense of the obstacles facing those who want to generate their own power and connect to the utility macro grid. The California Public Utilities Commission recently issued an order to private utilities to expedite the construction and connection of microgrids for resiliency and emergency purposes (but not for the sole purpose of generating electricity), and will be holding hearings addressing more-rapid deployment of microgrids during the remainder of 2020 and

[30] There is an additional cost called PCIA, or "Power Charge Indifference Adjustment" of roughly 3.3¢ per kilowatt hour, which is "the calculated rate paid by departing CCA customers for power supply cost stranding resulting from leaving Investor Owned-Utility (IOU) generation service." Gary Saleba, "How Does the Newly Passed Power Charge Indifference Adjustment Affect California Community Choice Agencies," Clean Power Exchange, January 23, 2019, at: https://cleanpowerexchange.org/how-does-the-newly-passed-power-charge-indifference-adjustment-affect-california-community-choice-agencies/ (accessed August 31, 2020).

[31] Katie Van Dyke, et al., "Berkeley Energy Assurance Transformation (BEAT) Project—Case Study," City of Berkeley, June 20, 2018, at: https://www.cityofberkeley.info/uploadedFiles/Planning_and_Development/Level_3_-_Energy_and_Sustainable_Development/BEAT_Case_Study.pdf (accessed June 25, 2020).

probably into 2021.[32] Whether the outcomes of these hearings will facilitate increased construction of microgrids remains to be seen.[33]

## IV. Financing & economics as obstacles

Do solar microgrids pencil out? That is, can they generate monetary and other benefits over their lifetimes that exceed capital and operating costs? Answers to such questions are critical for both public funders and private investors, the former to demonstrate that money has been put to good use, the latter seeking a robust return on investment. Independent microgrids can be financially risky projects if the CPUC and the IOUs can burden them with all kinds of costs that raise their retail electricity prices to noncompetitive levels. Even though the generating and control technology is readily available, tested successfully and demonstrated lower generation costs and increased resilience, that is still not of sufficient mass to kill the dinosaurs. The asteroid has been sighted, but it has yet to hit the Earth.

Financial viability is enormously complicated and involves not only capital costs but also design, interconnections, construction, transmission, ancillary services, utility tariffs, taxes and tax credits, among other things.[34] A homeowner might pay around $20,000 to put 5 kilowatts of solar PV on her roof, with a reasonable payback period that depends on electricity generated and consumed. By contrast and comparison, and all else being equal, the returns from a 10-megawatt microgrid (10,000 kilowatts) must cover not only equipment costs ($15-20 million) but many others. Table 1 below is an incomplete list of financial considerations.

---

[32] CPUC, "Administrative Law Judge's Ruling Requesting Comments on the Track 2 Microgrid and Resiliency Strategies Staff Proposal," July 23, 2020, Rulemaking 19-09-009, at: https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M344/K038/344038386.PDF (accessed July 28, 2020). See also: Herman K. Trabish, "PG&E, SCE abandon big microgrid plans for temporary emergency measures as wildfire season nears," *UtilityDive*, March 23, 2020, at: https://www.utilitydive.com/news/pge-sce-abandon-big-microgrid-plans-for-temporary-emergency-measures-as-w/574506/ (accessed July 16, 2020); PG&E, "PG&E Strengthening Community Resilience with Comprehensive Microgrid Solutions," New Release, June 11, 2020, at: https://www.pge.com/en/about/newsroom/newsdetails/index.page?title=20200611_pge_strengthening_community_resilience_with_comprehensive_microgrid_solutions (accessed August 2, 2020).

[33] General and ongoing information about these proceedings is available at the CPUC's "Resiliency and Microgrids Events and Materials," at https://www.cpuc.ca.gov/General.aspx?id=6442463482 (accessed September 12, 2020). The Microgridknowledge.com web site offers some continuing reporting on and analysis of the CPUC proceedings.

[34] Rima Kasia Oueid, "Microgrid finance, revenue, and regulation considerations," *The Electricity Journal* 32 (2019): 2-9. A sense of the financial complexity of a microgrid can be seen in the "Cost of Renewable Energy Spreadsheet Tool (CREST)," a model published by the National Renewable Energy Lab. CREST is available at https://www.nrel.gov/analysis/crest.html.

