



Engaging Stakeholders and Evaluating Microgrids in Kentucky

November 12, 2021

Prepared for Sandia National Laboratories Microgrids and Energy
Storage for Emergency Grid Resilience Webinar Series



Acknowledgements



SEPA would like to thank the Kentucky Energy and Environment Cabinet Office of Energy Policy for the opportunity to conduct this study. The study was made possible by the U.S. Department of Energy's State Energy Program (SEP), which provides funding and technical assistance to enhance energy security, advance state-led energy initiatives, and maximize the benefits of decreasing energy waste.



Microgrid Study Lead



Role for our project

- Stakeholder engagement
- Data collection and landscape review
- Research and industry knowledge
- Microgrid site selection and economic analysis



Profile

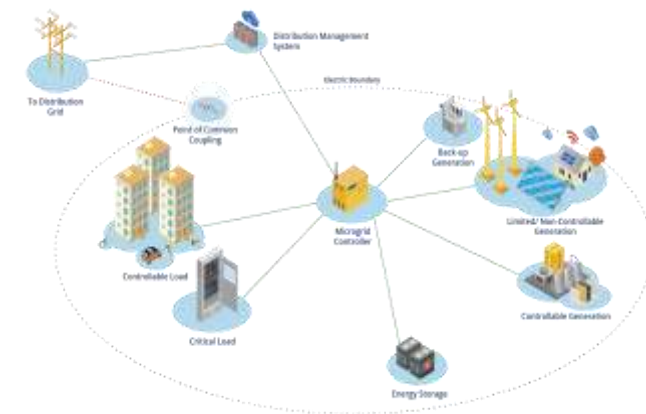
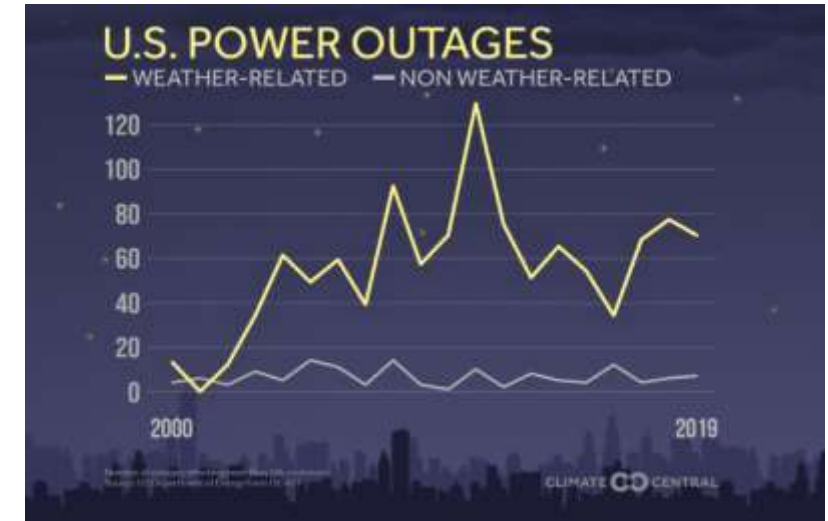
- A 501c3 membership organization founded in 1992
- Staff of ~ 50, budget of ~ \$10M
- Based in Washington, D.C.
- Advisory services, research, and industry collaboration

Microgrid Study Motivations and Goals



Microgrids as an economic solution and a BRIC funding opportunity

- Power outages are a major contributor to economic loss that can be mitigated with microgrids
- Support private and public sector opportunities for BRIC and other resiliency funding
- Select and evaluate potential sites and areas in Kentucky to achieve resilience through microgrid deployment
- Evolving hazard mitigation planning with microgrid considerations



Summary of Results

Smart Electric
Power Alliance



Smart Electric
Power Alliance

6,640

sites considered

SEPA evaluated 6,640 sites for microgrid solutions using 6 selection criteria. SEPA identified 558 potential site-specific installations and 12 potential regional community microgrids.



6

site selection criteria



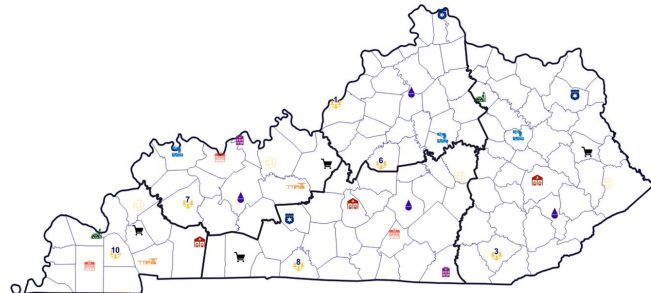
558

potential site-specific
installations



12

potential regional
community microgrids



Study Methodology

Identifying potential microgrid deployments for critical facilities to increase the state-wide resilience in Kentucky against natural hazards

Landscape Review

- Stakeholder engagement
- Prioritizing critical facilities and natural hazards

Data Collection

- Critical facilities
- Load profiles
- Reliability hostpots
- Natural hazards
- Population density
- Urban areas
- Energy Burden

Site Selection

- Nanogrids (specific facilities)
- Regional community microgrids (clusters)

Deployment Strategy

- Sizing
- Cost estimates
- Deployment options





Kentucky Public Service Commission



Kentucky Retail Federation



Kentucky Environmental Response Team



Kentucky Geological Survey



Kentucky Emergency Management



Duke Energy Kentucky



Kentucky Division of Water



**Louisville Gas & Electric
Kentucky Utilities**



Kentucky Petroleum Marketers Association



National Rural Electric Cooperative Association



Kentucky Office of Energy Policy



American Electric Power Kentucky



Smart Electric Power Alliance

Stakeholders

Landscape Review – Critical Facilities and Natural Hazards



Natural Hazard Prioritized List:

- ✓ Extreme Cold & Winter Storms
- ✓ Floods
- ✓ Wind
- ✓ Tornadoes

Avoiding Microgrid Deployment in High-Risk Areas of:

- ✓ Earthquakes, landslide, karst, mine subsidence and wildfires

Natural Hazards for Future Consideration

- ✓ Extreme heat















Critical Facility Prioritized List:

- Water Treatment Facilities - Wastewater/Water Treatment Plants
- Emergency Operations Centers - Temporary or Permanent Emergency Preparedness Command Centers
- Health Care Facilities - Hospitals and Nurseries
- Fire Stations
- National Defense - Military & National Guard Bases
- Law Enforcement - Police, Sheriff and Park Police Stations
- Gas Stations & Petroleum Terminals
- Grocery Stores
- Communications Facilities - Radio, TV and Cell Tower Transmission



