Building Versus Community Scale Resiliency Strategies

Comparison of the Economic and Operational Characteristics

Dara Salour

August 8th, 2024 | ACEEE Summer Study for Buildings

Agenda

Community Scale Sustainability and Resiliency Strategies

Resiliency Study of an Office Building

Resiliency Study of a College Campus

Comparison of Building versus Campus Resiliency Solutions

Conclusions

Community Scale Sustainability and Resiliency Strategies

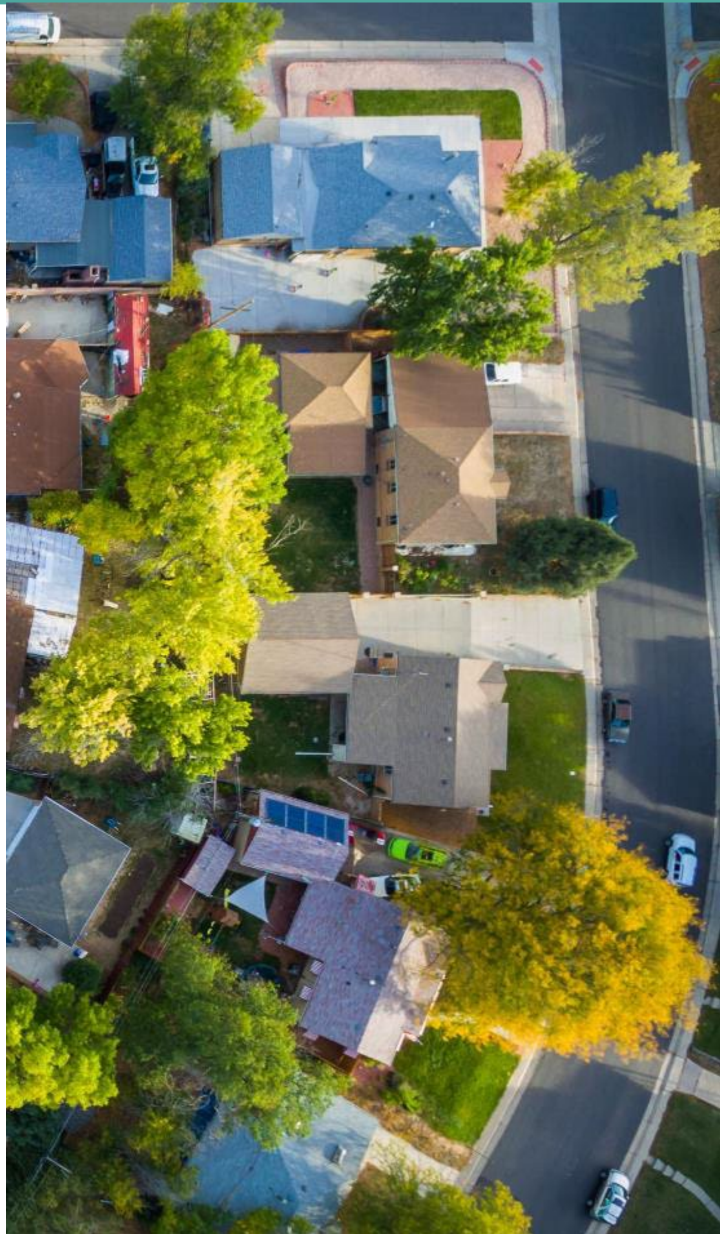
Definition of Resilience

Resilience is the ability of a power system and its components to withstand and adapt to disruptions and rapidly recover from them, allowing continuity of power within a building or community

Community Scale Sustainability and Resilience Strategies

Design Considerations

- Will the DER's be Front of the Meter or Behind the Meter?
- Will the whole community or only some of community be participating in the community microgrid?
- Are there priority community loads such as wastewater treatment or electric vehicle charging that need to be backed up?
- Load and generation balancing
- Black start and grid forming capabilities



