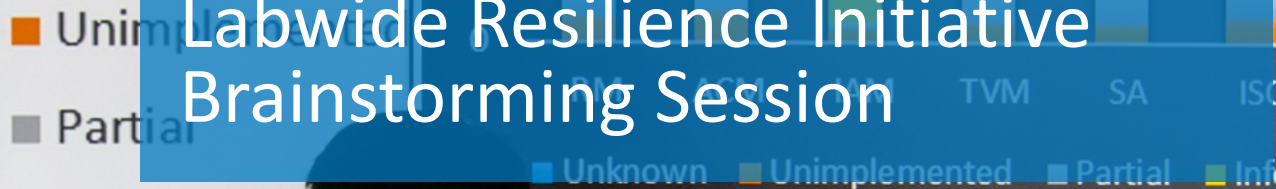


Labwide Resilience Initiative Brainstorming Session

Eliza Hotchkiss, ESR
 Greg Guibert, SEAC
 Nika Durham and Rachel Wolford, ESI
 Communications



Total Partial Controls



6%

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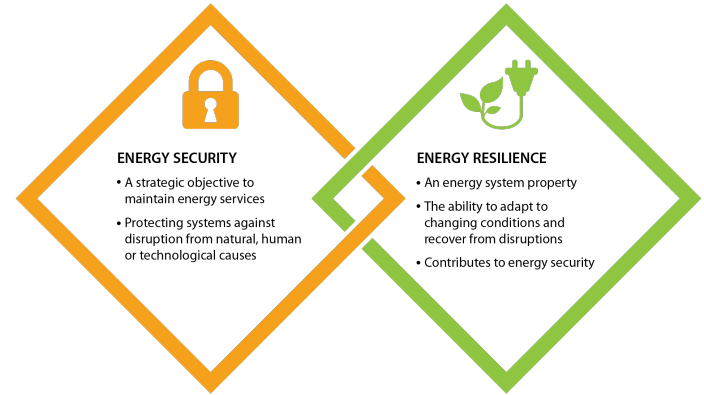
Wrap Up and Next Steps



NREL's Energy Security & Resilience Program

The Energy Security & Resilience (ESR) program seeks to:

- Improve the current understanding of potential energy service disruption and their consequences
- Improve energy security under different scenarios, by continuing to provide energy services protecting energy systems from when human or natural disruptions occur
- Develop more resilient energy systems.



NREL Mission

NREL advances the science and engineering of energy efficiency, sustainable transportation, and renewable power technologies and provides the knowledge to integrate and optimize energy systems.



Research Capabilities



200+ power systems engineering and renewable generation **experts**



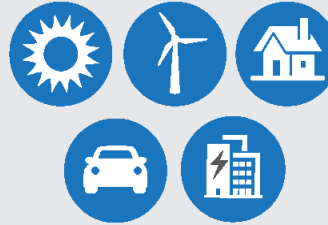
World-Class Operations

World-class electric grid research **facilities**



Record-setting models, maps, data sets, and **tools** for advanced grid analysis

Megatrends Driving Energy Security & Resilience Research



Electrification & Distributed Energy



Cyber threats

System Security and Resilience

Vulnerability Analysis

Multilayer energy systems scenario analyses

Utility, site-level, campus, and systems assessments

Mitigation Modeling

Hazard and threat mitigation R&D

Resilience research for distributed energy resources

Situational Awareness

Hazard and threat identification and visualization (historic and future)

Consequence analysis across interdependent systems and compounding hazards/threats

Stakeholder Engagement

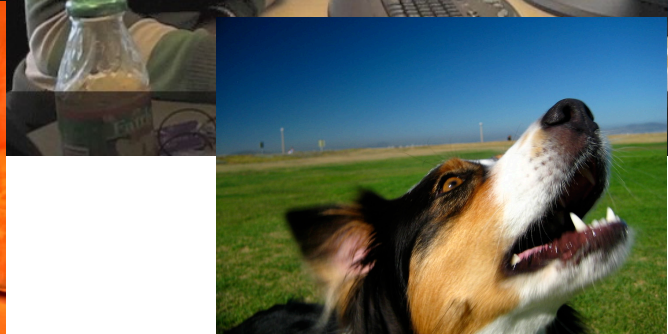
Qualitative and quantitative analyses through stakeholder driven-process to identify site-specific needs

Methodologies, tools, best practices, and cutting edge research to enhance energy security

