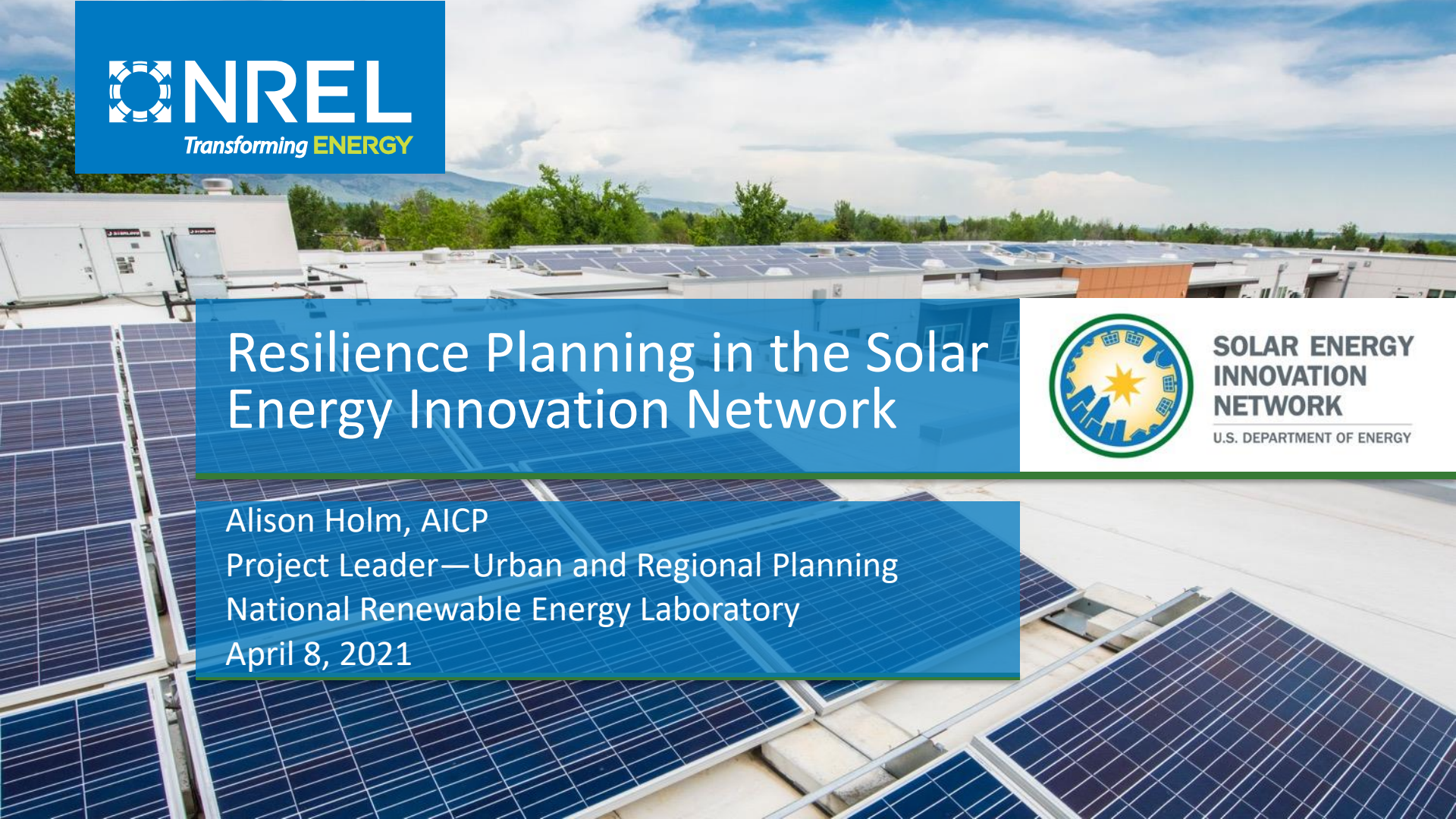

Resilience Planning in the Solar Energy Innovation Network

SOLAR ENERGY INNOVATION NETWORK
U.S. DEPARTMENT OF ENERGY

Alison Holm, AICP
Project Leader—Urban and Regional Planning
National Renewable Energy Laboratory
April 8, 2021

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NREL Overview

NREL Science Drives Innovation

Renewable Power

Solar

Wind

Water

Geothermal

Sustainable Transportation

Bioenergy

Vehicle Technologies

Hydrogen

Energy Efficiency

Buildings

Advanced Manufacturing

Government Energy Management

Energy Systems Integration

Grid Integration

Hybrid Systems

Urban Resilience and Energy Planning

The Big Picture

What is Urban and Regional Planning?