Data Collection - Critical Facilities



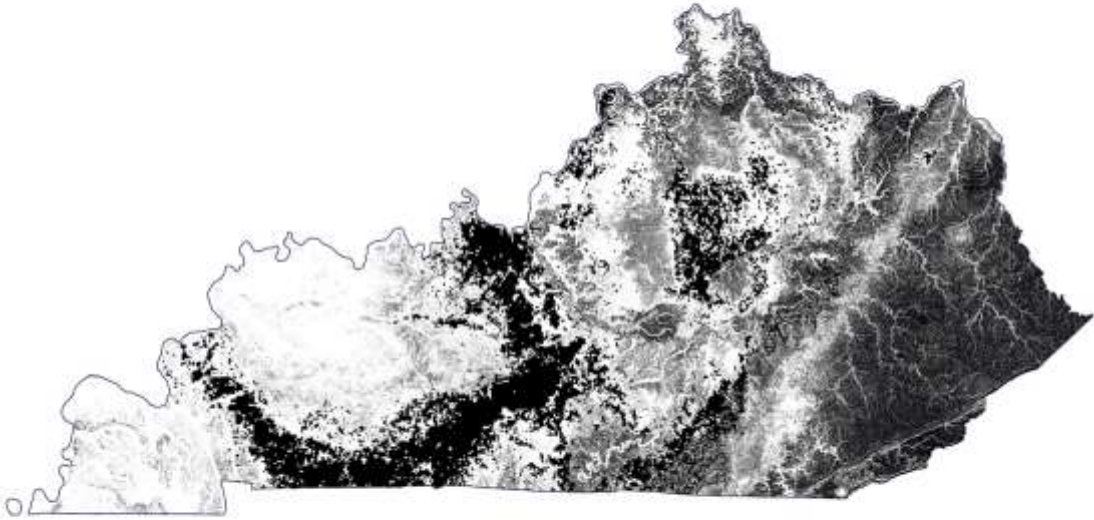
	Facility	Data Source	Key Stats	Notes
	Communication Facilities	HIFLD	1,234 total	Clusters of sites exist in more densely populated counties
	Hospitals	OEP	137 total	More sites exist in densely populated counties.
	Nursing Homes	OEP	379 total	More sites exist in densely populated counties.
	Water Treatment Plants	KyGovMaps Open Data	213 total	Sites are mostly uniformly distributed across the state.
	Wastewater Treatment Plants	KyGovMaps Open Data	240 total	Sites are mostly uniformly distributed across the state.
	National Defense Facilities	Data Axle	46 total	Most sites are located in densely populated counties.
	Law Enforcement Facilities	OEP and HIFLD	484 total	Clusters of sites exist in more densely populated counties.
	Fire Stations	OEP and HIFLD	1103 total	Clusters of sites exist in more densely populated counties.
	Emergency Operations Centers	HIFLD	142 total	Sites are distributed uniformly across the state.
	Gas Stations	Data Axle	1973 total	Clusters of sites exist in more densely populated counties.
	Grocery Stores	Data Axle	1273 total	Clusters of sites exist in more densely populated counties.
	Natural Gas Underground Facilities	EIA	23 total	Most sites are located in central Kentucky.
	Petroleum Terminals	HIFLD	31 total	Clusters of sites exist in more densely populated counties.

Data Collection - Tier 1 and 2 Hazards



0 25 50 mi

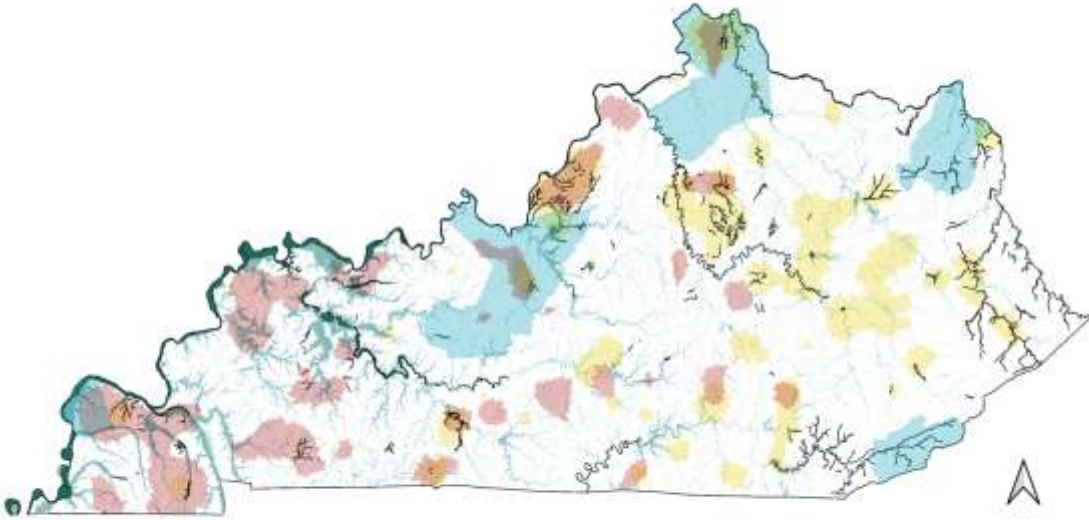
Areas at High Risk of Tier 1 Hazards:
Earthquakes, Landslides, Karst, Mine Subsidence, and Wildfire



■ Area at High Risk of Tier 1 Hazard

0 25 50 mi

Areas at High Risk of Tier 2 Hazards:
Tornadoes, Wind, Extreme Cold and Winter Storm Events, and Floods

