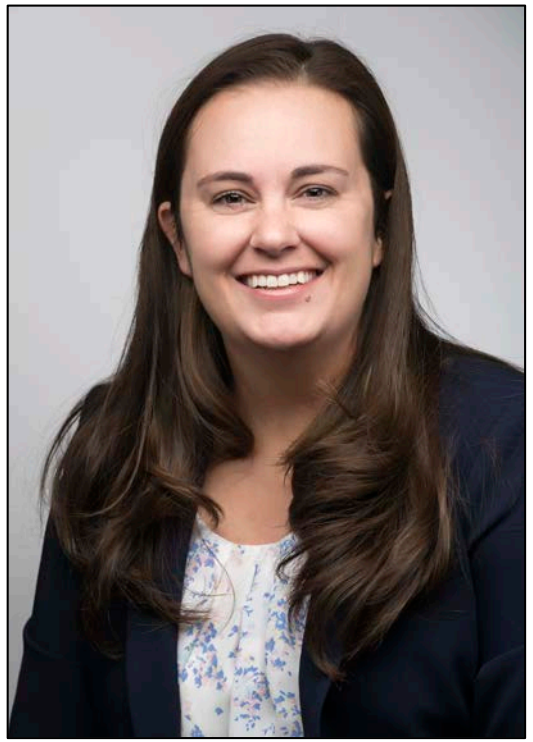
Resilient Energy Platform and Power Sector Resilience Planning in Lao PDR

Sherry Stout and Yevang Nhiavue | August 2019

Presenters



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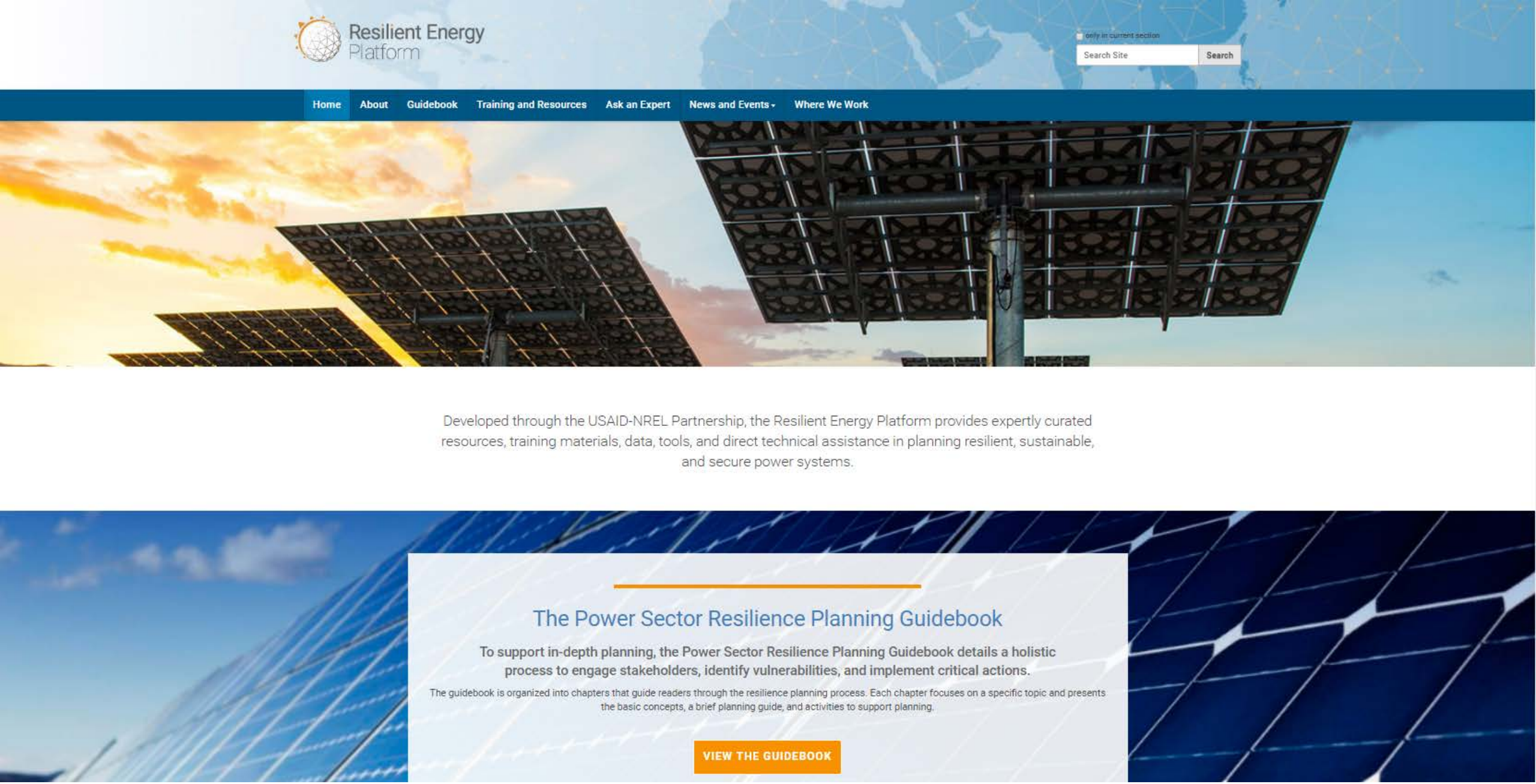

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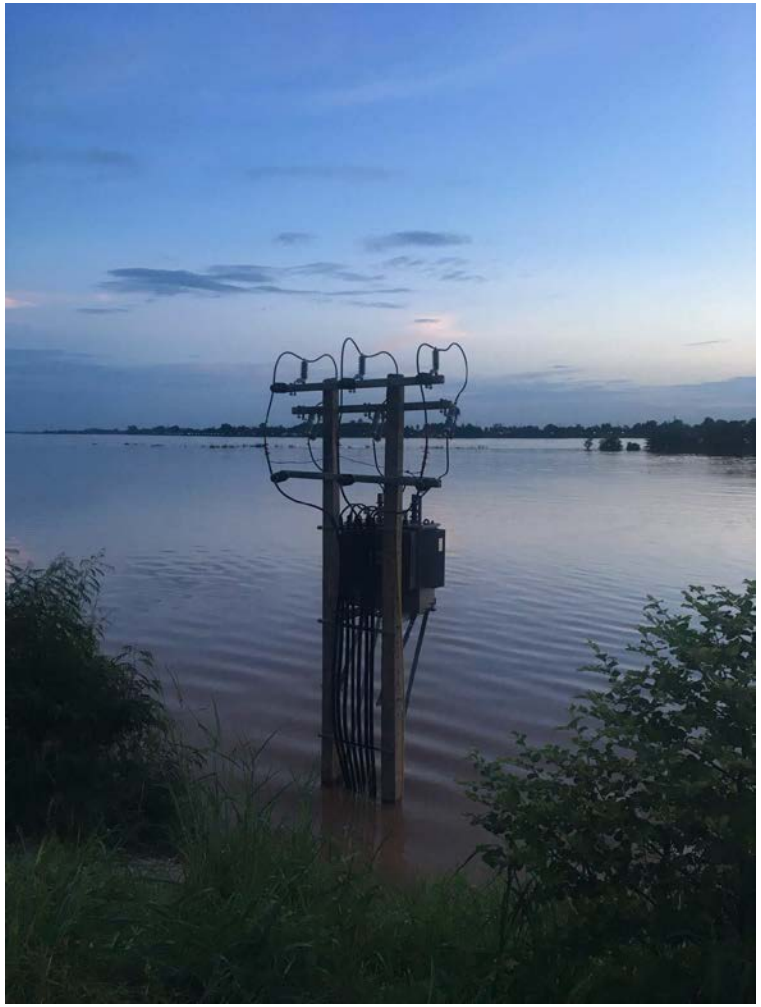
Resilient Energy Platform

The Platform provides expertly curated resources, trainings, data, tools, and direct technical assistance in planning resilient, sustainable, and secure power systems.