"The goal of planning is to **maximize the health, safety, and economic well-being of residents** in ways that reflect the unique needs, desires, and culture of those who live and work within the community… While architects often focus on a single building, a planner's job is to work with residents and elected officials to guide the layout of an **entire community or region**. Planners take a broad viewpoint and look at **how the pieces of a community — buildings, roads, and parks — fit together** like pieces of a puzzle. … [P]lanners also work to imagine **what can and should happen to a community**: how it should grow and change, and what it should offer residents 10, 15, or even 20 years into the future."

Cynthia Bowen. "What Is Planning?" American Planning Association. https://www.planning.org/educators/whatisplanning/

"Urban planning… attempts to organize **sociospatial relations across different scales of government and governance**. Urban planning is concerned with the social, economic, and environmental consequences of delineating spatial boundaries and influencing spatial distributions of resources."

Huxley, Margo, and Andy Inch. "Urban planning." (2020): 87-92. https://www.sciencedirect.com/science/article/pii/B9780081022955102288

Issues Urban Planning Deals With (not exhaustive)

- Plans and Plan Making (comprehensive plans, urban design, regional, neighborhood, transportation, housing, economic development, parks and open-space, critical and sensitive areas plans)
- Participation (stakeholder identification, community visioning, public meetings and hearings)
- Environmental Planning and Management (air, water, land, hazards)
- Structures (buildings: single and multi-family residential, office, schools, medical facilities, commercial and industrial facilities, etc.)
- Transportation (streets, sidewalks, transit systems, pedestrian infrastructure)
- Utilities (waste, water, wireless infrastructure, energy)
- Parks and Open Space; Farming and Forestry
- Places and Place Making (regions, neighborhoods, districts, mixed-use and transit-oriented development, conservation development)
- Research and Analysis (projections and demand analysis, impact assessments, mapping and visualization)
- Implementation (legal foundations, growth management, zoning, permitting, property rights, etc.)
- Preservation, Conservation, and Reuse (open-space, farmland, viewshed, historic preservation, brownfields)
- Economic and Real Estate Development

Urban Planning Is:

- A big-picture, system-of-systems approach to community design, development, and management
- A highly collaborative process
- Both technical and political
- Future-looking

Resilience Planning Overview

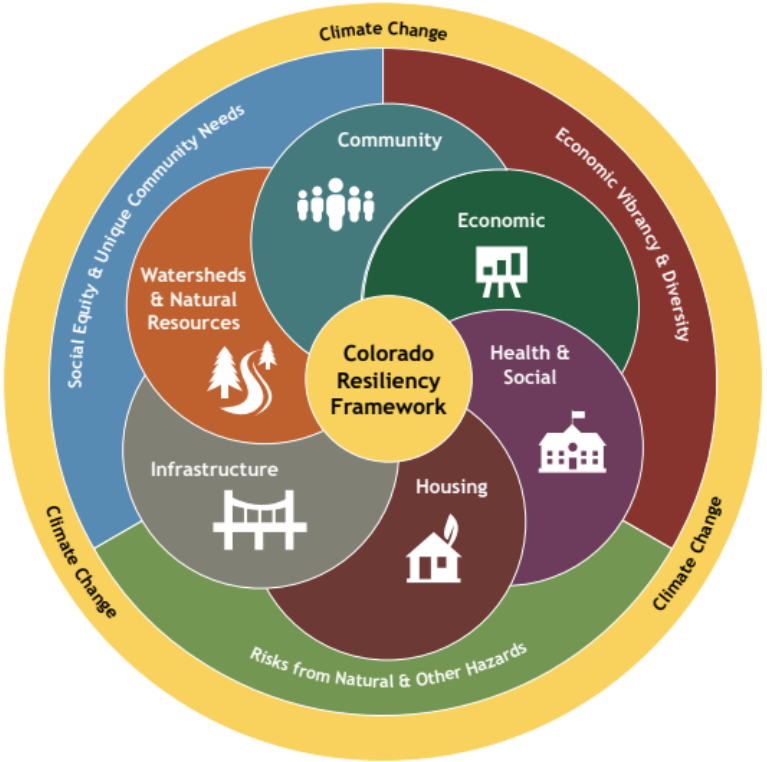
- "The ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions through **adaptable and holistic planning and technical solutions.**"