Building Level Versus Community Scale Solutions

Where to Draw the Line

- Front of the Meter (Larger Loads)
  - Wastewater Treatment Plants
  - Police Stations
  - Food Banks with Refrigerated Warehouses
  - Jails and Prisons
  - Multifamily Residences
  - Fleet Charging for Municipal Vehicles
- Behind the Meter (Smaller Loads)
  - Libraries
  - Fire Stations
  - Cooling Centers
  - Nursing Homes
  - Homeless Shelters
  - Single Family Residences

Building Technologies and Operations Methods

Contributing to Efficient and Resilient Performance

- Single Family and Multifamily Residential
- Fleet Charging
- Municipal Buildings
- Nursing Homes and Medical Facilities
- Food Banks
- WWTPs
- Solar Self Consumption
- Electrochemical Energy Storage
- Combined Heat and Power
- Thermal Energy Storage

Best Value Efficient and Resilient Technologies

Where to Make Investments

- Energy efficiency and resiliency
- Electrification
- Enabling Technologies
  - Tying DERs and end uses together

- Smart Electrical Panels
  - Metering and control of loads by circuit
  - Scheduling of loads
  - Dynamic load control
  - Panel upgrades
  - Participation in Demand Response Programs

Valuation of Resilience Benefits

From DERs

- Avoidance of lost revenue during an outage
- Bill savings from operation of DERs in parallel with the grid
  - Energy Arbitrage
  - Demand Charge Management
- Revenue from participating in ancillary services markets

- Examples of Ancillary Services Markets offered by ISO
  - Frequency Regulation
  - Voltage Regulation
  - Spinning Reserve
  - Non-spinning Reserve

Efficient and Resilient Strategy Integration

Disaster Planning and Disaster Recovery

- Prioritization of critical loads
  - Data center in an office building
  - Communications in an Emergency Operations Center
  - HVAC within a cooling center or library
- Reduction of non-critical loads
  - Extending backup duration of batteries
  - Relying on solely on DER generation

- Microgrids can help the larger grid recover from a disaster
  - UC San Diego Microgrid in 2007

AESC CELEBRATING 30 YEARS

Resiliency Study of an Office Building

Existing Condition

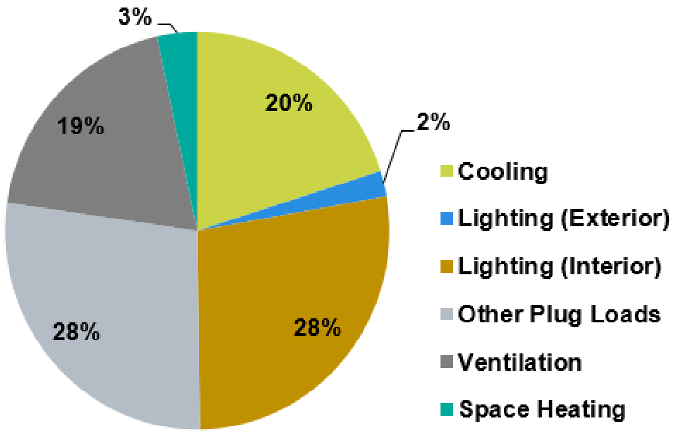
Building Characteristics	• Offices, IT rooms, meeting rooms, break areas, and lobbies	
	• 2-story	• 62,000 SF
	• Occupied in 2016	• Located in Red Bluff
Energy Loads	HVAC consists of 5 large roof top DX systems and 9 smaller split condensing units	
	Interior lighting is 80% LED with occupancy sensors except in the certain areas where it is fluorescent	
	Occupancy sensors in all areas	
	Outdoor lighting controlled by photocells	