The platform enables decision makers to assess power sector vulnerabilities, identify resilience solutions, and make informed decisions to enhance power sector resilience at all scales.



Source: Sherry Stout, NREL

Planning for Power Sector Resilience

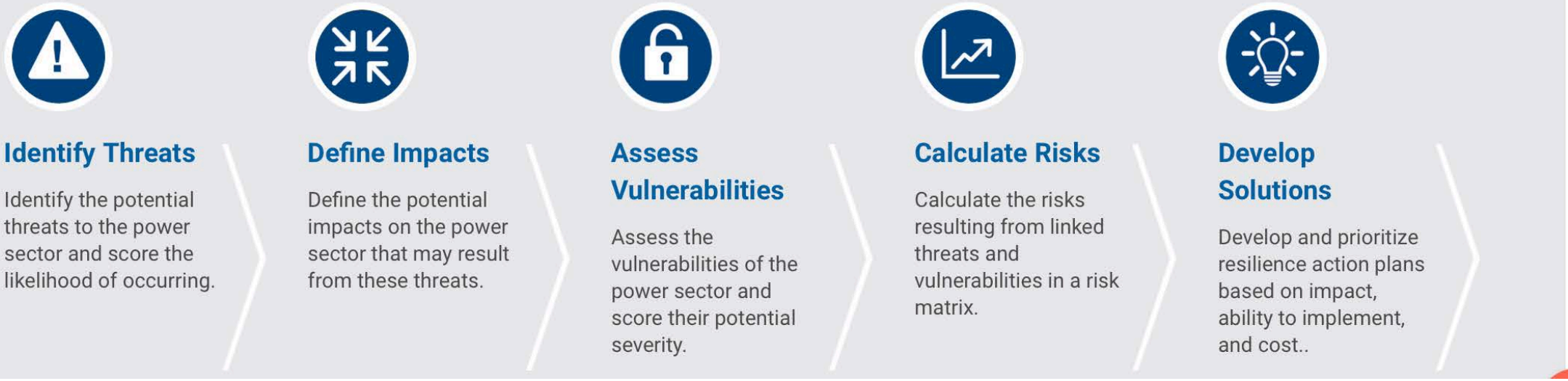
Resilient Energy Platform

Power Sector Planning Guidebook

A Self-Guided Reference for Practitioners

To support in-depth planning, the Power Sector Resilience Planning Guidebook details a holistic process to engage stakeholders, identify vulnerabilities, and implement critical actions.

The guidebook is organized into chapters that guide readers through the resilience planning process as shown below. Each chapter focuses on a specific topic and presents the basic concepts, a brief planning guide, and activities to support planning. These resources facilitate the step-by-step power sector resilience planning process and enables readers to:



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Training and Resources

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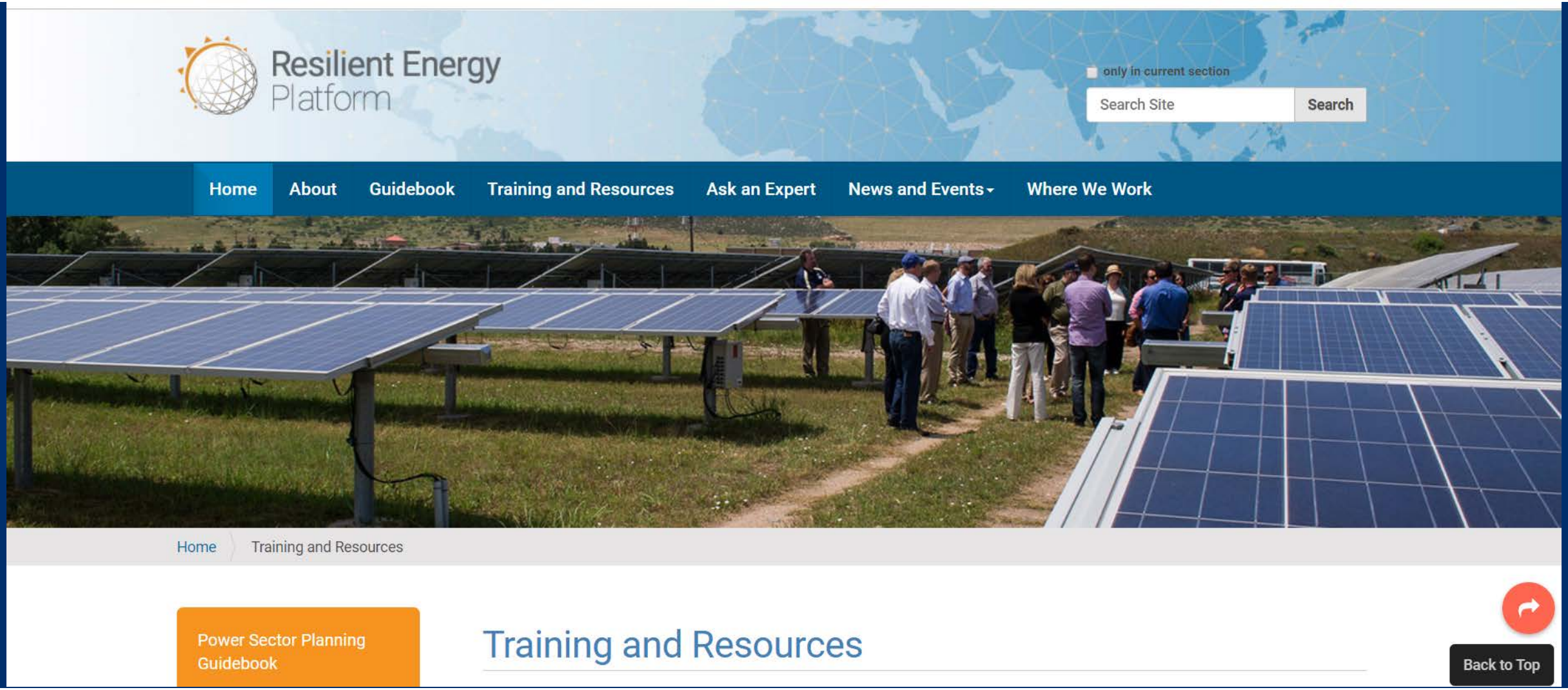

Resilient Energy Platform Knowledge Products

Resilient Energy Platform

- Collection of fact sheets on cutting-edge topics to support resilience in the energy sector, in partnership with RALI program including:
  - Transformative technology solutions to support resilience
  - Cross-border power trade for resilience
  - Integrated resource and resilience planning (IRRP)
  - Mini-grids and resilience
- Webinars
- Curated news feed