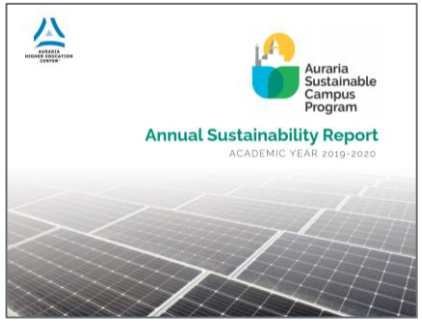
  Resilience Roadmap: A Collaborative Approach to Multi-Jurisdictional Planning (https://www.nrel.gov/resilience-planning-roadmap/)

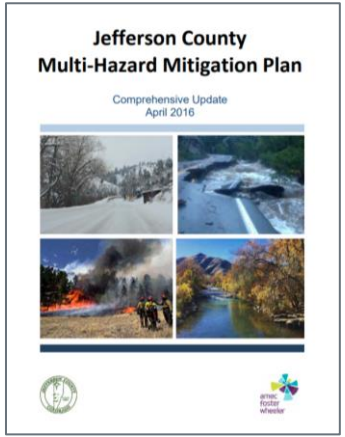
- "Power sector vulnerabilities—weaknesses within infrastructure, systems, or operations—are susceptible to natural, technological, and human-caused threats. Impacts from these threats include potential fuel supply shortages for transportation and energy generation, physical infrastructure damage, shifts in energy demand, and disruption of electricity supply to the end user."

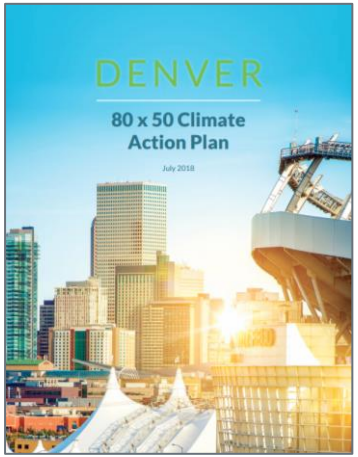
  Power Sector Resilience Planning Guidebook (https://www.nrel.gov/docs/fy19osti/73489.pdf)

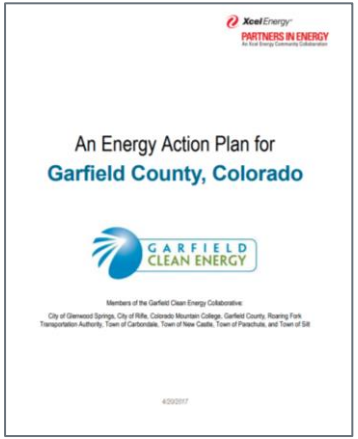
Layers of Urban Resilience & Energy Planning









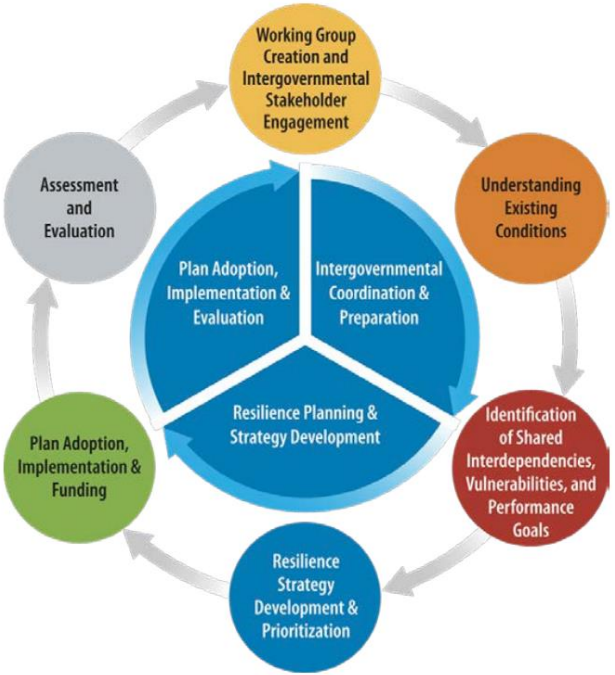


Source: "2020 Colorado Resiliency Framework." Colorado Resiliency Office – Department of Local Affairs.
https://www.coresiliency.com/colorado-resiliency-framework

Resilience Planning Process

Resilience Assessment Methodology

Source: Anderson, K., et al. "Energy Resilience Assessment Methodology." National Renewable Energy Laboratory. (2019). https://www.nrel.gov/docs/fy20osti/74983.pdf