**Table 1: Inputs into microgrid financing**

| Costs | Offsets |
|---|---|
| Capital (equipment, plant, construction) | State & federal tax credits |
| Investor return on investment | Value of generated electricity |
| Loan interest | Depreciation |
| Land & development | Ancillary services & value stacking |
| Operation & maintenance | Renewable energy credits |
| Insurance & liability | Carbon credits |
| Connection to grid (if necessary) | Avoided costs of new plant construction |
| Taxes | |

The benefits of microgrids are not limited simply to the economic case for or against or the cost of power. There are additional benefits that will be difficult to capture. For example, electrification of California by 2045, required under 2018's Senate Bill 100,[35] signed by then-Governor Jerry Brown, will require not only new sources of generation but also new transmission and distribution lines, which will be quite costly. Microgrids could minimize this latter need. The social cost of carbon is, for the moment, quite low, but we can imagine that it will rise in the future. Resilience, reliability, peak load resources, reductions in utility capital expenditures, greenhouse gas reductions, grid and voltage stability are benefits[36] not presently monetized or recognized, much less internalized in financing and operating calculations (what is the value of carbon reductions?).[37]

Some communities and community choice aggregators (CCAs) do include these broader benefits in their calculations, even if they cannot be monetized. It is possible, for example, that a city like San Francisco might seek to create a municipal utility by purchasing or exercising eminent domain over PG&E's distribution network

---

[35] The text of the bill, SB-100 California Renewables Portfolio Standard Program: emissions of greenhouse gases, is available at: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB100 (accessed September 12, 2020). A critique of the bill can be found at: Roger Andrews, "Assembly Bill 100 and a 100% renewable California," *Energy Matters*, September 11, 2018, at: http://euanmearns.com/assembly-bill-100-and-a-100-renewable-california/ (accessed September 12, 2020).

[36] Elke Klaassen, et al, "Flexibility Value Stacking," Universal Smart Energy Framework, October 18, 2018, at: https://www.usef.energy/app/uploads/2018/10/USEF-White-Paper-Value-Stacking-Version1.0_Oct18.pdf (accessed August 5, 2020).

[37] Peter Asmus, "California's Critical Facility Challenge—The Case for Energy as Service Municipal Microgrids," Navigant Consulting, May 8, 2019, at: https://internationalmicrogrids.org/wp-content/uploads/2019/05/Navigant-Research-White-Paper-Schneider-Electric-Municipal-Microgrids-5-8-19.pdf (accessed June 25, 2020); Microgrid Knowledge, "Why Energy-as-a Service Microgrids are the Logical Next Step for California…and the Rest of the U.S.," 2020, at: https://microgridknowledge.com/white-paper/energy-as-a-service-microgrids-california/ (accessed June 23, 2020).

within their boundaries (which PG&E refuses to do). CCAs could contract for supplies from local microgrids rather than purchasing solar electricity generated hundreds of miles away (as Monterey Bay Community Power is doing). Even neighborhoods could get into the game, linking rooftop solar to supply their own needs as well as their neighbors and exporting the surplus for sale across the grid. But these are mostly possibilities for the future.[38] Monetization of the value stack will help to increase financial viability.

In September 2019, Monterey Bay Community Power (MBCP; now renamed “Central Coast Community Energy”), Santa Cruz’s regional community choice aggregator (CCA), issued a “5-Year Electrification Programs Roadmap,”[39] which described a “Smart Connect Microgrid Program…designed to facilitate the development of microgrid projects in the MBCP service region to support the company’s GHG reduction, economic development, grid reliability and resiliency, and community emergency preparedness goals” (p. 51). MBCP has requested proposals for public emergency site microgrids but has not gone further in fostering general-purpose projects for providing local power. Instead, it is contracting with independent solar producers based in Kern County, California and across the state line in Nevada.[40]

Indeed, it is not entirely clear whether California CCAs are very interested in either building or contracting with community-based solar microgrids for electricity—at least, beyond resilience projects. They should have the legal authority to do so, although it is less clear that they have the credit rating to raise financing bonds. One example of a CCA partnering with others to build and operate a local microgrid is the “Redwood Coast Airport Renewable Energy Microgrid.” Partners are Humboldt County, the Redwood Coast Energy Authority (RCEA), the Schatz Energy Research Center (SERC) and PG&E. The project is funded by a $5 million grant from the California Energy Commission and $6 million in match funding from RCEA. As the project website puts it, “The County will house the airport microgrid, RCEA will own and operate the solar and battery systems, PG&E will operate the microgrid circuit [i.e.,

[38] Ecoblock, at: https://ecoblock.berkeley.edu/ ; Zach Barr, et al., “Accelerating the Deployment of Advanced Energy Communities: The Oakland EcoBlock,” California Energy Commission. Publication Number: CEC-500-2019-043, at: https://ww2.energy.ca.gov/2019publications/CEC-500-2019-043/CEC-500-2019-043.pdf (accessed August 2, 2020).