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Ask an Expert

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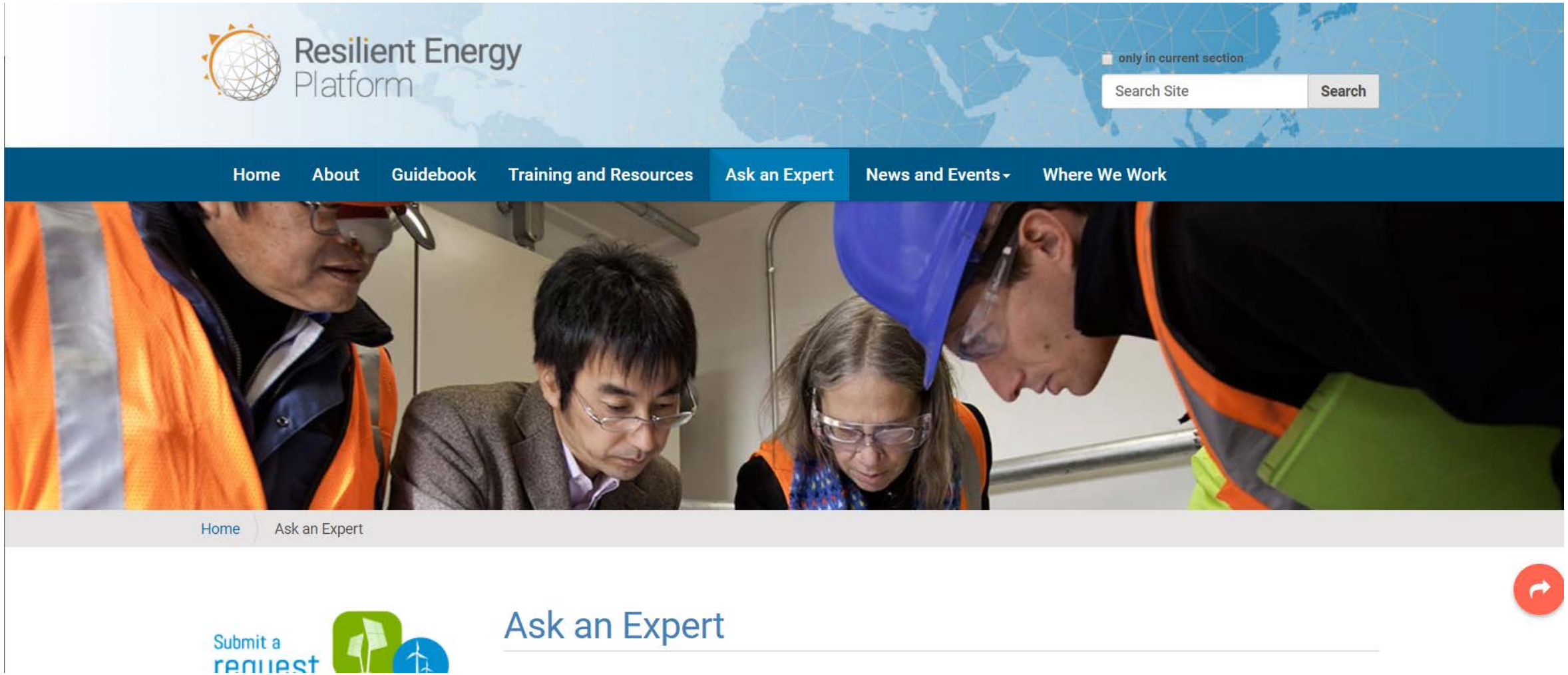

Lao PDR Vulnerability Assessment and Resilience Planning Process

Key Messages

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Reliable, safe, and secure electricity is essential for economic and social development and is a necessary input for many sectors of the economy.

The power sector is vulnerable to climate-related threats, natural hazards, technological threats, and human-initiated threats.

Governments and utilities must identify challenges and solutions in the energy sector, including the need to reliably meet growing electricity demands, lessen dependence on imported fuels, expand energy access, and improve stressed infrastructure for fuel supply and electricity transmission for climate resilience.

What is Resilience?

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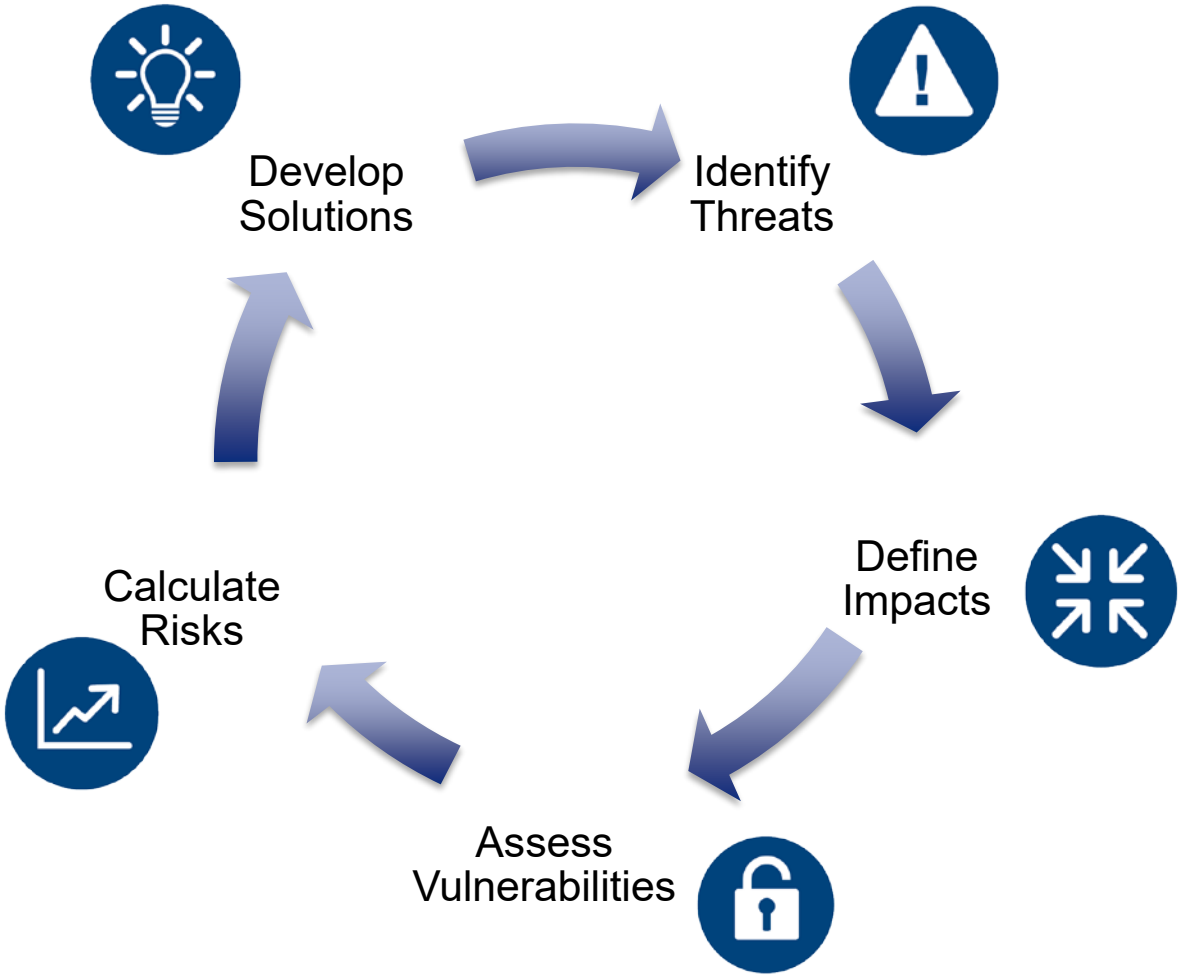
At its most basic level, resilience refers to the ability to recover after the application of stress.

NREL defines resilience as “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.”

Utilities often talk about resilience in terms of reliability. Resilience encompasses more than reliability – topics such as economic resilience, readiness for climatic changes, operational flexibility, and ability to shift resources should also be considered.