Intergovernmental Planning process for resilient regions and infrastructure systems

Source: Hotchkiss, E. and Dane, A. "Resilience Roadmap: A Collaborative Approach to Multi-Jurisdictional Resilience Planning. (2019). https://www.nrel.gov/docs/fy19osti/73509.pdf

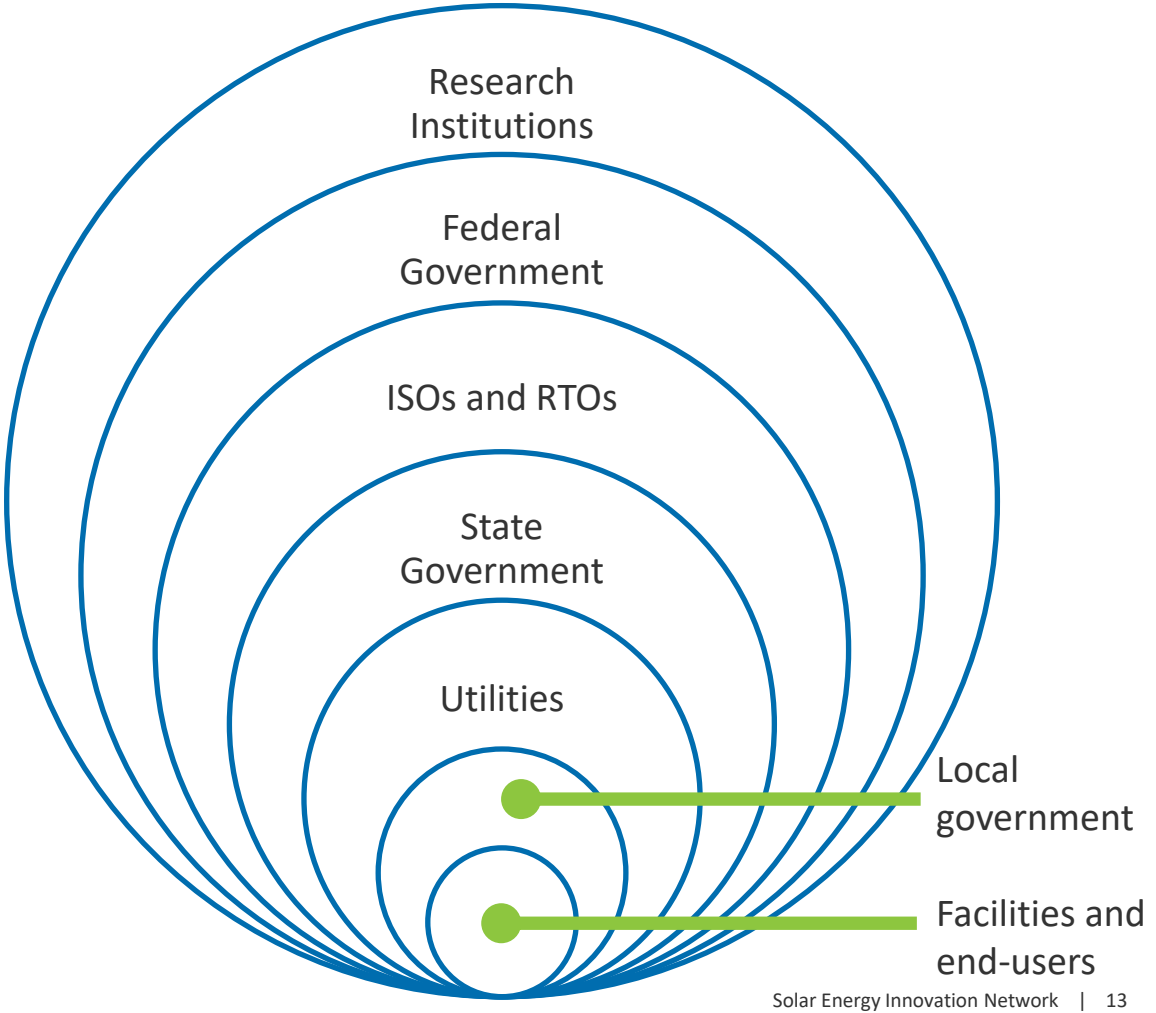
Cross-Sectoral Approach

- Electricity
- Transportation
- Buildings
- Agriculture
- Manufacturing

ILLUSTRATION BY BESIKI KAZAISHVILI, NREL

Urban energy resilience is inherently cross-sectoral and multi-dimensional

- **Different geographic scales:** Facility, campus, city, region, nation.
- **Different energy system layers:** Markets, system controls, data services, load control, devices.
- **Different decision-making entities:** Utilities, regulators, policymakers, consumers.