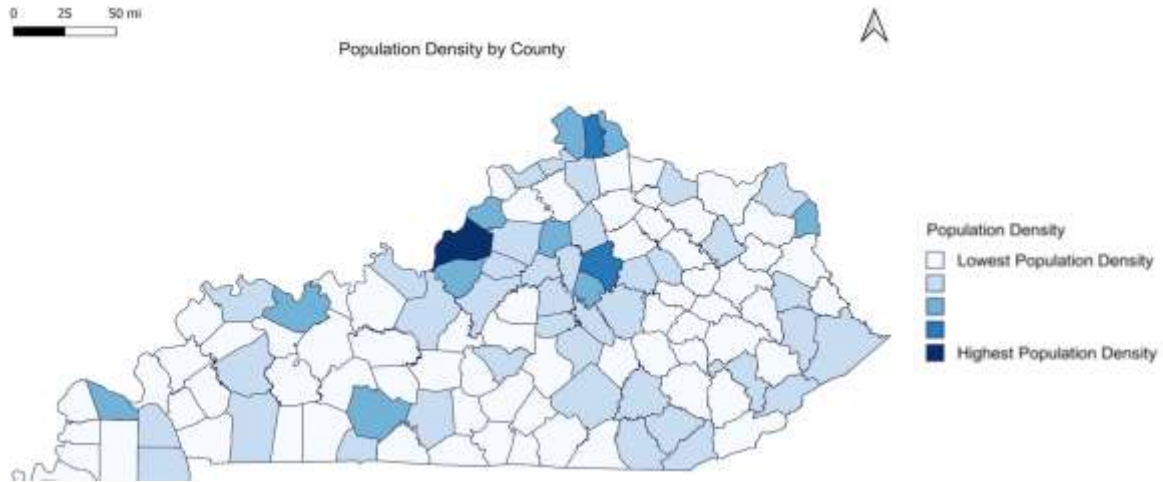


Tornado	Wind	Extreme Cold and Winter Storm Events	National Flood Hazard Layer
High Risk	High Risk	High Risk	100 Year Flood
			500 Year Flood
			Floodway

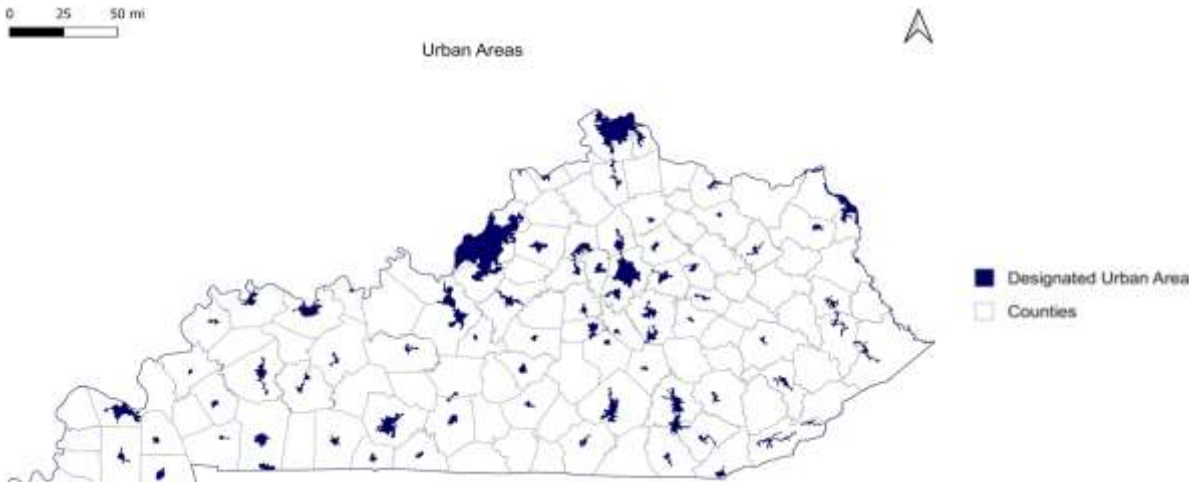
Source: Smart Electric Power Alliance (2021) based on data provided by Matt Crawford, a Kentucky Geological Survey scientist with the University of Kentucky (2020).

Source: Smart Electric Power Alliance (2021) based on data provided by NOAA's National Centers for Environmental Information [Storm Events Database](#), HIFLD's [Historical Tornado Tracks](#) dataset, and FEMA's [National Flood Hazard Layer](#) (2020).

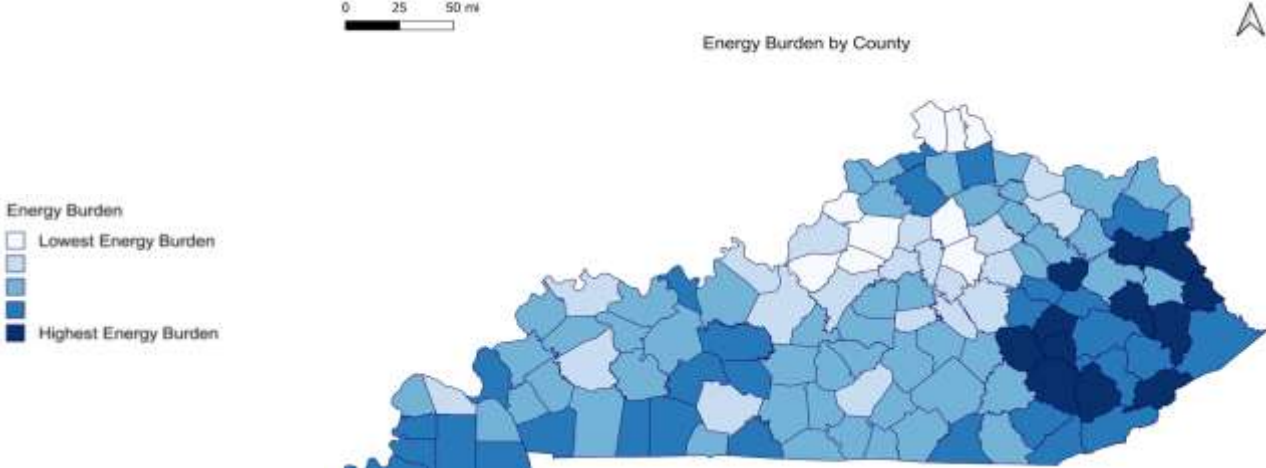
Data Collection - Population Density, Urban Areas, and Energy Burden



Source: Kentucky Atlas and Gazetteer. [Commonwealth of Kentucky](#) (2020).



Source: United States Census Bureau. [Urban Areas](#). TIGER/Line Shapefiles (2010).