Resilience Planning Process



Identify Threats

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Natural

- Cyclones
- Floods
- Earthquakes
- Drought
- Wildfire
- Wildlife Interactions
- Solar Flares

Technological

- Infrastructure Failure
- Poor Workmanship or Design
- Unpredictable Loads
- Water-line Disruption Impacting Power Sector

Human-Caused

- Accidents
- Terrorism
- Cyberattacks
- Political Upheaval

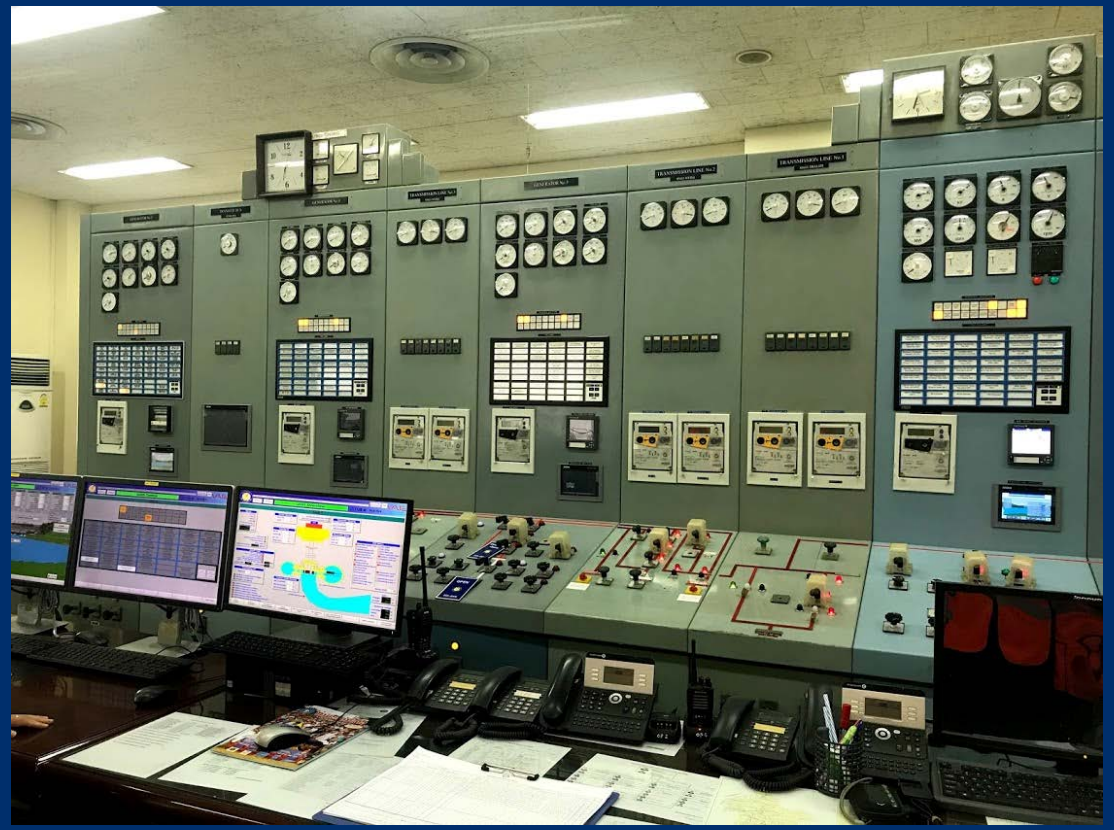
Score Threat Likelihood

Threat Likelihood Score		Threshold Descriptions
Qualitative	**Quantitative**	
High	9	Almost Certain to occur. Historic and frequent occurrences.
Medium-High	7	More likely to occur than not.
Medium	5	May occur.
Low-Medium	3	Slightly elevated level of occurrence. Possible, but more likely not to occur.
Low	1	Very low probability of occurrence. An event has the potential to occur but is still very rare.

- **Natural threat likelihood scores**: Assigned using a combination of documented natural threats and climate projections based on likelihood of occurrence assessed from the quality and consistency of data and the degree of agreement between different sources.
- **Human-caused and technological threat likelihood scores**: Assigned based on current understanding of conditions from information collected during stakeholder interviews.

Where to Find Threat Data

- Power system operator
- National weather center
- River or hydrology authorities
- National planning units
- Integrated Resource Plans (IRP)
- National emergency response organizations



Source: Sherry Stout, NREL

Define Impacts

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- Stakeholder engagement to understand how threats impact the power sector
- This engagement helps to inform identification of vulnerabilities
- Questions to ask:
  - How have past events affected the power grid?
  - Do different regions experience threats differently?
  - Do different populations or customers experience threats differently?

Source: Sherry Stout, NREL

Assess Vulnerabilities

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Vulnerabilities are weaknesses within infrastructure, systems or processes, which can be modified and mitigated to either prevent a disruption from occurring or lessen the impact of a disruption.

Vulnerabilities are identified through stakeholder interviews and/or literature reviews.

Source: Annie Weyiouanna

Vulnerabilities: Types and Severity

Types of Vulnerabilities	Examples
Physical	Lack of backup systems and supplies or single pointes of failure in transportation route, electrical line, water supply, or fiber optic cable.
Natural	Location prone to flooding, fire, etc.
Technological (i.e., hardware, software, or media)	Lack of cyber security defenses.
Human	Poor resources or under-trained workforce.
Others	Location-specific vulnerabilities identified by the resilience assessment team.

Vulnerabilities: Types and Severity

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Vulnerability Severity Score		Threshold Descriptions
Qualitative	**Quantitative**	
High	9	Highest magnitude of consequence. Entire power system would be impacted. Extreme financial impacts would exist.
Medium-High	7	Significant consequences to the organization. Majority of population served would be impacted. Staff tasks would be switch to emergency/critical operations. Significant impacts would exist.
Medium	5	Medium magnitude of consequence. The organization would be somewhat affected. Specific systems or functions would be substantially interrupted, but not all, Financial impacts would be expected to change budgeting plans or require reallocation of funds.
Low-Medium	3	Slightly elevated consequence to the organization. The power sector may need to temporarily transition operations to backup systems to resolve failure. Limited financial impacts may become apparent.
Low	1	Lowest magnitude (or severity) of consequence to the organization. The power sector would experience little to no effect or an in-place backup system would resolve the failure.

Calculate Risk

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Threat likelihood x Vulnerability Score = Risk

VULNERABILITIES	Vulnerability Severity Score	Extreme Precipitation	Extreme Temperatures	Flooding	Landslides	Wildfire Interactions	Wind	Human Actions: Bad Actors	Human Actions: Accidents	Technological Design	Technological Materials	Technological Workmanship	Drought	Lightning
		THREATS												
		Threat Likelihood Score												
		9	7	7	7	5	5	5	5	5	5	5	5	1
Power system rules, regulations, and technical standards do not meet current and changing environmental conditions	9	81		63	63			45		45	45			
Corruption leads to code violations	9	81			63	45	45	45			45	45		
Dam construction does not follow design specifications	9	81	63		63	45	45	45	45	45	45	45		
Installation does not follow design specifications	9			63	63	45		45	45	45		45		
Lack of compliance with codes in design	9	81	63	63	63	45	45			45	45	45		
System operations are not flexible enough to respond to changes in demand and supply	7	63	49	49			35			35			35	7
Demand forecasting is not responsive to changing load conditions	7	63	49							35			35	
Heavy power sector reliance on hydro generation	7		49	49						35			35	
Inadequate domestic generation capacity requires costly energy imports	7		49	49	49	35	35	35	35	35	35	35	35	

Develop Solutions

- Supply chain assurance
- Spatial diversification
- Generation mix diversification
- Islandable energy systems for critical loads
- Critical load panels in emergency facilities
- Passive survivability
- Load shedding
- Energy storage