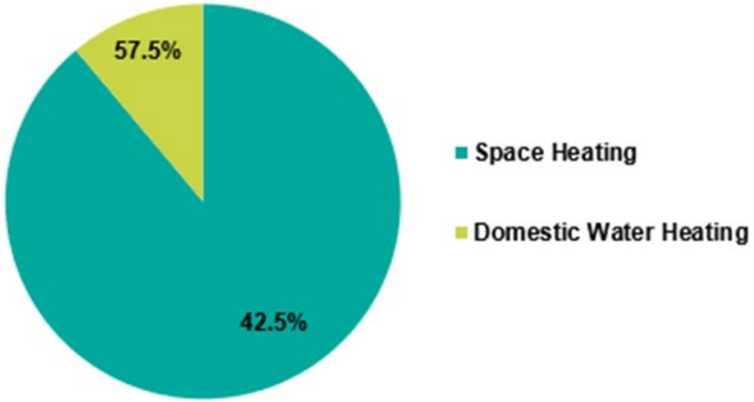
Steps Taken to Assess Resiliency

- Onsite evaluation of electrical infrastructure
- Onsite evaluation of energy efficiency opportunities
- Load assessment using utility interval data
- Adjustment of annual load based on implementation of EE measures
- Sizing of Solar PV and Energy Storage
- Single Line Diagram
- Project cashflow based on PPA and purchase options
- Final Report Outlining EE Measures and Resiliency Solution

Assessing Load and Potential EE Reductions

Load	• Annual energy consumption 620,000 kWh per year • Peak Demand 257 kW • Utility Bills $149,000 per year
Energy Efficiency Measures	Replace Remaining T8 Fluorescent Lamps with LED Equivalents Verify AHU5 Duct Static Pressure Reset is Functioning





Behind the Meter Energy Resiliency

Proposed Solution

- 250 kW/750 kWh lithium-ion energy storage system
- 360 kW rooftop and carport solar system
  - 400W Solar Modules, QTY 899
  - Steel Carport Structure
  - Ballasted rooftop racking (10-degree tilt, Class A fire rating)
  - Inverter 50 kW, QTY 6

Resiliency Duration

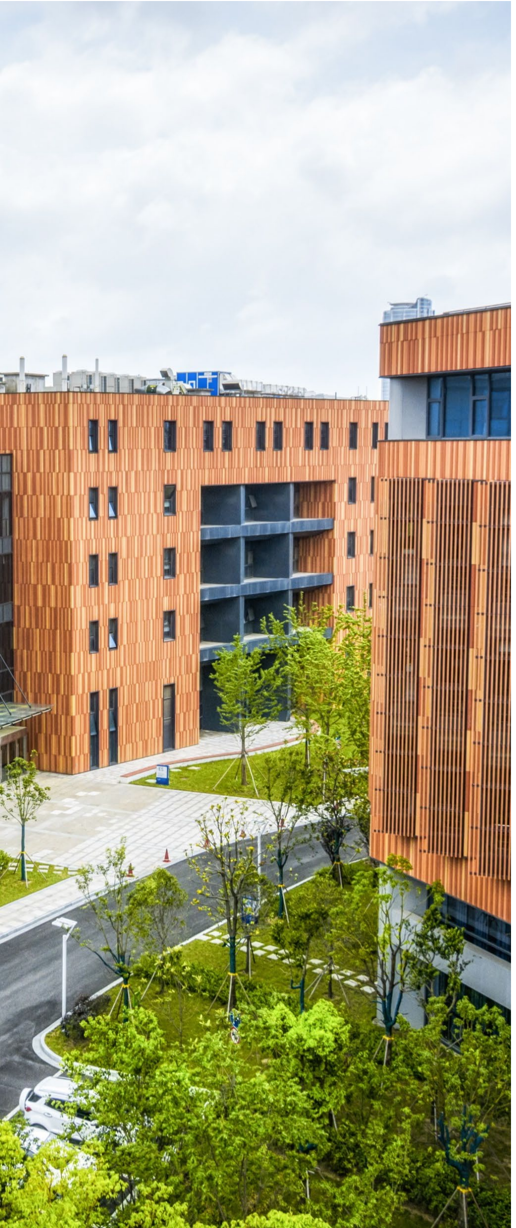
- Six hours between 6AM and 7PM

Energy Resiliency Impacts

Economics	Solar Net Investment	$735,881
	Battery Net Investment	$563,000
	Total Net Costs	$1,298,881
	IRR	6%
	Break-even	12.4 years
Environmental Impact	Annual CO_2 emission reduction	147 tons
	Equivalent cars removed from road	31.7