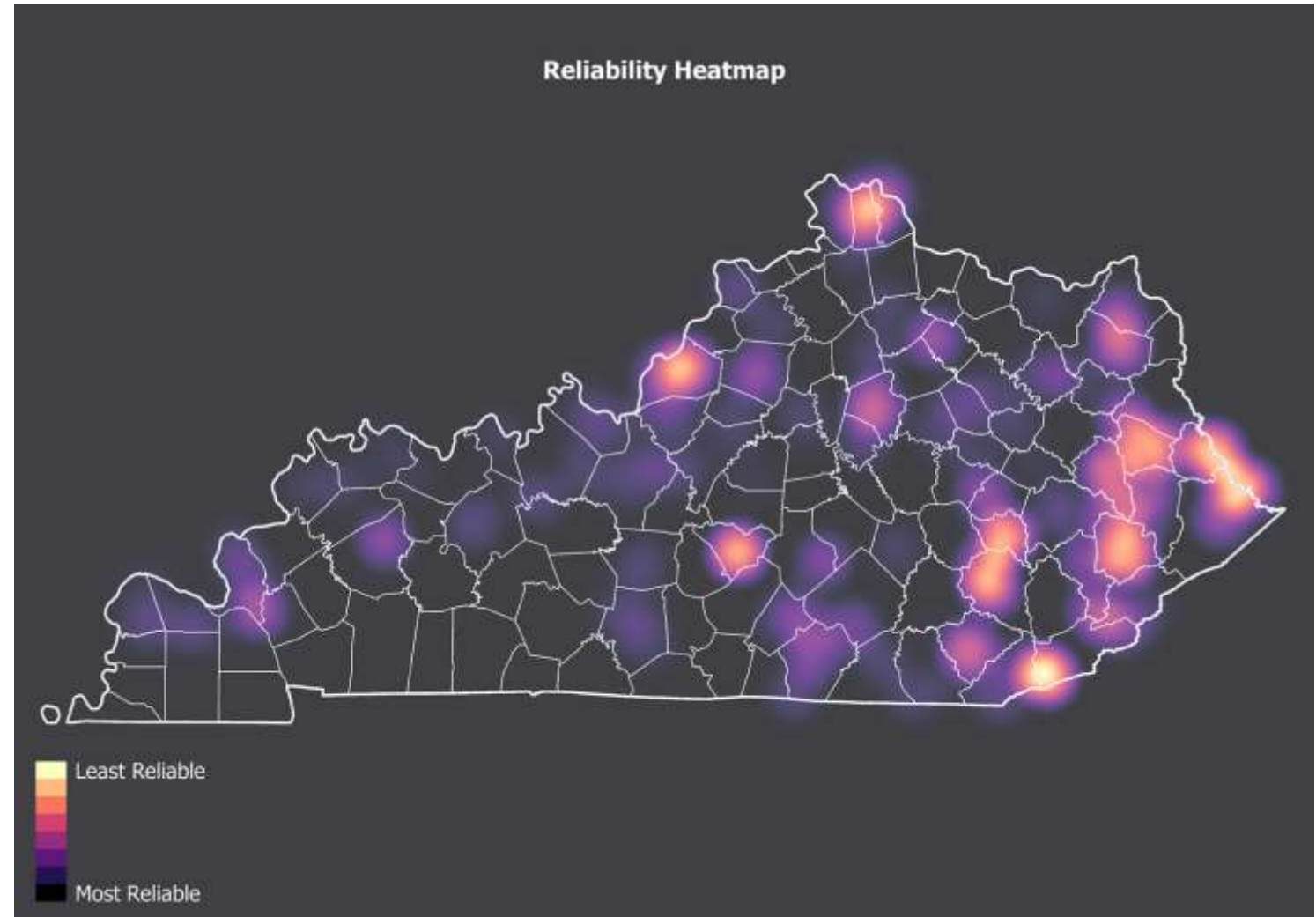
Source: United States Department of Energy. [Avg. Energy Burden \(% income\) for Counties in Kentucky](#). Low-Income Energy Affordability Data (LEAD) Tool (2020).

Data Collection – Reliability Hotspots



Map Development Methodology

- Data collected from annual reliability reports filed by utilities with the Kentucky Public Service Commission.
- Locational data for the top ten worst performing circuits (based on SAIDI values) for each utility was used to develop a heatmap.
- Lowest reliability in the eastern region of Kentucky.

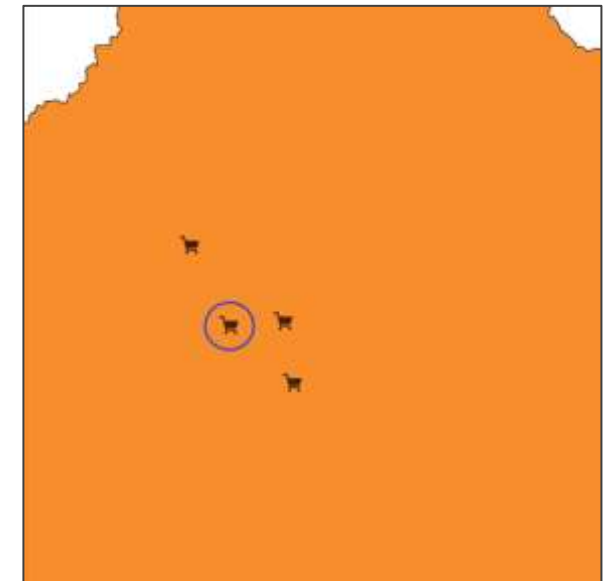
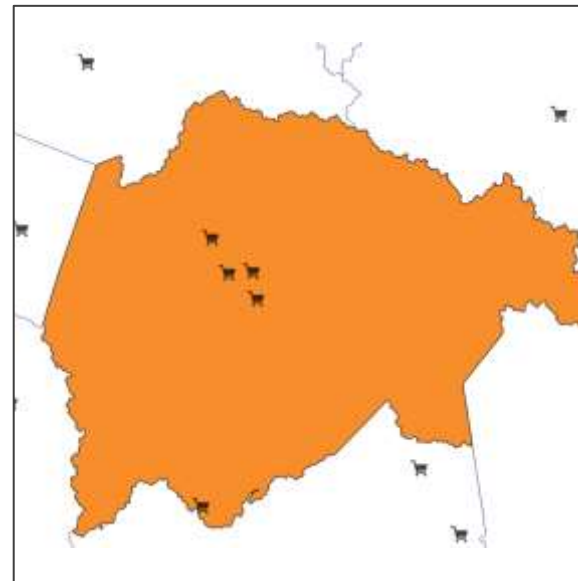