Center	Capabilities
Energy Security and Resilience	Resilient system design and engineering; evaluation of system resilience and mitigations against disruption *resilience coordination across the lab
Strategic Energy Analysis	Resilience analysis and modeling of systems, GIS data visualization
Integrated Applications	Resilience technoeconomic analysis, stakeholder engagement, technical assistance, and planning
Power Systems Engineering	Resilient power system components, systems and operational strategies
Computational Science	Resilience visualization, digital twin development and deployment, data center/cloud/edge interaction for resilient systems analysis, resilience of AI/ML model forms
National Wind Technology Center	Resilient technology demonstrations, durability testing, cyber-resilience testbed
Integration Mobility Sciences	Resilient transportation, urban/social interface with resilience (e.g., social science applications)
Buildings and Thermal Sciences	Resilient building designs (e.g., passive survivability), modeling, and analysis of buildings and districts
Material Science	Materials durability and applications for resilience
Site Operations	NREL's resilience assessments, stakeholder engagement, and implementation on NREL's campus
JISEA	Interdisciplinary resilience research linking renewable energy with natural gas, nuclear energy and traditional generation; industry/manufacturing supply chains; international power systems transformation.



Today's objective is to understand the gaps and the vision for a labwide resilience strategy that can be supported by each center to grow the resilience program in a coordinated manner across the lab.



SETTING EXPECTATIONS and HOUSEKEEPING TIPS

- Mute yourself when you're not speaking!
- Please use the chat box for ideas!
- Let us know if you have technical difficulties!

Center

Energy Security and Resilience

Strategic Energy Analysis

Integrated Applications

Power Systems Engineering

Computational Science

National Wind Technology Center

Integration Mobility Sciences

Buildings and Thermal Sciences

Material Science

Site Operations



INTRODUCTIONS

- **Your name**
- **Where do you work in our organization?**
- **Where was the last place you vacationed and when?**



What are your dreams?

Big Sky Ideas

*Source: Assessing the DNS Cyber Attack Security Risk
2018 Ponemon Report on DNS Security and Cyber Attack Risks*

Big Sky Ideas



- Climate science
- ESTCP-funded initiative to impartially evaluate all previous and current funded DoD projects on resiliency and microgrids to create a capability gap analysis report and investment roadmap to address those shortfalls
- I would love for us to take the lead on community resiliency. I think we are in a unique position to offer assistance to communities who are simultaneously interested in climate action and mitigation; we also have expertise in engaging with less-technical audiences (like city governments). Doing this well, however, requires developing and linking a lot of capabilities, including detailed threat models, component failures, backup power (REopt), demographics data, transportation models, and interviews.
- National analysis of resilient energy futures. How does integration of natural hazard risks inform planning around renewable energy deployment?
- Roadmap for and assessment of RE community resiliency microgrids and modeling to demonstrate range of deployment scenarios based on resiliency value stack. 750 - 1 million. DOE.
- Ability to run complex weather models (e.g. hurricanes, heat waves) over regions and understand how the infrastructure reacts, and then how to mitigate impacts through renewables, storage, community engagement, etc. Probably need \$5M or so and not sure who would fund,
- DOE/DOD funded 75 million for a Energy and Water Resiliency Research Center with building scale resiliency demonstrations and component research capabilities operating as a operating microgrid facility.
- Research, create, compile, and/or organize extensive high resolution spatial data library that is relevant to resiliency analysis and visualization. Estimated cost would be \$150k-\$300k. Potential funders could include FEMP or DOD.
- Resiliency Planning (i.e., Continuity of Operations) for states with DOE/NARUC support.
- Visualization tools for energy decision makers that pull from a centralized database that has ROBUST and VERIFIED historical and predictive outage (threats/hazards/vulnerabilities) capabilities.