Solar Energy Innovation Network

Solar Energy Innovation Network

Program Overview

The Solar Energy Innovation Network is a collaborative research program that supports multi-stakeholder teams to research and share solutions to real-world challenges associated with solar energy adoption.

Approach

- Teams identify local and regional challenges, and receive technical and financial assistance to formulate and test innovations, and validate new models
- Teams meet in person for several multiday workshops to further refine solutions and learn from other teams
- Research and innovative solutions shared through peer network and stakeholders nationally

Objective

- Develop innovative solutions that make solar energy adoption easier and enable adoption by stakeholders across the United States facing similar challenges.

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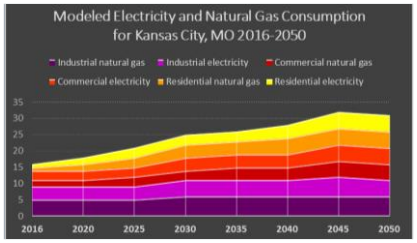
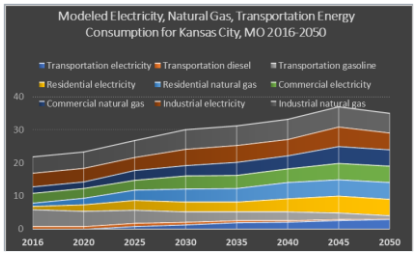
Questions Drive Analytical Approach

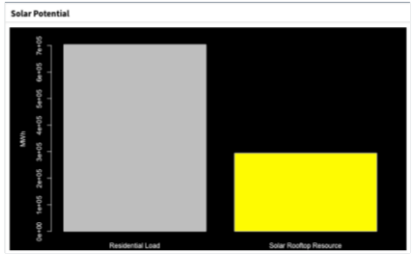
"How do we match renewable energy generation with **projected demand**, including transportation electrification?"



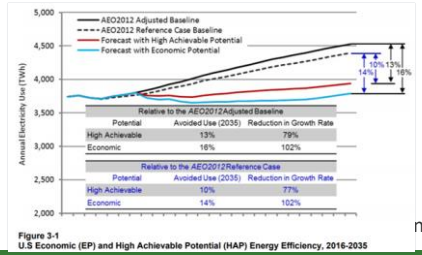
"How does our city ensure energy transitions do not negatively affect **low-income communities**?"



"How much of our city's electricity consumption can be met by **rooftop PV**?"



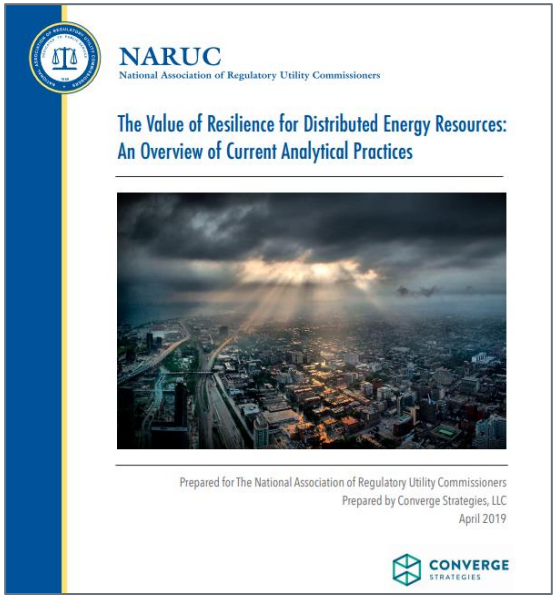
"How much could our city reduce consumption through **energy efficiency**?"