Site Selection

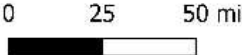


Selection Criteria

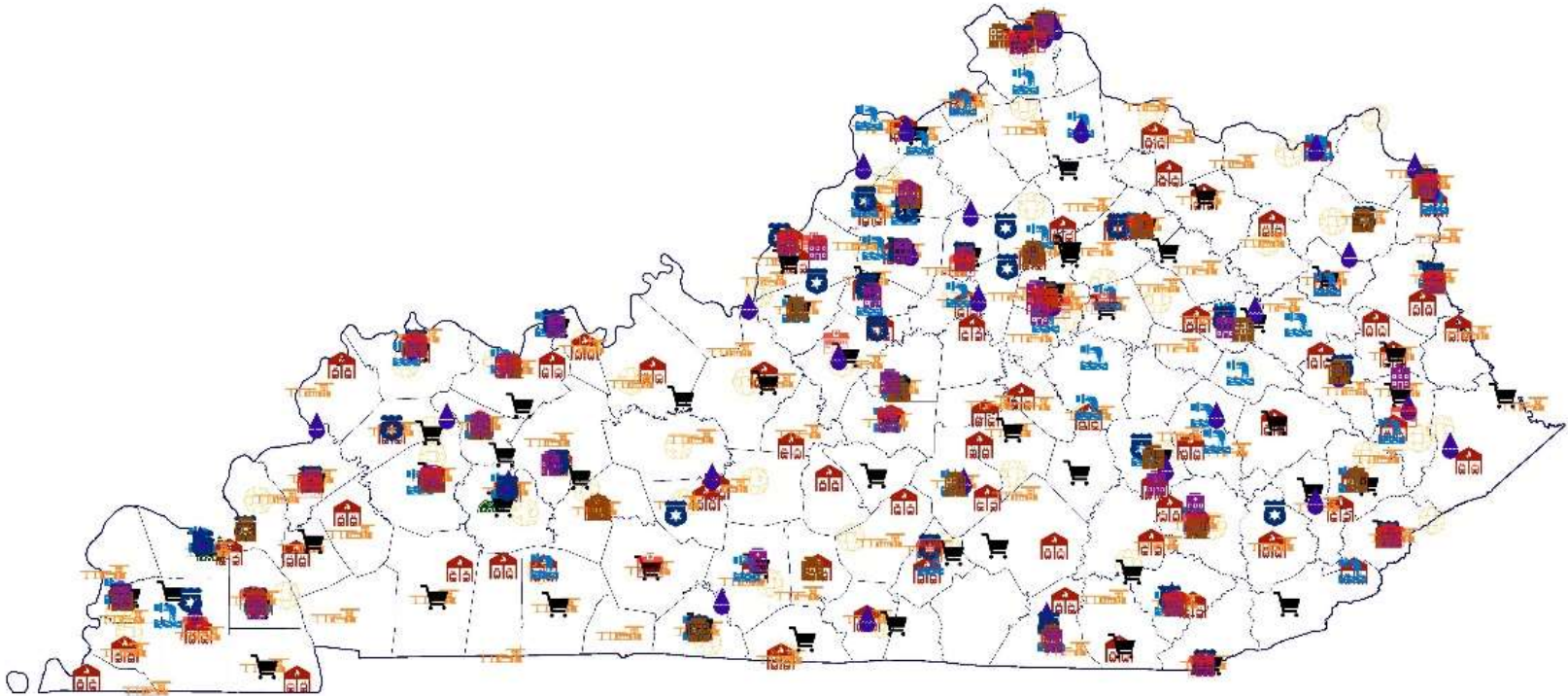
- Critical infrastructure facility type
- Geographical proximity
- Areas at high risk of natural hazard
- Reliability hotspots
- Population density
- Energy burden / underserved areas



Site Selection – Nanogrid Deployment Selection Results



Selected Nanogrid Deployment Locations



- | | | | |
|-----------------------------|----------------------------|----------------|------------------|
| Hospital | Law Enforcement | Grocery Store | Fire Station |
| Nursing Home | Water Treatment Plant | Cellular Tower | National Defense |
| Emergency Operations Center | Wastewater Treatment Plant | Gas Station | Counties |

Site Selection - Regional Community Selection Results

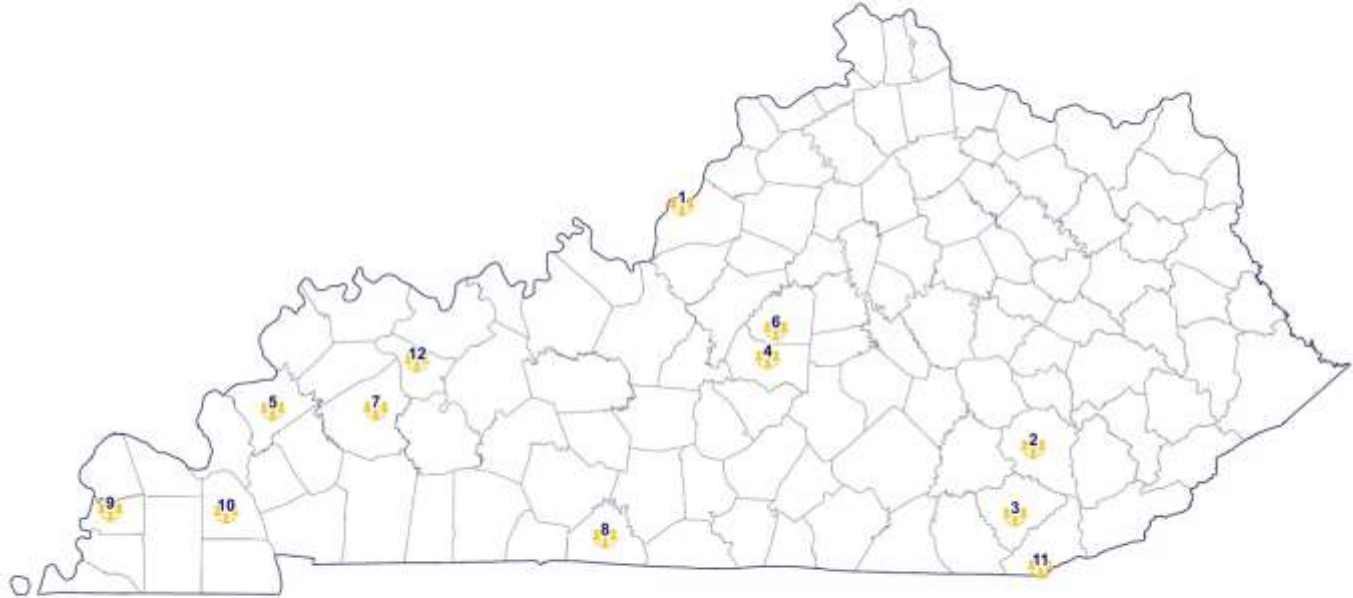


Regional Community Microgrid Legend

- 1. Jefferson County Community Microgrid
- 2. Clay County Community Microgrid
- 3. Knox County Community Microgrid
- 4. Marion County Community Microgrid
- 5. Crittenden County Community Microgrid
- 6. Washington County Community Microgrid
- 7. Hopkins County Community Microgrid
- 8. Allen County Community Microgrid
- 9. Carlisle County Community Microgrid
- 10. Marshall County Community Microgrid
- 11. Bell County Community Microgrid
- 12. McLean County Community Microgrid