Resilience Strategy: Spatial and Generation Diversification

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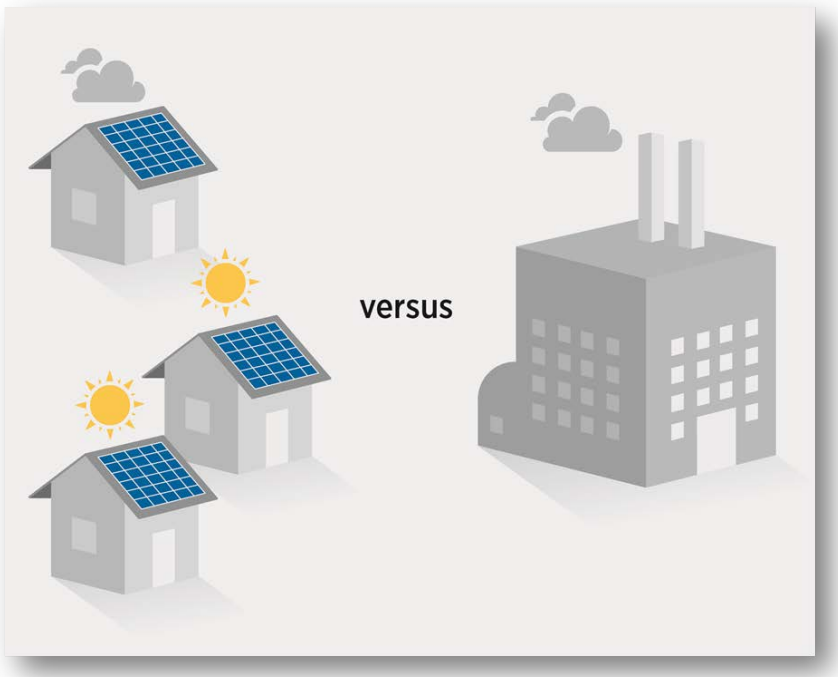
The modular nature of renewable energy technologies, such as wind turbines and PV allows greater spatial diversification of energy supplies compared to conventional power generation systems.

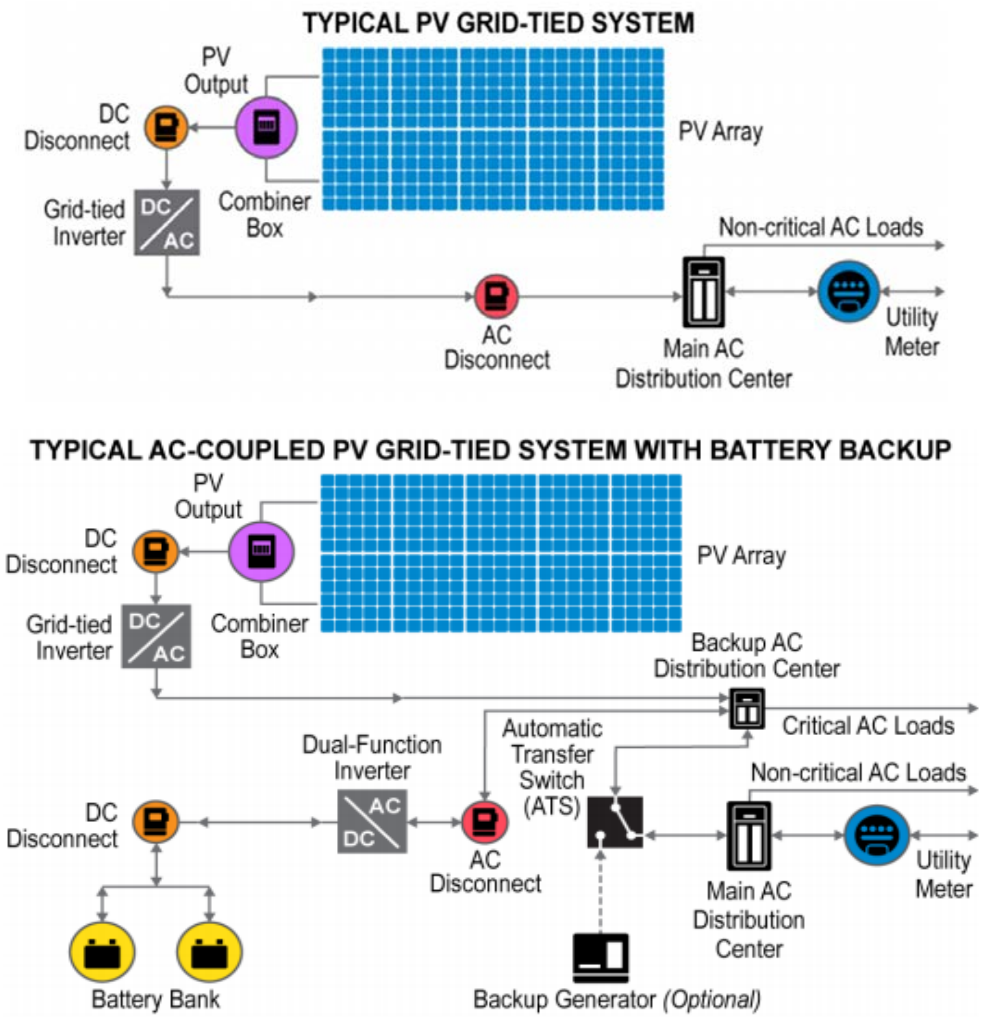
Modular renewable energy technology also allows for increased diversification of energy mix compared to single fuel conventional power plants.

This increased diversification reduces the vulnerability of the energy supply to cause damage from a single event or a single critical location, which increases overall energy system resilience.



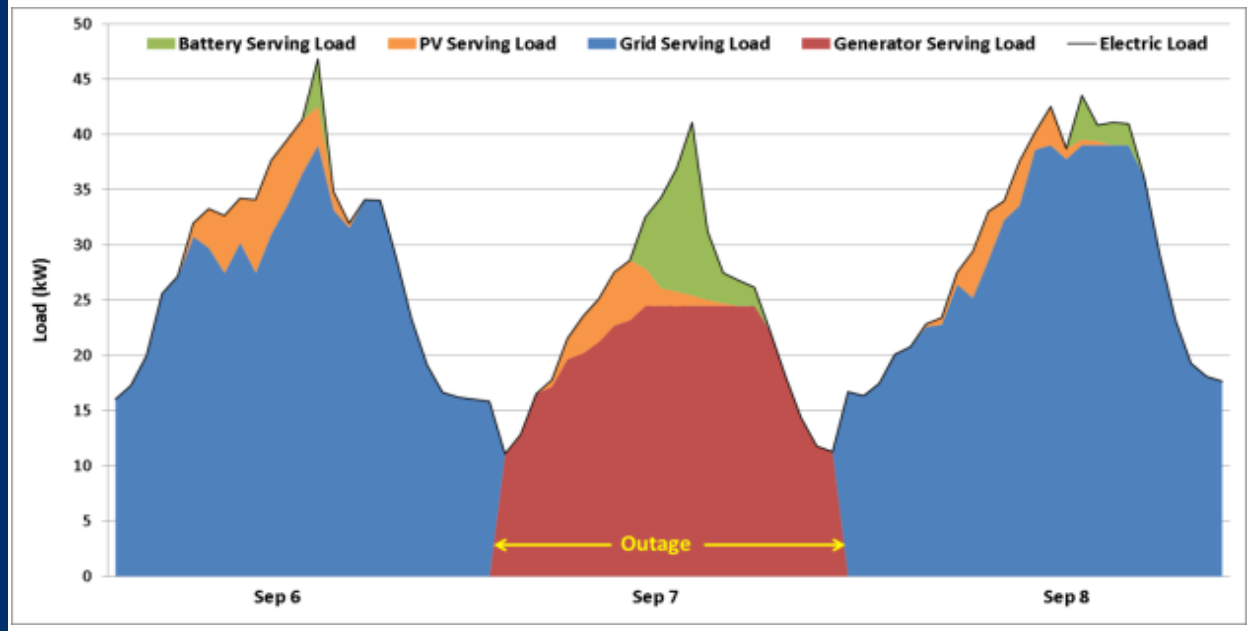
Resilience Strategy: Microgrids

- DG based microgrids **capable of islanding** can disconnect from the central grid during an outage event to allow energy to be diverted to critical loads
  - This allows utilities flexibility in restoring generation stations, responding to critical outages, and shutting down systems before an anticipated major event (e.g., storm) to prevent damage.
- Islanded DG systems ensure consumers have access to power during long-term power outages that severely impact central grid systems, which can occur after major natural disasters.
- During non-outage events, microgrids can participate in demand response programs to reduce electric loads during times of peak demand.