Resiliency Study of a College Campus

Existing Condition



Campus Characteristics	• College campus. Lost 9 instructional days in 2019 fire season resulting in $3.5 million in lost revenue and unreimbursed expenses	
	• 17 buildings	• 469,000 combined SF
	• Campus in Tier 2 fire zone	• 9,400 full time students
	• Existing solar generation	• No energy storage

Steps Taken to Assess Resiliency

- Onsite evaluation of electrical infrastructure
- Onsite evaluation of energy efficiency opportunities
- Load assessment using utility interval and solar generation data
- Adjustment of annual load based on implementation of EE measures
- Powerflow analysis of the campus distribution system including existing solar
- Rate Analysis
- Sizing of Generator and Energy Storage
- Single Line Diagram
- Project cashflow based on PPA and purchase options
- Final Report Outlining EE Measures and Resiliency Solutions

Assess Load, Existing Generation & EE Potential

Load	• Annual energy consumption 6,901,338 kWh per year • Utility Cost $290,831 per year
Existing Solar	• 4,576 kW AC • 5,516,429 kWh generated in 2019

		Estimated						
EEM #	Measure Description	kWh Saved	Peak kW Reduced	Therms Saved	Annual Cost Savings	Rebate / Incentive	Project Cost	SPB (yrs)
1	Comprehensive Retrocommissioning	90,600	3	9,900	$28,926	$10,600	$104,500	3.2
2	Interior Lighting LED Upgrade	186,500	24	0	$39,165	$26,000	$717,970	17.7
3	Exterior Lighting LED Upgrade	17,000	0	0	$3,570	$2,000	$27,500	7.1
4	Water Cooled Chiller Upgrade at a Allied Health	45,800	1	0	$9,618	$5,700	$267,520	27.2
5	Blower and Controls Upgrade at Sewer Treatment Plant	15,000	1	0	$3,150	$2,000	$78,650	24.3
6	Gym High Bay Lighting LED Upgrade	4,700	1	0	$987	$900	$12,320	11.6

Energy Resiliency Solution

Implement EE measures outlined above

Install new solar to offset 95% of the load for one existing building and one planned new construction building

- Costs associated with new solar not considered in these scenarios.

Partner with a third-party vendor to own, maintain and operate:

- Battery energy storage with a minimum size of 3MW/5.91MWh (Two-hour peak discharge duration)
- Diesel backup generator with a minimum size of 1750kW
- Microgrid controller

Add controllers to existing solar plants on the College Campus

Connect existing building load data to the microgrid controllers

An optional, strongly encouraged, recommendation is to incorporate the building's EMS with the microgrid controller