Selected Regional Community Microgrid Locations

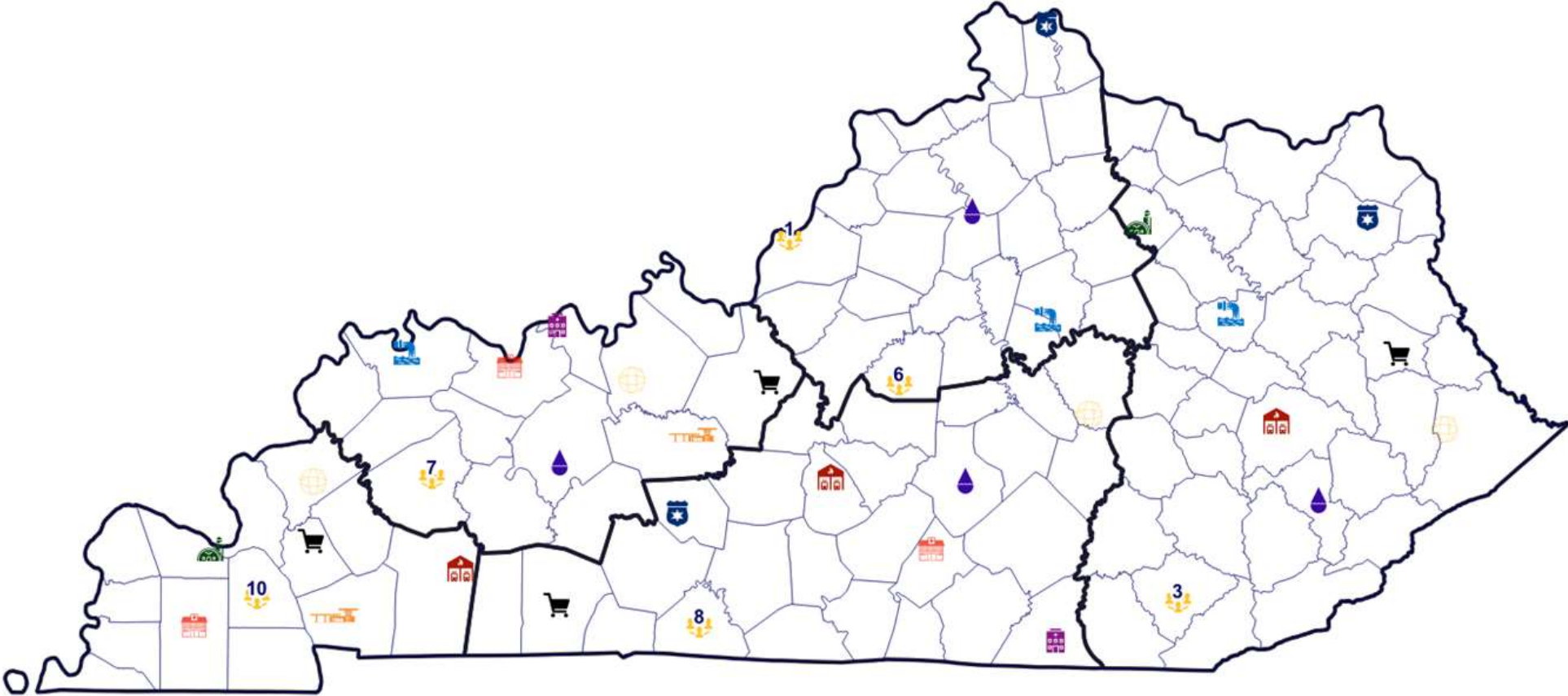


- Selected Regional Community Microgrid Location
- Counties

Site Selection - Representative Strategy



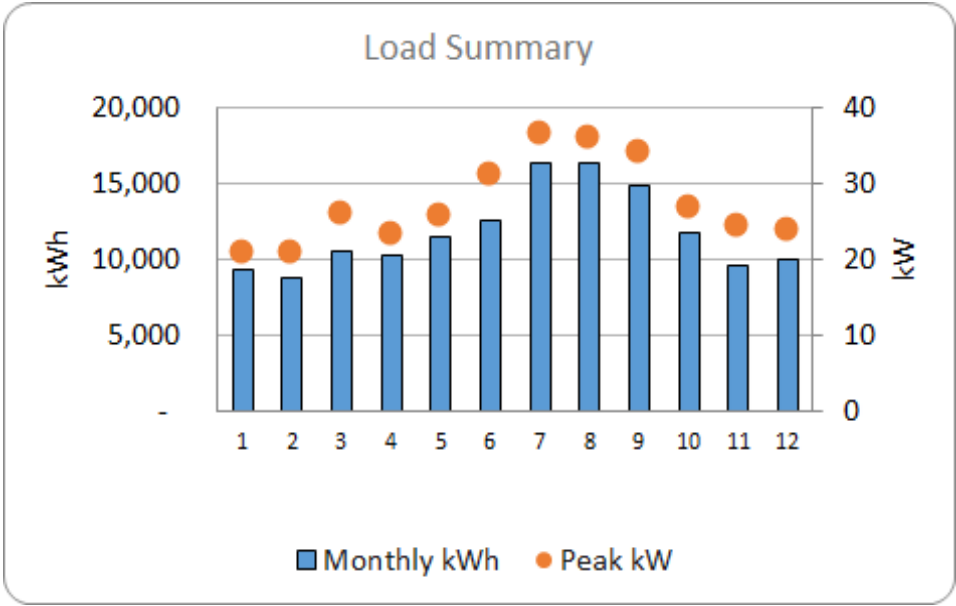
Representative Nanogrid & Regional Community Microgrid Deployment Strategy