Big Sky Ideas

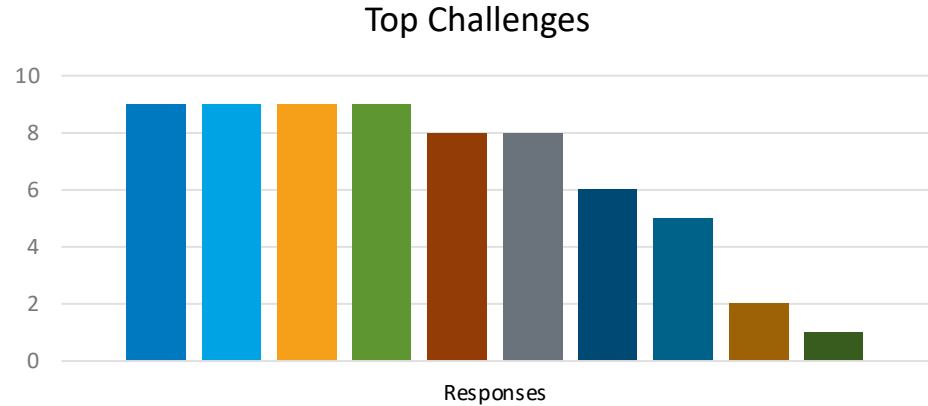
- Capabilities to examine interdependencies between energy systems, infrastructure and human action
- model integration in a meaningful way for rapid scenario development and sharing is an area that clearly needs work and resilience should be a decision factor in there because end users care about it (like cost effectiveness and job development). We are seeing how hard it is on the LADWP project, and that's with a uniform and proactive single funding source. Accomplishing this has a lot of limitations both technical and institutional (e.g. funding sources, org structures, typical interest of researchers in narrow areas, we can't do it alone)
- A coupled analysis of electricity, natural gas, water, and transport infrastructure to find coupled weakness to resilience. Probably \$5-10 million. OE and DOD.
- Host a resilience "wizard", a very simple app for very high-level self-assessment. This could be a short <\$500k LDRD. The wizard would increase NREL's exposure externally and bring new clients to our door.
- I would love to see more complex adaptive system modeling that integrates the technology and human systems in a more robust way and considers compounding hazards. DoE office of science or NSF, would be potential funders



Survey Results: Question 2

Discussion Question

- Is there any disagreement that these are the top challenges facing the resilience program?



- Lack of expertise in key disciplines
- Competition from other national labs
- Perception that NREL is institutionally limited to renewable energy
- Client-driven scopes of work
- Lack of established trust and confidence from some sponsor communities
- Volatile or unpredictable funding environment
- Other
- Business/contracting processes

Other Challenges

- Lack of internal coordination
- Ambiguity about resilience, what it is, how it is measured, what data are available, what analyses are needed
- Lack of a viable business model to fund resiliency strategies beyond diesel generators for code required life safety
- General nature of 'resilience' and its placement within a broader set of needs to balance within a community. It's easy to tell when a community could use efficiency support or solar support. It's harder to know the balance of factors that drives the importance of resilience to economic development or energy systems modernization. Resilience specialists tend to make the argument that resilience covers all of it - but that generalization sometimes makes it less useful to a community in balancing priorities. This survey forced me to pick three in addition to 'other' so I hope this answer comes through
- Lack of data
- Burdened cost is high relative to consulting firms

Survey Results:

Question 4

Discussion Question

- **Do we agree that these are our top three strengths and three weaknesses?**

Strengths (top 3):

1. Advanced computer science and data visualization
2. Analysis of novel energy materials, energy supply and storage, transportation, efficient buildings, sensors, and controls
3. Ability to design, construct, and operate leading-edge specialty research facilities

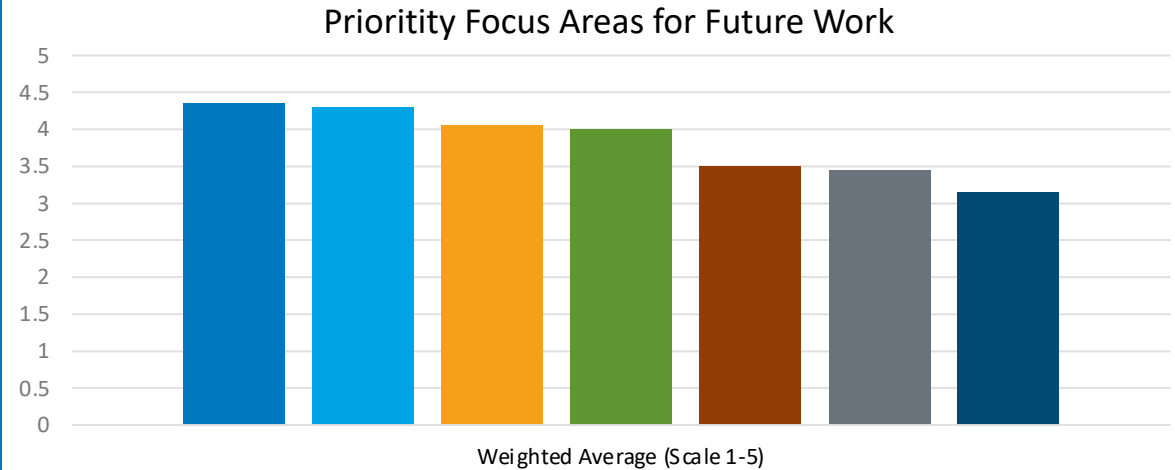
Weaknesses (top 3):