[39] Monterey Bay Community Power, 5-Year Electrification Programs Roadmap,” September 2019, https://www.mbcommunitypower.org/wp-content/uploads/2020/02/MBCP-ESP-Task-3-Electrification-Programs-Roadmap.pdf (accessed July 1, 2020).

[40] Staff Report for Policy Board of Directors, Monterey Bay Community Power/Central Coast Community Energy, September 2, 2020, at: https://mbcommunity.onbaseonline.com/1800AgendaAppNet/Documents/DownloadFile/Staff%20Report%20for%20-%20POWERPOINT%20(4841).pdf?documentType=1&meetingId=281&itemId=4841&publishId=7815&isSection=False&isAttachment=True (accessed August 28, 2020).

the intertie to the grid], and SERC will be the prime contractor responsible for the project design and technology integration."[41]

The Redwood Coast project includes

- 250 kW net-metered system to offset daily electricity usage at the airport
- 2 MW of wholesale power that will feed clean energy directly into the grid
- 2 MW battery storage system providing 8MWh of energy storage
- Microgrid controller providing the ability to "island" from the main grid so the airport and adjacent Coast Guard facility can run fully on solar and batteries if there is a regional power outage
- Electric vehicle charging stations capable of demand response
- Enough solar-generated electricity to power 430 households and prevent the emission of ~880 metric tons of carbon dioxide (id.)

PG&E's control of the intertie eliminates most of the regulatory and other complications described earlier in this brief. No other California CCA has gone this far.[42]

Why go where no one else seems interested in going? Sooner or later, microgrids will begin to appear in growing numbers and, as more and more customers generate their own electricity and rely on PG&E for supplementary power or even leave the grid, it will become necessary for the IOUs to come to terms with the changing power generation landscape. In our view, the time to prepare for this future is now. We believe it is a good idea to have systems in place and operating before that day arrives, and SWIM is an initial step in that direction. If the microgrid is designed properly and made as "grid ready" as possible and feasible,[43] it can provide a model

---

[41] Redwood Coast Energy Authority, "Airport Solar Microgrid," https://redwoodenergy.org/community-choice-energy/about-community-choice/power-sources/airport-solar-microgrid/ (accessed August 2, 2020). The Clean Coalition (https://clean-coalition.org), a non-profit with offices in Santa Barbara and Menlo Park, California and Denver, Colorado, is working to develop a number of community-based solar microgrids, although it is not entirely clear where they are in the development stage (see "programs" on the Clean Coalition's website.

[42] Steve Weissman & Anna M. Brockway, "Community Solar in California: A Missed Opportunity," Center for Sustainable Energy, San Diego, CA, February 2018, at: https://energycenter.org/sites/default/files/docs/nav/policy/resources/Community_Solar_in_California-A_Missed_Opportunity.pdf (accessed July 23, 2020).

[43] This is the plan for the Gonzales Agricultural Industrial Business Park, which will install all of the hardware needed for an intertie to the grid in the expectation that it will be able to sell wholesale power at some time in the future. See "Joint Meeting of the Gonzales City Council, Gonzales Successor Agency and Gonzales Electric Authority, Agenda Packet, September 8, 2020, p. 249, at: https://gonzalesca.iqm2.com/Citizens/FileOpen.aspx?Type=1&ID=1135&Inline=True (accessed September 6, 2020).

for subsequent microgrids that could supply electricity not only to single buildings and their neighbors, but to the community as a whole.[44]

## VI. The Plan for SWIM

At present, there are only a few microgrids within Santa Cruz city boundaries, even though there has been local interest in seeing such facilities built for at least the last decade. Those that do exist are small and serve single buildings (see Sandbar Solar's microgrid, for example[45]). There are conversations underway about developing local microgrids for power outage resilience, as well. Although SWIM could include a resilience component (see Phase 4, below), current planning focuses on creation of a grid encompassing two sides of the Mission Street extension and extending to Delaware Street, in four phases, from 2020 to 2030.