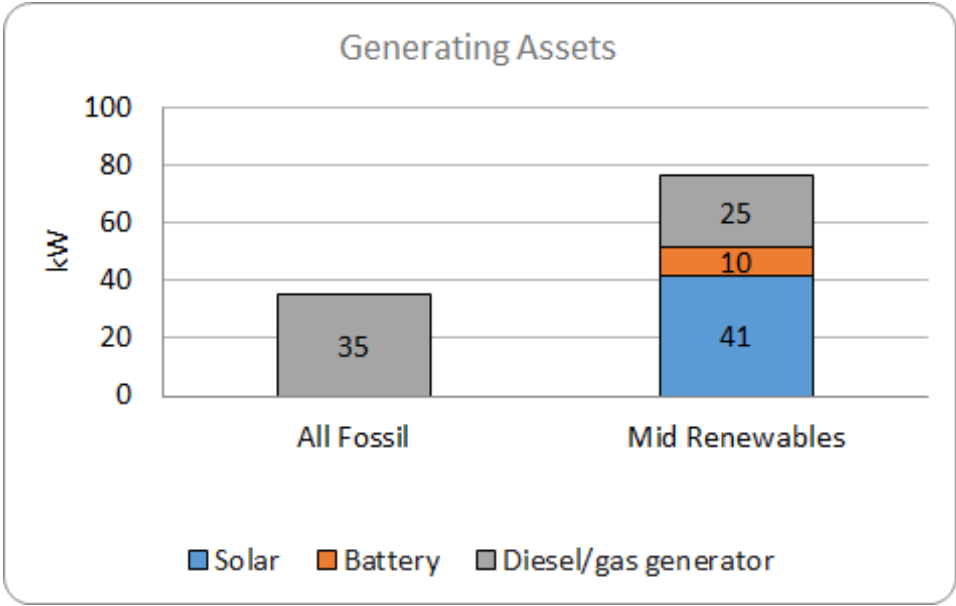
Sizing – Fire Station Example



Fire Station Load Profile



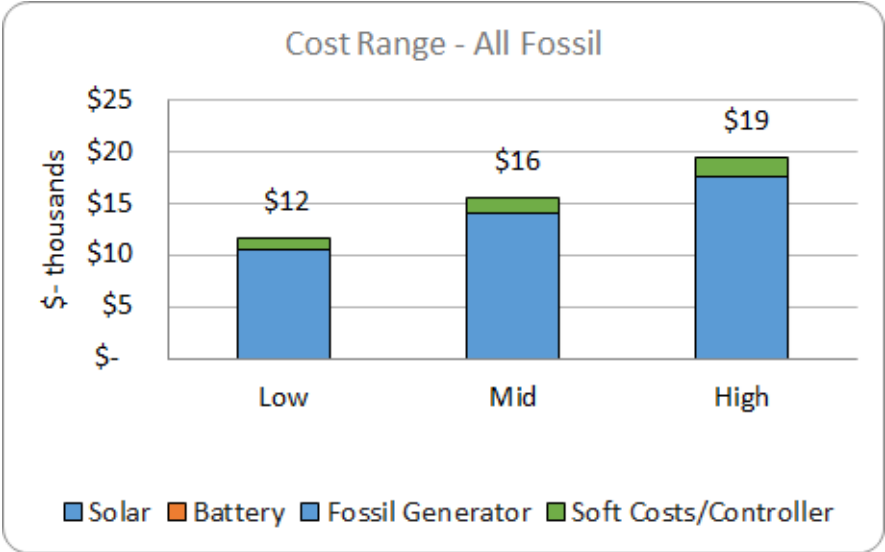
Fire Station Microgrid Design Options



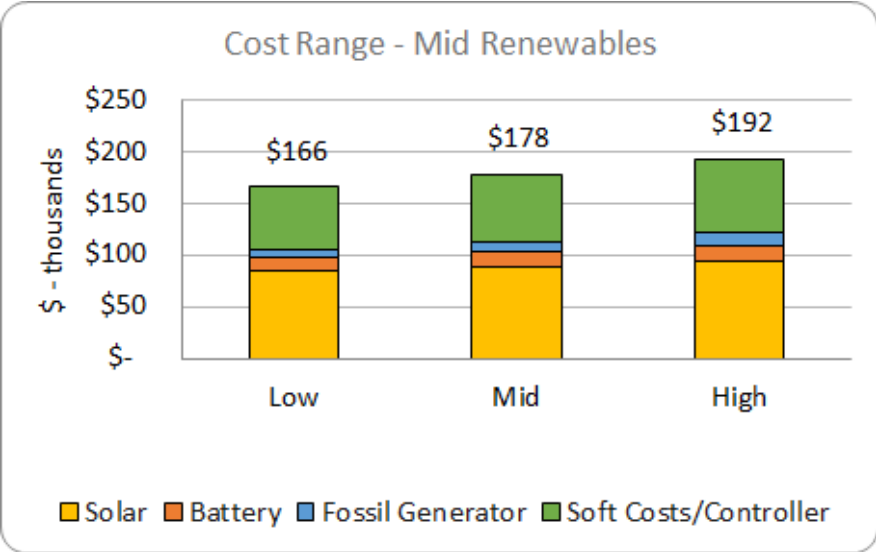
Cost Estimates – Fire Station Example



Design Option 1: Fossil Fuel



Design Option 2: Moderate Renewable



Deployment Strategies Overview: Site-Specific Installation



		Fossil Fuel Only Design Cost	Moderate Renewables Design Cost
Critical Facility Type	# Sites Selected	Per facility (thousands)	Per facility (thousands)
Cell Towers	56	\$5 - \$8	\$86 - \$97
Hospitals	26	\$861 - \$1,378	\$10,703 - \$12,260
Nursing Homes	32	\$17 - \$28	\$203 - \$235
Water Treatment Plants	44	\$10 - \$17	\$239 - \$272
Wastewater Treatment Plants	50	\$10 - \$17	\$239 - \$272
National Defense Facilities	5	\$5 - \$8	\$43 - \$51
Law Enforcement Facilities	42	\$7 - \$11	\$98 - \$113
Fire Stations	90	\$12 - \$19	\$166 - \$192
Emergency Operations Centers	33	\$7 - \$11	\$78 - \$90
Gas Stations	110	\$10 - \$17	\$176 - \$201
Grocery Stores	70	\$12 - \$19	\$153 - \$177