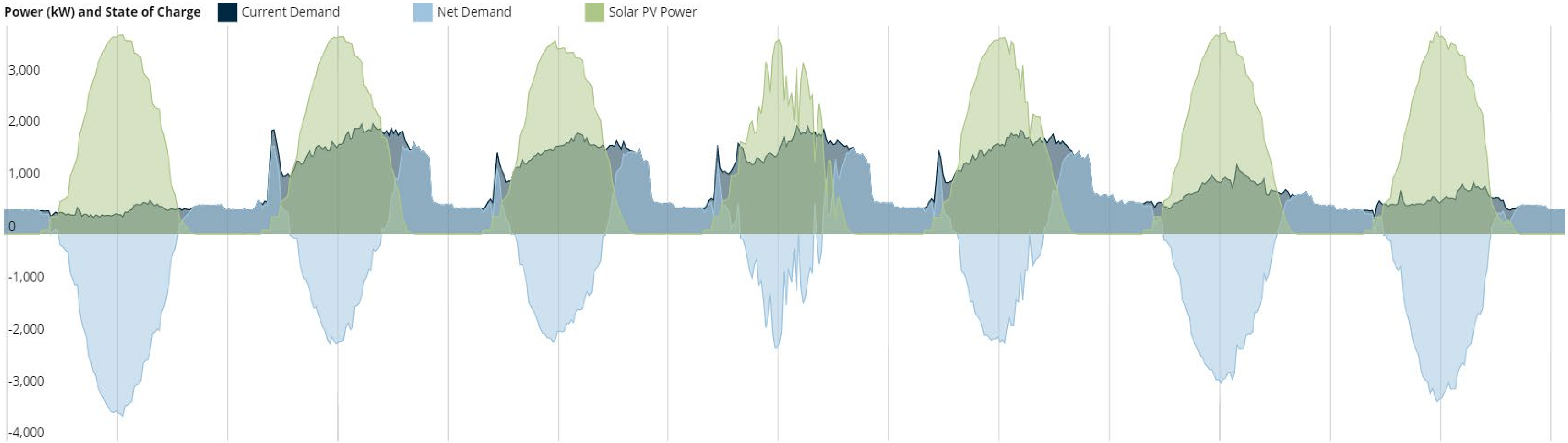
RS 1: On-Campus Microgrid

Existing Solar System MW AC	4.58
Battery Energy Storage System MWh	5.90
Backup Generator System MW	1.75

Resiliency Services (Year 1, Anticipated to Increase 3% a Year)	$	280,000
Fuel Costs per Three Day Outage (per Outage)	$	1,437

Scope includes a third-party vendor to provide a backup generator and BESS to keep the College online during PSPS related outages.

Modeling Assumptions



- The BESS and the generator were sized to allow resiliency during the highest peak load days with the lowest solar insolation
- The generator fuel costs are calculated using a three-day outage scenario, during high usage summer loads
  - With refueling the microgrid could be resilient indefinitely
- A diesel generator has been presented in order to increase resiliency in the event of a natural gas outage as well as an electricity outage
  - Specifications provided can be used to procure either a natural gas or a diesel generator

Economics for Resiliency Solution

Cost for Campus	$280,000 per year in the first year with 3% increase per year
Cost for 3rd Party	$7,534,882 • 10% IRR based on 20-year cashflow • Revenue generated by participating in CAISO ancillary markets and by fees from the College • Resiliency services provided during fire season

Recommendations and Solution Ranking

- Evaluate the effectiveness of the 115kV switch installed on the incoming transmission line in preventing PSPS events during the 2020 fire season
- If it proves to be ineffective pursue the energy resiliency options in the following priority order based on cost to College and the time needed for installation

1. Implement as many EE measures as financially feasible.
2. Implement new solar at one existing building and future new construction building.
3. On-campus microgrid built, owned and operated by a third party.

Comparison of Building versus Campus Resiliency Solutions

Comparison of Building vs Campus Resiliency Solutions

Common Areas

- Energy Efficiency was a first step
  - To reduce load and cost
- Integration of the microgrid control system with the energy management system
  - Making the load dispatchable
  - Extending the duration of resiliency

Differences

- The campus was much older than the office building
  - More EE opportunities
  - Large existing solar system
- Campus solution was FTM
  - Allowing for participation in ancillary services markets
- Office building solution was BTM
  - Allowing for opportunities in energy arbitrage and demand charge management

aesc CELEBRATING 30 YEARS

Conclusions

Key Takeaways

- Energy Efficiency is a key in making energy resiliency projects cost effective
- It is important that DERs used for resiliency be able to provide benefit when the grid is operational
- There is a diverse array of resiliency solutions available for all kinds of end uses
- An important distinction in the management of DERs and loads in a microgrid are whether the DERs are BTM or FTM
- Energy storage is a key when installing solar generation to provide resiliency when the sun is down

Thank You

Dara Salour
dsalour@aesc-inc.com
(925) 200-0499