**Phase 1 (2021-23):** University Business Park (aka, the Wrigley Building) will be connected by a conduit to the building currently occupied by Santa Cruz Nutritionals (see map below). Wrigley already has 650 kilowatts of solar panels on its roof and over a parking lot across the street and it has rooftop space for up to 2 megawatts. The SC Nutritionals building can accommodate roughly another 2 megawatts of panels. There is also considerable open area between the two buildings, on which ground-mounted solar panels could be installed. This system will also be extended to the cold storage facility to the east of the Wrigley Building.

**Phase 2 (2023-25):** This will consist of a buildout of rooftop solar installations on the north side of the Mission Street extension. As noted above, Sandbar Solar already operates an islanded solar microgrid on its own property, and it is allowed to provide electricity to its adjacent neighbors. Other building owners would be solicited to accept similar rooftop installations and to share electricity with neighbors. Eventually, these would be integrated into a single system, with battery storage, supplying the entire block.

**Phase 3 (2025-27):** This involves connecting the north and south side microgrids into a single system, contingent on city and utility permission to cross the public street. The Wrigley system already has an underground conduit linking the solar carports on the north side parking lot to the main building on the south side of the street. An upgraded link, and perhaps a second east of the first, would allow sharing and storage across the Microblock.

---

[44] Adewale A. Adesanya, Roman V. Sidortsov & Chelsea Schelly, "Act locally, transition globally: Grassroots resilience, local politics, and five municipalities in the United States with 100% renewable electricity," *Energy Research & Social Science* 67 (2020): https://doi.org/10.1016/j.erss.2020.101579.
[45] "Blue Planet Energy Reinforces 11,500-Sq-Ft Warehouse Microgrid," at: https://app.box.com/s/6ukgn2os4wij9m8f53rafqu8jb8jz6w1 (accessed August 2, 2020).

**Phase 4 (beyond 2027)**: This would see the linking of the Microblock to the utility grid. There is also the possibility of supplying emergency power during blackouts to emergency facilities along Mission Street (Dignity Health clinic, Palo Alto/Sutter Medical Foundation clinic, and Almar Street Fire Station).

In Table 2, we provide a broad-brush description of the financials and economics of SWIM as currently envisioned.[46] We assume a 10-megawatt solar PV and a 20 Megawatt-hour battery storage facility at full build-out.[47] In Santa Cruz, a 10 megawatt solar facility will generate around 15.8 million kilowatt-hours (kWh) annually.[48] We assume both low and high base cases, including electric generation and 20 megawatt-hours of storage, a 20 year loan at 4% interest, and operating, maintenance, insurance, property taxes, and a 30 year project lifetime. The inclusion of batteries allows the system to deliver electricity into the grid during night hours and to provide ancillary services and value stacking, which could reduce generating costs by several cents. Case 1, which draws on data from an NREL study which offers a relatively low "utility scale" cost of $1.90/watt installed for generation and storage equipment,[49] and private investment. Case 2 assumes an upper cost case of $3.50/watt installed and pure debt.

Because these are fairly crude estimates and calculations, the results must be viewed with caution. Profit flows are quite different, although both accumulate about the same profit over the project lifetime. Connecting this system to the utility grid would impose significant additional costs and make the project unattractive to investors. We may hope and expect that the regulatory and financial environments for microgrids will improve over the next five to ten years, especially as California tries to achieve its renewable energy and electrification goals.

---

[46] We have used the "Cost of Renewable Energy Spreadsheet Tool (CREST)" published by the National Renewable Energy Lab to model this system. The model is not always easy to understand, so the numbers here should be regarded as provisional. CREST is available at: https://www.nrel.gov/analysis/crest.html

[47] We make a number of assumptions about microblock demand and the shape of the demand curve over a typical day, from which we derive battery capacity.

[48] A typical California home consumes 200-300 kWh/month, although in Santa Cruz, the average is much lower. A one-megawatt (1,000 kilowatt) solar PV installation is said to be able to supply around 250 homes for a year; see Solar Energy Industries Association at https://www.seia.org/initiatives/whats-megawatt.

[49] This cost is based on interpolation from the National Renewable Energy Lab's reports on "utility scale" solar PV and battery storage for 100 MW plants ($1.89/Watt). Depending on siting and configuration, SWIM will probably be more expensive. See Ran Fu, Timothy Remo, and Robert Margolis, " 2018 U.S. Utility-Scale Photovoltaics-Plus-Energy Storage System Costs Benchmark," National Renewable Energy Lab, November 2018, at: https://www.nrel.gov/docs/fy19osti/71714.pdf (accessed September 12, 2020).