Deployment Strategies Overview: Regional Community Microgrids



Regional Community Microgrids		Estimated Costs for Fossil Fuel Only Design	Estimated Costs for Moderate Renewables Design
Microgrid	# of Critical Facilities within Microgrid	Cost (thousands)	Cost (thousands)
1 - Jefferson County Community Microgrid	5	\$537 - \$894	\$8,798 - \$9,940
2 - Clay County Community Microgrid	4	\$1,141 - \$1,931	\$11,012 - \$12,616
3 - Knox County Community Microgrid	4	\$1,148 - \$1,943	\$11,116 - \$12,732
4 - Marion County Community Microgrid	4	\$43 - \$72	\$750 - \$856
5 - Crittenden County Community Microgrid	5	\$45 - \$75	\$667 - \$766
6 - Washington County Community Microgrid	8	\$63 - \$106	\$1,191 - \$1,352
7 - Hopkins County Community Microgrid	4	\$25 - \$42	\$367 - \$420
8 - Allen County Community Microgrid	5	\$38 - \$64	\$724 - \$823
9 - Carlisle County Community Microgrid	4	\$30 - \$50	\$548 - \$622
10 - Marshall County Community Microgrid	4	\$28 - \$47	\$614 - \$693
11 - Bell County Community Microgrid	5	\$42 - \$69	\$659 - \$754
12 - McLean County Community Microgrid	4	\$38 - \$64	\$615 - \$704

Key Takeaways

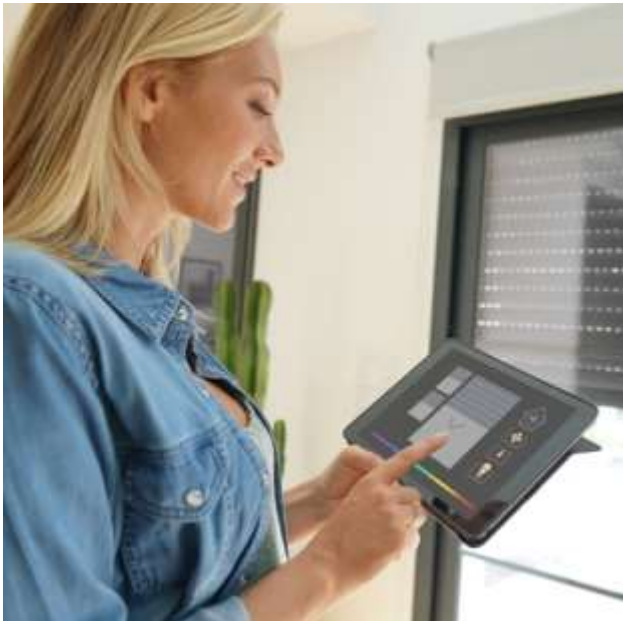


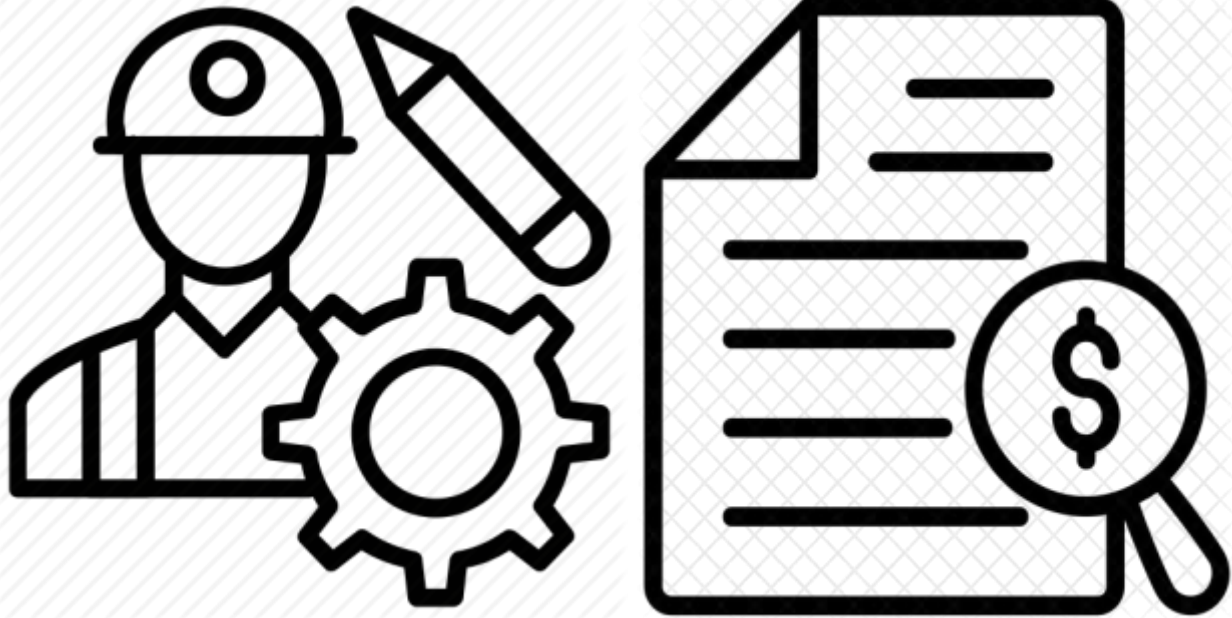
- Engage all stakeholders early and often to socialize ideas, collect data, and to solicit input on microgrid deployment process

- Prioritize critical facilities, natural hazards, reliability hotspots, population density, and low income communities

- In rural areas, nanogrid installations may be necessary due to the limited number of critical facilities within a close proximity

- A combination of nanogrid installations and regional community microgrids achieve increased resilience





Next Steps



● Conduct design & engineering work of the selected sites.

● Apply for FEMA and other funding to construct and install microgrids.

● Conduct further circuit, financial, and benefit-cost analysis of particular sites.

● Socialize with other states and community stakeholders to facilitate microgrid project success.

Who is eligible for BRIC funding?



Learn and Engage More with SEPA



SEPA Resources

- [Microgrid Playbook: Community Resilience for Natural Disasters](#)
- [SEPA Microgrid Design Framework](#)
- [How to Design Multi-User Microgrid Tariffs](#)

Learn More About SEPA's Microgrids Working Group at <https://groups.sepapower.org/home>

Contact Jared to learn more about SEPA's Microgrids for Resilience Consulting Services at jleader@sepapower.org





Q & A