Source: https://nysolarmap.com/media/1655/dghubresiliencyretrofitfactsheet_8_8_16.pdf

Resilience Strategy: Redundancy

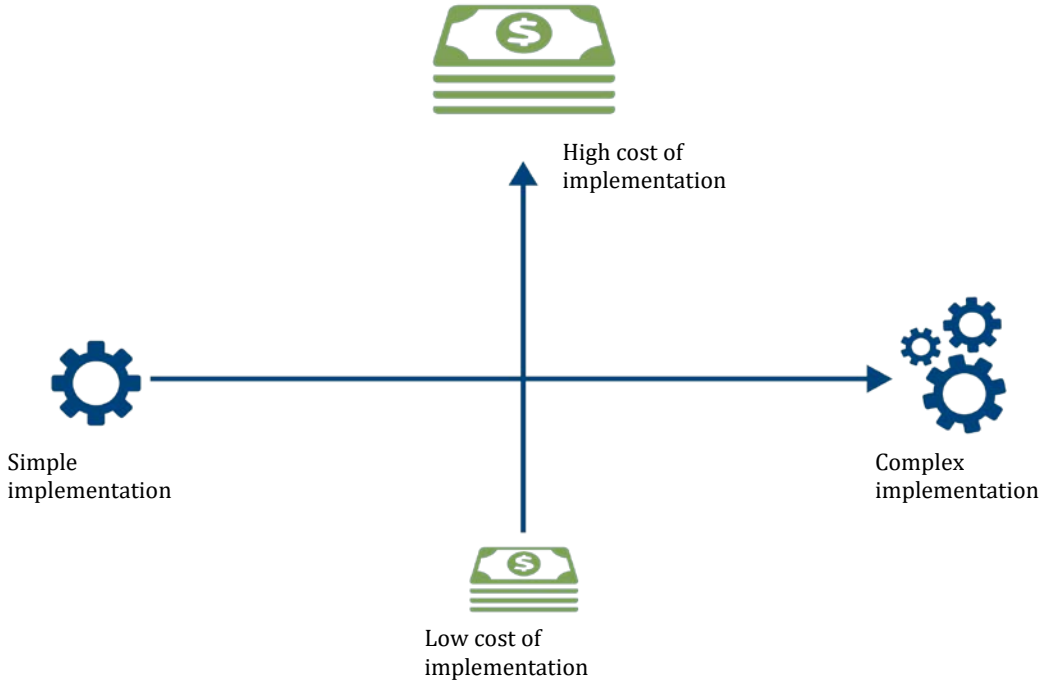


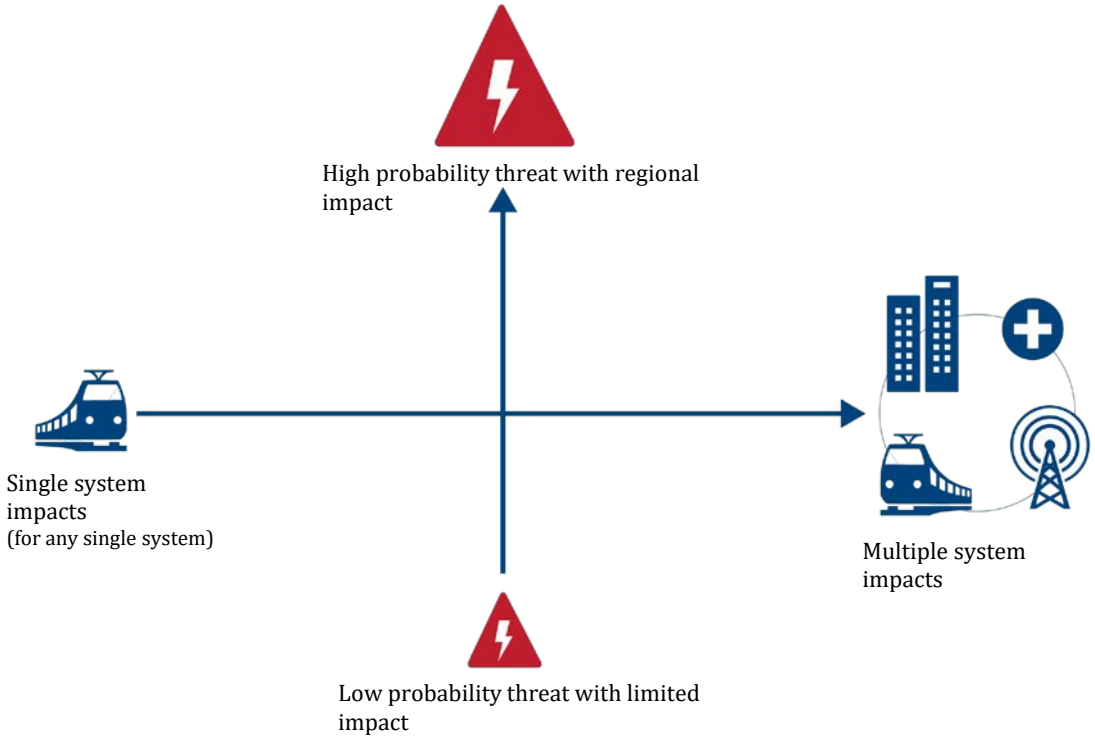
- Redundancy is the inclusion of additional resources that are not necessarily required for daily operations that are relied upon in case of failure in other components.
- Redundancy is essential for resiliency. Renewable DG can add redundancy while stretching fuel supplies for conventional generators.
- The increased stress on infrastructure systems as a result of changing climate or other threats has the potential to increase the likelihood of failure of one or more parts of a system.
- Communities served by only one power line or generating station have limited resilience. Increasing supplies, routes, or incorporating redundancy to overall systems will reduce the risks of those systems.

Important Note: Policy Matters!