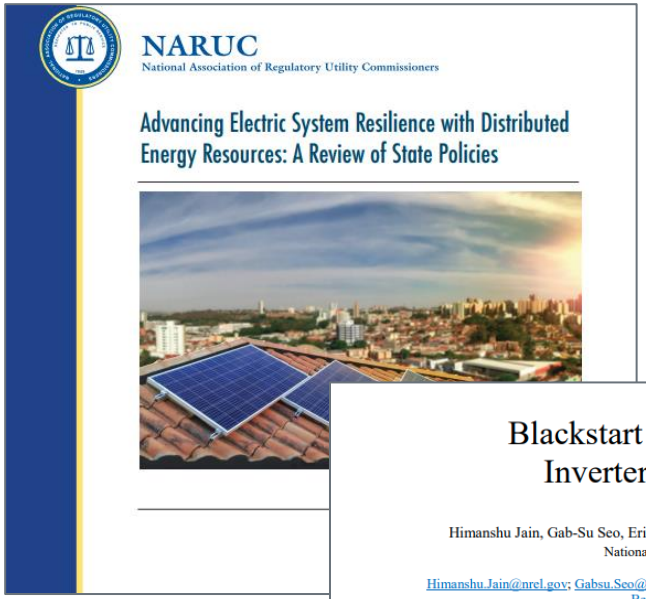


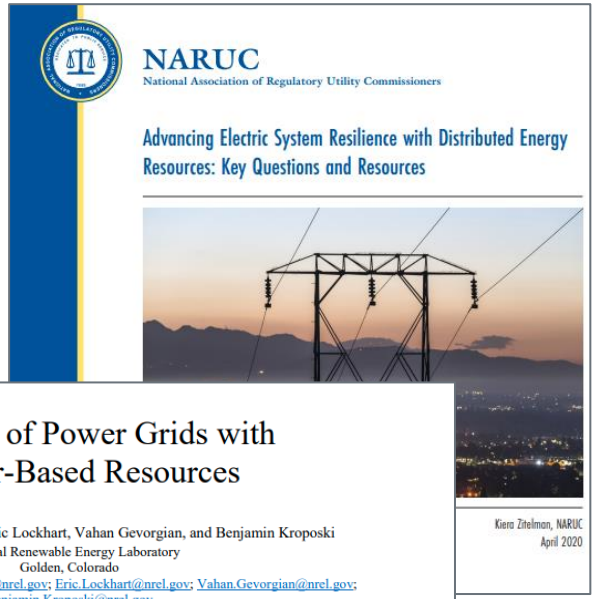
SEIN R2 Team Resilience Questions

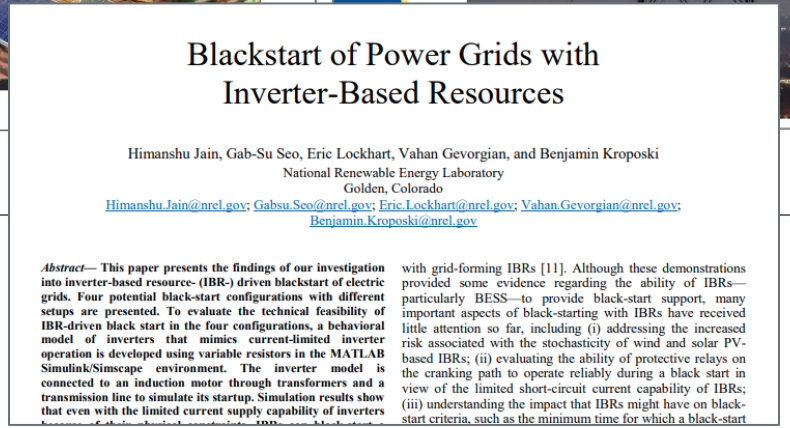
- How can solar+storage microgrid systems be designed through a community-driven process? How can solar+storage microgrids be designed to provide resilience benefits to low- and moderate-income communities?
- How can local governments identify and prioritize facilities for solar and storage deployment to enhance resilience within their jurisdictions? How might the costs and benefits of solar plus storage be quantified and assessed in terms of disaster mitigation and broader socio-economic resilience?
- What are emergency managers' priorities and where are there opportunities for solar plus storage to address those priorities?
- What are the use cases for solar plus storage to shorten the investment payback period while achieving the City's emergency response, public safety, and sustainability goals?
- What are the related policy and contracting considerations for integrating resilience factors into solar-plus-storage procurement?