1. Large-scale production of new materials
2. Cybersecurity research, including technology research and development, distributed energy security standards, vendor product cybersecurity evaluations, site security assessments, and security architectures
3. Identification of strategically available materials supporting large-scale deployment of advanced energy systems

Survey Results: Questions 3

Discussion Question

- Do the new investment and focus areas identified here address the challenges and areas of relative weakness?



- Decision-support tool development: translation of complex data and technical analysis into user-friendly tools to inform stakeholders and decision-makers.
- Resilience metrics and valuation: measurement of costs and benefits related to resilience associated with different power system architectures.
- Analytic methodology and modeling: assessment component and system dynamic response to operational perturbations.
- Other areas
- Energy resilience evaluation and roadmaps: simulation and evaluation to inform resilient energy system design
- Resilience visualization: visualization capabilities for resilience research along with other capability developments.
- Foundational framing: standardization of an energy resilience taxonomy, conceptual framework, and resilient design principles to support consistency by NREL staff.

Other Priority Focus Areas

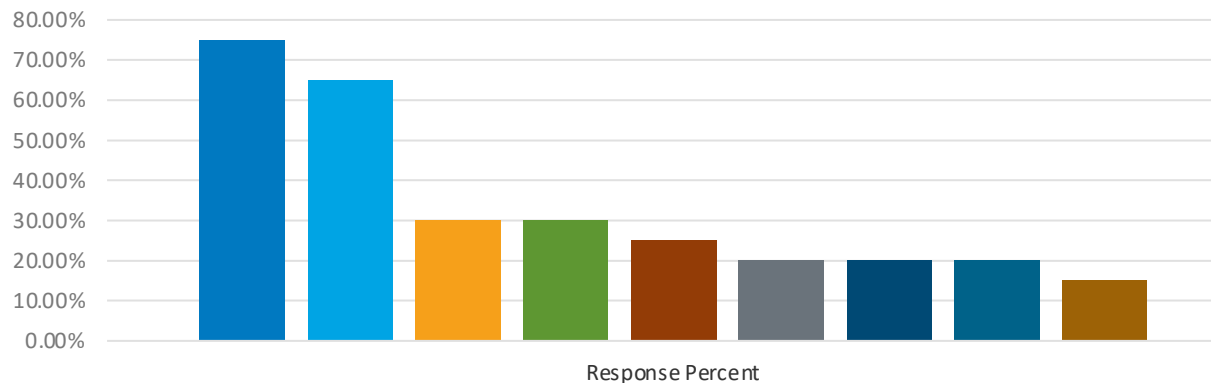
- Foundational data resources and methods
- High-fidelity scalable simulation/modeling capabilities
- Solar/storage as viable UL approved emergency/life safety power systems
- Links among resilience of communities and energy and infrastructure
- Direct assistance: improving our knowledge of technical, social, and institutional interactions through direct community support and feeding into the research portfolio

Survey Results: Question 5

Discussion Question

- Are there new investments identified that should take priority?

New Capabilities NREL Will Need to Grow




- Development of advanced energy resilience analytical frameworks and modeling capabilities
- Integrated energy resilience modeling with other critical infrastructure models to demonstrate national-level impacts of disruption scenarios
- Enhanced energy resilience science, such as analytical frameworks, taxonomies, or metrics and measures, etc.
- Complex adaptive systems modeling or agent-based modeling
- Security and resilience collaborative research capability
- All-hazards threat analysis capability
- Power and communications visualization laboratory
- Extension of the energy resilience assessment framework to address broader critical infrastructure space
- Integrated cyber-physical systems research and evaluation capability



What are your dreams?

Big Sky Ideas

*Source: Assessing the DNS Cyber Attack Security Risk
2018 Ponemon Report on DNS Security and Cyber Attack Risks*



Wrapping Up and Next Steps



- Consolidate survey results and feedback into a document for your review
- Labwide review
- Finalize document
- Send to ALDs for approval
- Center level resilience strategies to tie into the labwide strategy
- Forming a labwide BD resilience group and supporting materials for consistent communication (FY21)

Questions?

www.nrel.gov