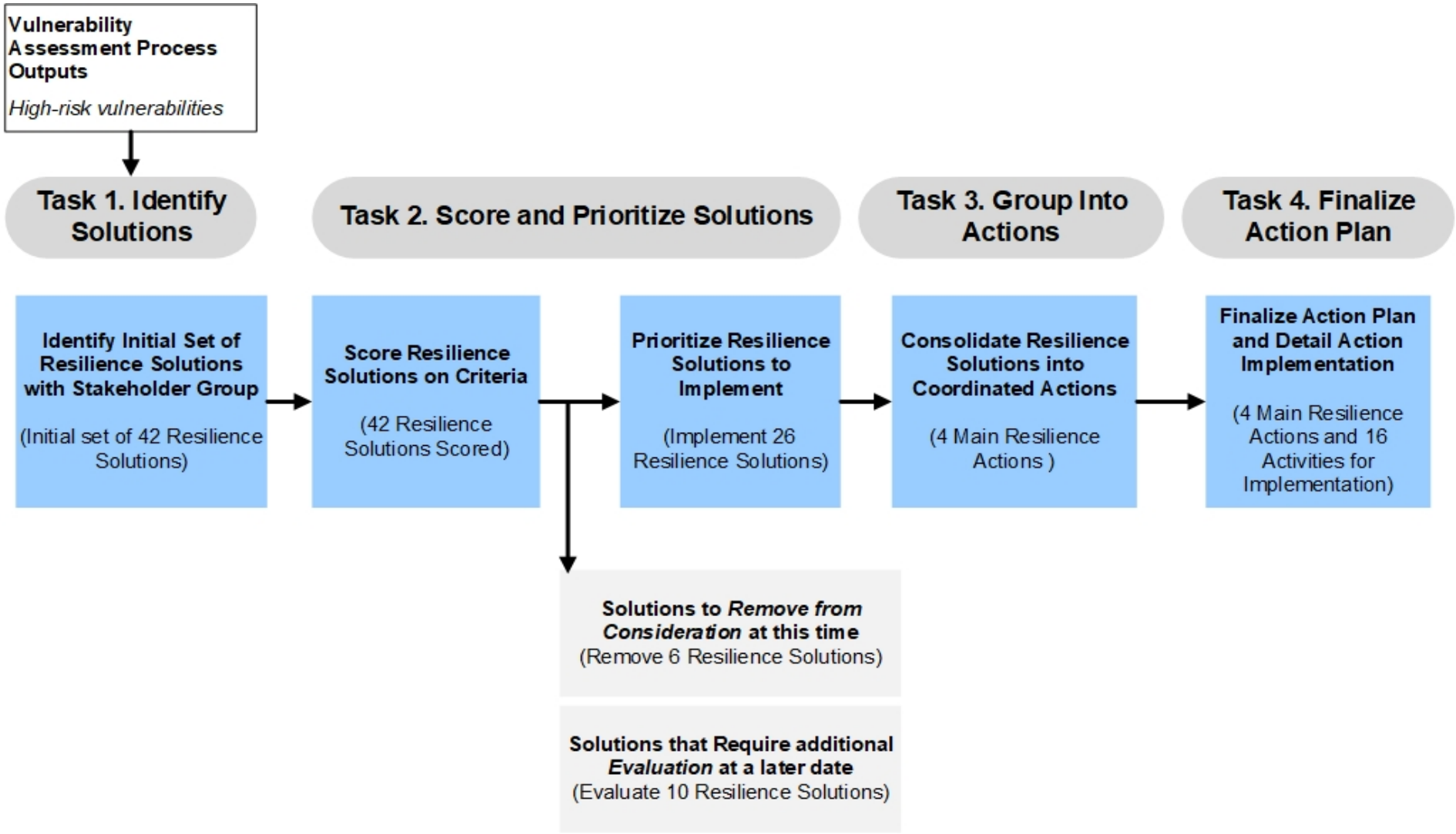
- In 2012 New Jersey had the second most installed solar PV of any U.S. state. However, when Hurricane Sandy hit, only a few of those systems provided power during the 12-day ensuing power outage.
- Why? Lack of resilience-enabling policy!

Prioritize Resilience Solutions





Resilience Action Planning



Resilience Action Planning

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Months 1-6	Months 7-12	Months 13-18	Months 19-24	Beyond Month 25
Action 1. Develop and Implement Resilient Power System Policies				
Activity 1.1 Develop standard operating procedures and continuity of operation plans for extreme events - including staffing plans, prioritized re-powering of networks, and aid agreements with neighboring countries				
Activity 1.2 Develop climate projections and geospatial data for hydropower and other generation planning, make these maps available publicly - including developers, and include policy provision that asset development will only occur within pre-selected zones				
		Activity 1.3 Develop standards and enforcement mechanisms for power reliability **Activity 1.4** Improve community readiness for extreme events that may impact the power sector		
	Activity 1.5 Improve enforcement of dam design and construction codes - including planning for expected hazards (such as floods, high winds, landslides) where these cannot be avoided **Activity 1.6** Include resilience provisions within annual operating budgets of relevant agencies			
Action 2. Improve Power System Flexibility				
Activity 2.1 Consider multiple demand and supply scenarios for power system growth in the power development plan and related planning activities				
	Activity 2. Reduce dependence on hydropower through diversification of energy mix			
	Activity 2.3 Introduce Flexibility Solutions Into Power System Operations			
	Activity 2.4 Improve power system planning for future scenarios including education for dispatch scenarios, weather forecasting for variable renewable energy, and knowledge of demand forecasting methods			
	Activity 2.5 Develop and implement a demand side management program to reduce peak electricity demand (such as time-of-use tariffs, industry and large customer programs, or public awareness and educational campaigns			
	Activity 2.6 Establish a binding contract or agreement within an interconnection procedure to ensure commitment of new large electrical customers such as large industrial loads			
Action 3. Improve Coordination across Hydropower Dam Operations				
Activity 3.1 Establish protocol for data collection at all hydropower dams including data types, collection frequency, and data format for sharing				
	Activity 3.2 Mandate data sharing between hydropower dam operators			
Action 4. Facilitate Better Sedimentation Management in Hydropower Watersheds				
Activity 4.1 Develop incentive and enforcement structures to ensure that users and/or areas that are upstream from hydropower dams protect watersheds located upstream from hydropower dams				
		Activity 4.2 Create educational campaign and community awareness for watershed protection upstream from hydropower dams		
Months 1-6	Months 7-12	Months 13-18	Months 19-24	Beyond Month 25

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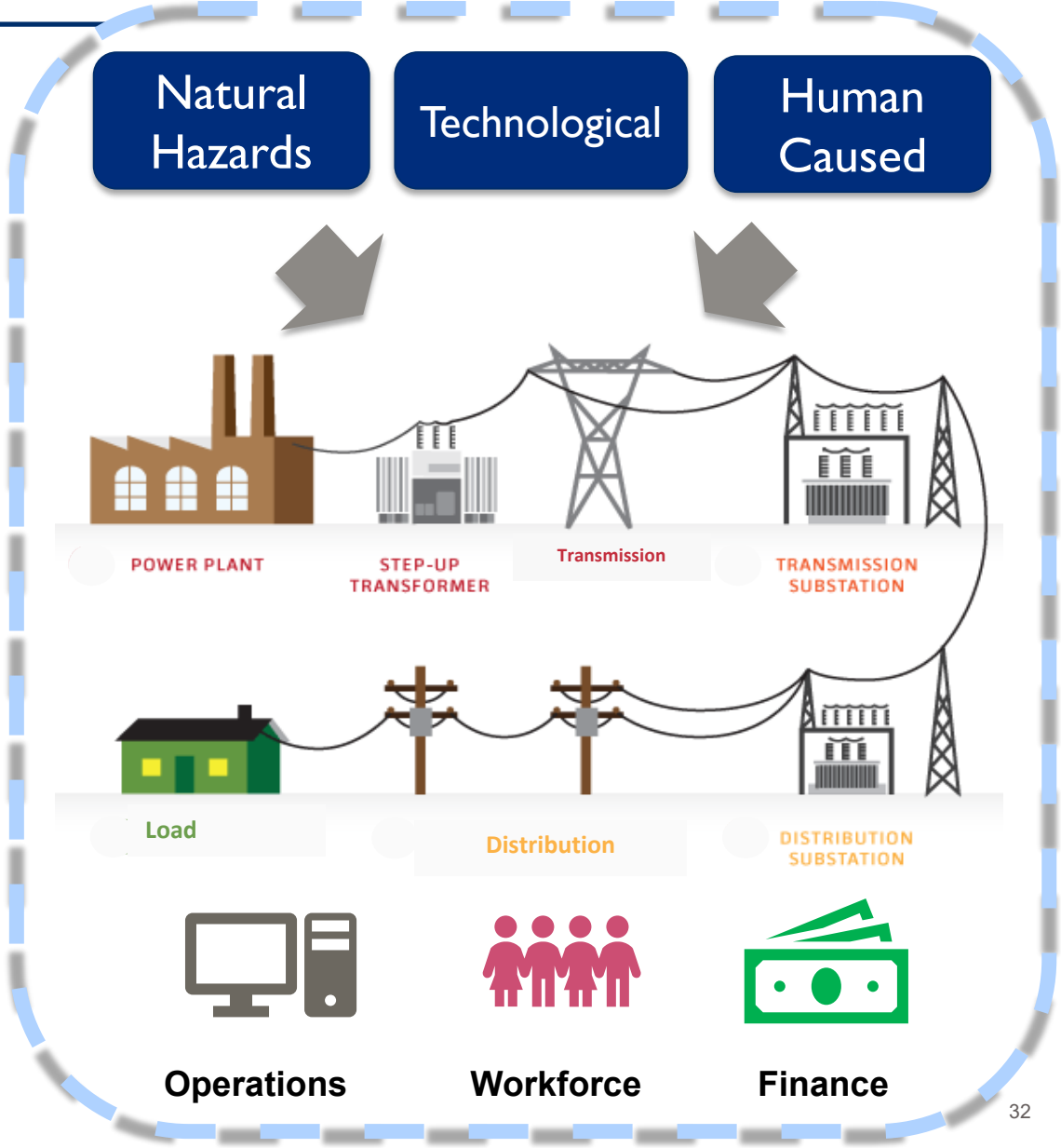
Enhancing Power Sector Resilience in the Lao PDR