**What are we to do?**

The easiest thing to do at this time would be to go with the status quo and wait ten years for the financial and regulatory environments to ease up and the learning curve to flatten out. If it becomes legal for microgrids to wheel power through the utility grid, SWIM could become part of a “community power system,” a network of microgrids across the city and county that, with appropriate storage, could provide resilience, stability and savings to electricity customers, both large and small. SWIM is a multiyear project and will be difficult to design, finance, build and operate.

We believe, however, that there is no need to wait to begin the project. If SWIM can be pulled off successfully, it will become a model for other communities and help to bring the IOU extinction event that much closer. SSRF intends to be “shovel ready” when that moment comes. We invite you to join us in this effort. For more information, or to join, please contact the Sustainable Systems Research Foundation at the email and phone numbers on the first page of this policy brief.

## Table 2: SWIM Financials*

| **Project elements** | **Case 1** | **Case 2** |
|---|---|---|
| Generator nameplate capacity (kilowatts DC) | 10,000 | 10,000 |
| Net capacity factor for California | 18% | 18% |
| Electricity production in Year 1 (kWh) | 15,808,000 | 15,808,000 |
| Project useful life (years) | 30 | 30 |
| | | |
| **Capital costs** | | |
| Generation & storage equipment installed* | $19,000,000 | $30,000,000 |
| Balance of plant & distribution system | $5,000,000 | $5,000,000 |
| Development costs & fees | $500,000 | $500,000 |
| Reserves & financing costs | $1,000,000 | $2,000,000 |
| **Total capital cost** | $25,500,000 | $37,500,000 |
| Federal tax credit (25%) & state tax credit (10%) | ($8,925,000) | ($14,875,000) |
| Final capital cost | $16,575,000 | $22,625,000 |
| | | |
| **Financing** | | |
| Sr. debt @ 4% for 20 years; C1: 30%; C2: 100% | $7,650,000 | $22,625,000 |
| Private equity (20% IRR) C1:35%; C2:0% | $8,925,000 | $0 |
| | | |
| **Operating, maintenance & other costs** | | |
| Fixed O&M ($2.50/kW-yr. DC) | $25,000 | $25,000 |
| Variable O&M (0.5 ¢/kWh) | $79,000 | $79,000 |
| Insurance | $200,000 | $400,000 |
| Property tax & leases | $100,000 | $100,000 |
| Annual Loan repayment over 20 years | $838,000 | $2,477,000 |
| **Total costs per year for year 1-20** | $1,239,000 | $3,081,000 |
| **Total costs per year for year 21-30** | $404,000 | $604,000 |
| | | |
| **Retail costs, revenues & profits** | | |
| Cost of electricity in year 1 (¢/kWh) | 7.8 | 19.5 |
| Levelized cost of electricity over 30 yrs. (¢/kWh) | 6.1 | 14.3 |
| Revenue in year 1<br>Case 1: 20¢/kWh; Case 2: 25¢/kWh | $3,162,000 | $3,952,000 |
| Net income in year 1 | $1,923,000 | $871,000 |
| Annual equity payout @ 20% IRR (Years 1-5) | $1,777,000 | 0 |
| Annual profit in year 1 | $146,000 | $871,000 |
| Annual profit year 6-20 | $1,923,000 | $871,000 |
| Annual profit year 21-30 | $2,327,000 | $3,348,000 |
| Cumulative profit over project lifetime | $52,825,000 | $50,900,000 |
| Simple payback (yrs.) | 8.62 | 21.6 |

*These are simplified cases that do not take into account declining system efficiency, tariff increases over time, discount rates or distribution costs for feed-ins to the grid.

**These are lower and upper bound cases. Case 1 is based the average per megawatt 2018 cost for a "utility-scale" 100 MW solar and storage plant installed, rescaled to 10 MW; Case 2 assumes $3.5/w including storage. **Source:** Ran Fu, Timothy Remo, and Robert Margolis, " 2018 U.S. Utility-Scale Photovoltaics-Plus-Energy Storage System Costs Benchmark," National Renewable Energy Lab, November 2018, at: https://www.nrel.gov/docs/fy19osti/71714.pdf (accessed September 12, 2020).