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

Proposal for a Renewable Community Energy System in Santa Cruz*

Ronnie D. Lipschutz

The City of Santa Cruz is an especially appropriate location for a community energy system (Figure 1, following the text). It sits at the end of PG&E's high voltage transmission lines and, as a result, 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. 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."[1]

Solar photovoltaic microgrids with battery storage offer a local solution to these and other problems with our regional monopoly IOU. The Sustainable Systems Research Foundation and its partners are investigating the development of solar photovoltaic microgrids with battery storage in the City of Santa Cruz to meet the Central Coast's future power needs. These include:

1. **Santa Cruz Westside Microblock** (SWIM), a 10-Megawatt system plus battery storage, which will serve light industrial buildings in an area bounded by the Mission Street extension, Natural Bridges Drive and Delaware Street (see Figure 2), with resilience transmission to essential facilities on and near Mission Street[2];

2. Boardwalk & Beach Flats Power Grid, a 6-Megawatt system plus storage, which will provide the SC Beach Boardwalk and adjacent neighborhoods with power from solar carports built over nearby parking lots (see Figure 3), and

3. Antonelli Pond Connected Community Microgrid, a 500-kilowatt microgrid plus storage serving a future community of new homes on property adjacent to Antonelli Pond (Figure 4). These homes will incorporate various smart building technologies and sensors and will be monitored for energy use and performance.

---

* This proposal is based on "A Community Energy Strategy for Santa Cruz," SSRF Policy Policy Brief #21-1, at: https://sustainablesystemsfoundation.org/a-community-energy-strategy-for-santa-cruz/

The complete community energy system will be developed and deployed over a ten-year period, during which, we anticipate, rules, regulations and financing options governing both installation and grid connections will be liberalized.

Phase 1: Designing & building SWIM (2021-25). This will consist of a buildout of rooftop solar installations within the boundaries of SWIM to a total of 10 MW.[3] Sandbar Solar already operates an islanded solar microgrid on its own property. The Wrigley Building has 650 kilowatts of solar panels on its roof and over a parking lot across the street and it has rooftop and lot space for up to another 2 megawatts. The SC Nutritionals building (formerly Lipton) and space around it can accommodate another 5 megawatts of panels plus batteries. The Wrigley Building will be connected to Santa Cruz Nutritionals via conduit running under the Rail Trail and to the cold storage facility to the east of the Wrigley Building. Building owners will be solicited to install solar + storage systems and to sell electricity to neighbors. Eventually, these independent installations will be integrated into a single system, with battery storage, supplying the entire block.

Phase 2: Building the Boardwalk & Antonelli Pond microgrids (2025-27). Contingent on approval of the owners, design, engineering, permitting and financing of these two installations will be initiated in 2023, and built between 2025 and 2027. The Boardwalk project could be operated to provide a basic universal income to residents of Beach Flats through SSRF's "End Poverty in California with Solar" (EPICS) program.[4]

Phase 3: Conduit installation along the Rail Trail & creation of Santa Cruz Solar Utility (2028-29): Permission to trench will be sought from the Regional Transportation Commission and other relevant agencies with financing to be determined. Beginning in 2023, there will be lobbying of the SC City Council to create a joint powers authority and municipal solar utility.

Phase 4: Connection of individual systems and the whole into the utility grid (2030). SWIM will include a cold connection to the utility grid adjacent to PG&E's 60 kilovolt substation at Western Drive and Highway 1. The three components will operate independently until the conduit is operational at which time they will be connected.

Financial viability of these projects 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.[5] Table 1 below is an incomplete list of financial considerations. 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. Resilience, reliability, peak load resources, reductions in utility capital expenditures, greenhouse gas reductions, grid and voltage stability are benefits[6] not presently monetized or recognized, much less internalized in financing and operating calculations (what is the value of carbon reductions?).[7]

We estimate that the total cost of the three systems, including generation, batteries and new transmission lines, will be around $50-60 million although, without detailed design, planning, engineering and financial studies, however, it is difficult to be more precise. The landscape for such microgrids in California is changing rapidly and these changes may have significant impacts on costs.

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 or bond 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	Avoided costs of new transmission & distribution

In Table 3, we provide a broad-brush description of the financials and economics of the SC system as currently envisioned.[8] Table 2 lists the assumptions built into the calculations.