Yevang Nhiavue

Motivation for Power Sector Resilience in the Lao PDR

- The power system of the Lao People's Democratic Republic (PDR) is essential to providing reliable, secure, and affordable electricity and to driving growth and development in the country.
- The power system faces potential risk from natural, technological, and human-caused hazards that could disrupt the power supply.
- A resilient power system could thrive under changing conditions and withstand, respond to, and recover rapidly from disruptions.
- To address these risks the Lao PDR conducted a stakeholder-driven power sector vulnerability assessment and resilience action planning process to safeguard the power system.



Approach to Power Sector Resilience Planning

Identify Threats
Identify the potential threats to the power sector and assign a likelihood score for each.

Define Impacts
Describe the effects that threats have on the power sector.

Assess Vulnerabilities
Determine power sector vulnerabilities and assign a severity score for each.

Calculate Risks
Evaluate risk, which is the product of the threat likelihood and vulnerability severity score.

Develop Solutions
Develop and prioritize resilience action plans based on impact, ability to implement, and cost.

1. Vulnerability Assessment

2. Resilience Action Plan

Vulnerability Assessment

- Identified and scored hazards and vulnerabilities to assess risks
- Prioritized the highest-risk vulnerabilities for the Lao power sector to address

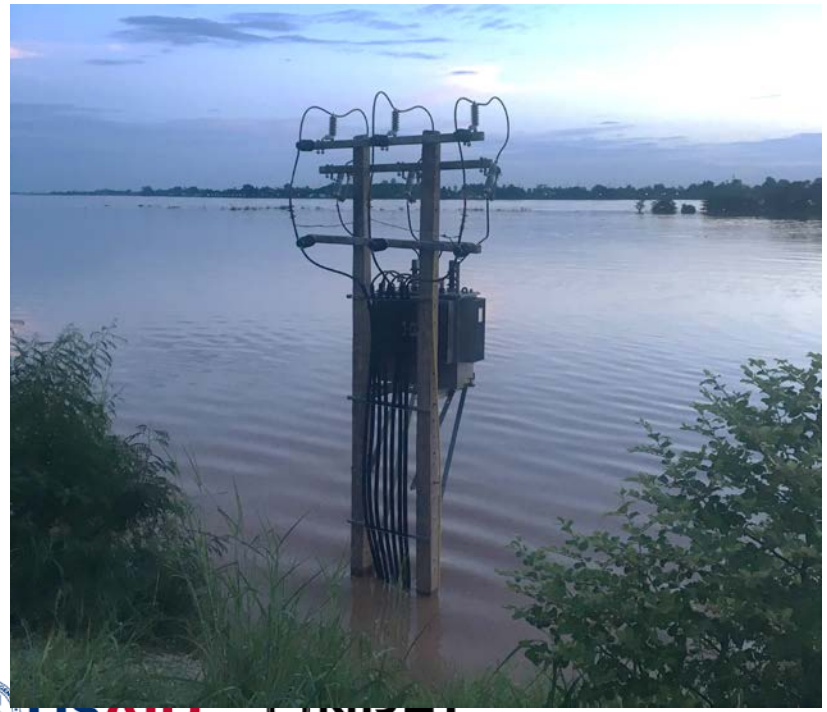


Figure. Mekong River Flooding in Vientiane

Table. List of highest-risk vulnerabilities

Risk Score*	Vulnerability
High	Power system rules, regulations, and technical standards do not meet current and changing environmental conditions
	Dam construction does not follow design specifications
	Installation does not follow design specifications
	Lack of compliance with codes in design
Medium-High	System operations are not flexible enough to respond to changes in demand and supply
	Demand forecasting is not responsive to changing load conditions
	Heavy power sector reliance on hydro generation
	Inadequate domestic generation capacity requires costly energy imports
	Hydro generation reservoir is too small for drought conditions
	Large industry (mining, cement, and economic zones) constitutes approximately 40% of demand and revenue
	Poor coordination between dam operators
	Transmission infrastructure located in wildfire prone areas
	Transmission equipment located in zones prone to flooding
	Transmission equipment located in zones prone to landslides
	Transportation impacts occur with power sector impacts
	Unreliable and or inadequate meteorological, hydrological, and climate change data for decision making

Resilience Action Plan

- Identified and prioritized solutions that address the highest-risk vulnerabilities
- Approach included both technical (such as infrastructure hardening) and operational (such as communications) solutions
- Developed a set of four (4) top-priority actions to support implementation:

1. **Develop and implement resilient power system policies**
2. **Improve power system flexibility**
3. **Improve coordination across hydropower dam operations**
4. **Facilitate better sedimentation management in hydropower watersheds**

Figure. EDL-Gen Solar Photovoltaics Plant, Naxaithong district, Vientiane

Timeline for Resilience Action Implementation

Months 1-6	Months 7-12	Months 13-18	Months 19-24	Beyond Month 25
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Months 1-6	Months 7-12	Months 13-18	Months 19-24	Beyond Month 25

Enhancing Lao Power Sector Resilience

Figure. Houay Lamphan Gnai Hydropower plant, Champassak province

- Identified the highest-risk vulnerabilities and top-priority actions that provide solutions to mitigate these vulnerabilities and build resilience
- Key to successful implementation of this resilience action plan will be:
  - Comprehensive resilience policies and strategies
  - Institutional capacity building for resilience
- Resilience action plan is not the final step to building Lao power sector resilience.
  - Support the ongoing Integrated Resource and Resilience Planning (IRRP) process to incorporate these outcomes in power sector planning
  - Continual evaluation and update of resilience plan to capture evolving power sector and new lessons

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Key Takeaways

- The Lao PDR followed a power sector resilience planning approach that consisted of two (2) main activities that other countries in the region could explore:
  - A vulnerability assessment
  - Resilience action planning
- Identified a set of prioritized resilience actions and detailed implementation solutions to be implemented over the next 2 years.
- Key components include:
  - Comprehensive resilience policies
  - Capacity building
  - Operational and Technical solutions
- This work will support ongoing and future power sector planning (such as the IRRP process)

Resilient Energy Platform

The Resilient Energy Platform helps countries address power sector vulnerabilities with strategic resources and direct country support to enable planning and deployment of resilient energy systems.

www.resilient-energy.org/

Questions?

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Thank you for joining this webinar!

For more information about resilience, the Guidebook, or to Ask an Expert, please visit the Resilient Energy Platform website at:

www.resilient-energy.org

Resilient Energy Platform and Power Sector Resilience Planning in Lao PDR

Sherry Stout | August 2019

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