Resilience in SEIN Round 1









Blackstart of Power Grids with Inverter-Based Resources

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***Abstract*— This paper presents the findings of our investigation into inverter-based resource- (IBR-) driven blackstart of electric grids. Four potential black-start configurations with different setups are presented. To evaluate the technical feasibility of IBR-driven black start in the four configurations, a behavioral model of inverters that mimics current-limited inverter operation is developed using variable resistors in the MATLAB Simulink/Simscape environment. The inverter model is connected to an induction motor through transformers and a transmission line to simulate its startup. Simulation results show that even with the limited current supply capability of inverters**

with grid-forming IBRs [11]. Although these demonstrations provided some evidence regarding the ability of IBRs—particularly BESS—to provide black-start support, many important aspects of black-starting with IBRs have received little attention so far, including (i) addressing the increased risk associated with the stochasticity of wind and solar PV-based IBRs; (ii) evaluating the ability of protective relays on the cranking path to operate reliably during a black start in view of the limited short-circuit current capability of IBRs; (iii) understanding the impact that IBRs might have on black-start criteria, such as the minimum time for which a black-start

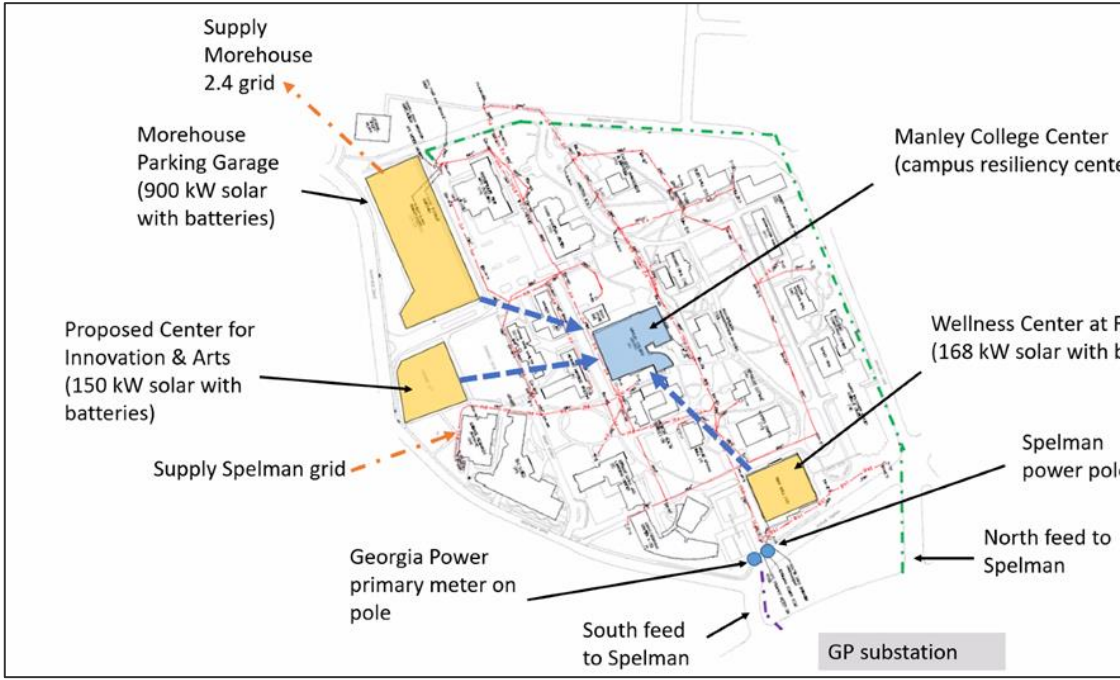
Creating an Innovative Urban Energy Resiliency Hub

Lead Organization: Groundswell Community Power

Team Members: Partnership for Southern Equity, the Atlanta University Center Consortium and its member historically black colleges and universities (HBCUs), and Spelman College

State Represented: Georgia

This team is collaborating with HBCUs and nearby energy-burdened residents in Atlanta to design an innovative urban energy resiliency hub integrating a microgrid, solar generation, and energy storage. The energy hub will help the HBCUs and the broader community to be more resilient. The team will design the resiliency hub, which includes technical, financial, and ownership considerations, to model a utility partnership. Eventually, this project will play a role in engaging and educating local communities and HBCU students about renewable energy sources and community resilience efforts.



Clear Sky Tampa Bay: A Regional Framework for Enhancing Resilience Through Solar Plus Storage

Lead Organization: Tampa Bay Regional Planning Council

Team Members: Pinellas County, Manatee County, Hillsborough County, City of Largo, Converge Strategies, University of South Florida's Patel College of Global Sustainability, Solar Energy Management, LLC

State Represented: Florida

This team is creating a regional technical and economic framework for integrating disaster risk reduction and other resilience factors into solar-plus-storage cost-benefit analyses. The project aims to develop model solar-plus-storage solutions and procurement strategies that can be deployed at critical facilities throughout Central Florida and beyond.