Table 2: Assumptions built into financial calculations[9]

Project name	SWIM	Boardwalk	Antonelli
Solar capacity (MW)	10	6	0.5
Storage capacity (MWh)	20	12	1
Lifetime	30	30	30
Green bonds rate	2.5%	2.5%	2.5%
Solar + storage capital cost[10]	$2/watt	$2/watt	$2.50/watt
Total cap cost after credits	$22,750,000	$14,770,000	$1,260,000
LCOE over 30 years (¢/kWh)	10.4	11	11.8

Table 3: Santa Cruz Community Energy System Financial Estimates

Project elements	**SWIM**	**Boardwalk**	**Antonelli**
Generator nameplate capacity (kw DC)	10,000	6,000	500
Net capacity factor for California	18%	18%	18%
Electricity production in Year 1 (kWh)	15,800,000	9,500,000	790,000
Project useful life (years)	30	30	30
Capital costs			
Generation & storage equipment	$20,000,000	$12,000,000	$1,250,000
Balance of plant & distribution system	$5,000,000	$3,000,000	$250,000
Development costs & fees	$500,000	$500,000	$250,000
Reserves & financing costs	$1,000,000	$600,000	$50,000
Conduit & distribution ($1 million/mile)	$6,000,000	$4,000,000	$0
Total capital cost	$32,500,000	$21,100,000	$1,800,000
Federal & state tax credits (30%)	($9,750,000)	($6,330,000)	($540,000)
Final capital cost	$22,750,000	$14,770,000	$1,260,000
Financing cost			
Green bonds @ 2.5% for 20 years (1.64x)	$14,560,000	$9,450,000	$806,000
Capital & financing costs	$37,310,000	$24,200,000	$2,066,000
Operating, maintenance & other costs			
Annual Loan repayment over 20 years	$1,865,500	$1,210,000	$103,300
Fixed O&M ($2.50/kW-yr. DC)	$25,000	$15,000	$5,200
Variable O&M (0.5 ¢/kWh)	$79,000	$47,500	$4,000
Insurance	$200,000	$120,000	$10,000
Property tax, leases, income taxes	$100,000	$60,000	$5,000
Total costs per year for year 1-20	$2,270,000	$1,453,000	$127,500
Total costs per year for year 21-30	$404,000	$242,500	$24,200
Retail costs, revenues & profits			
Cost of electricity in year 1 (¢/kWh)	14.4	15.3	16.1
Revenue in year 1-30 @ 20¢/kWh	$3,160,000	$1,900,000	$158,000
Net income in years 1-20	$890,000	$447,000	$30,500
Net income in years 21-30	$2,756,000	$1,657,500	$133,800
Cumulative profit over project lifetime	$45,360,000	$25,515,000	$1,948,000
Levelized cost of electricity over 30 yrs. (¢/kWh)	10.4	11	11.8

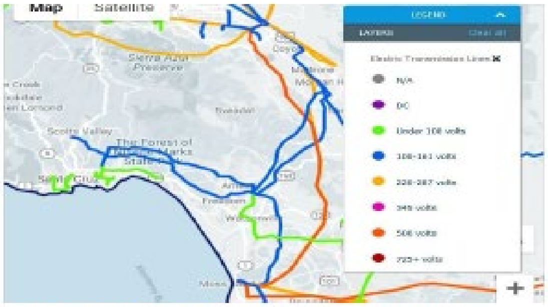

Figure 1: High-voltage power lines feeding the Santa Cruz Area[10]

Figure 2: SWIM Schematic & Phases

Figure 3: Proposed Boardwalk & Beach Flats Solar Carports

Figure 4: Antonelli Pond Connected Community Site

Figure 5: Proposed Santa Cruz Community Energy System

Endnotes

[1] "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).
[2] A detailed discussion of the current environment for microgrids in California can be found at https://sustainablesystemsfoundation.org/designing-the-santa-cruz-westside-microblock-a-strategy-to-kickstart-community-energy-systems/
[3] 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.
[4] See https://sustainablesystemsfoundation.org/ending-poverty-in-california-through-solar/.
[5] 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.
[6] 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).
[7] 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).
[8] 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
[9] We have used the "Cost of Renewable Energy Spreadsheet Tool (CREST)" published by the National Renewable Energy Lab and other data 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
[10] 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).