For more information: https://www.tbrpc.org/clearsky/

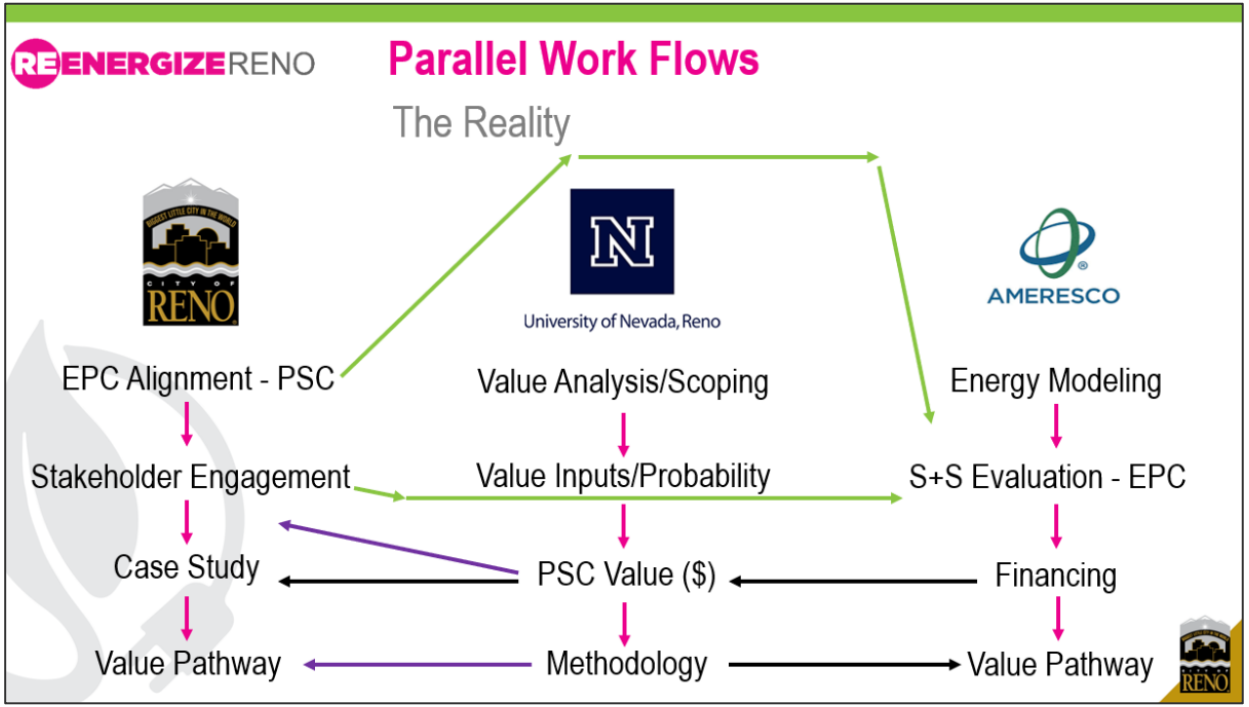
Quantifying the Resilience Value of Solar Plus Storage in Reno

Lead Organization: City of Reno

Team Members: Nevada Governor's Office of Energy, NV Energy, and Ameresco

State Represented: Nevada

This team is working to quantify the financial value of resilience benefits from solar-plus-storage systems and apply that value to energy performance contracts. The project aims to create a highly transferable valuation model, develop a proof of concept for how the value of resilience can be incorporated into energy performance contracts, and advance city- and county-level policy direction for integrating solar-plus-storage applications into emergency response and public safety facilities and networks.



Summary: Key Takeaways

- **Urban Resilience and Energy Planning:** Energy resilience considerations can be integrated across other community resilience planning processes. Community resilience is inherently multi-disciplinary and cross-sectoral.
- **Renewable energy for community resilience:** When designed to do so, solar, storage, microgrids, and other technologies can provide islandable power with on-site energy generation, which can be used as backup power during a grid outage; redundancy and diversification are critical.
- **Stakeholder perspectives:** Different stakeholders bring different perspectives to the resilience planning process and will be key for implementing solutions. Questions drive the analytical approach and can facilitate a more open, collaborative process.
- **Varied solutions:** Resilience solutions are multifaceted and can be wide-ranging, spanning hardware, siting, system design, system sizing, policy and regulation, business models, and planning processes; robust resilience solutions will address root causes and multiple sources of vulnerabilities.
- **Iterative process:** Resilience planning is an iterative process; planning in the context of uncertainty requires plans to be updated regularly.

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Thank you!

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