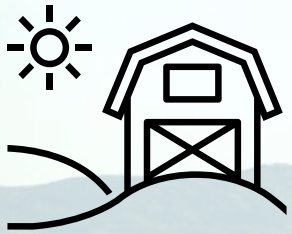

Pathway #1 *Create framework for identifying and evaluating climate resilience threats and impacts to energy and communications systems serving rural communities*

- Identify climate resilience threats/aspect of threats applicable to Vermont electric and communications infrastructure
- Refine municipal electric/communications vulnerability index methodology and develop tool for broad use by stakeholders to identify priority areas for investment
    - This includes prioritization of locations where communications are served by solely by digital voice service (fiber, coax cable, Voip), which require electrical power at the home, that also lack cell coverage/copper-wire landlines, to the extent that this information can be identified (in other words, where communications are entirely dependent on electricity)

- What resilience **threat(s)** is the focus?
- What **aspect(s)** of the threat(s) is of concern?
    - *Can we measure the extent to which these concerns are or will be addressed? How will we know if we have made things better or if they are getting worse (in the absence of an actual threat)*
- What is our **design standard** for addressing these concerns?
- What are the pros and cons of available **alternatives** for meeting these standards?
    - *What is the lowest cost option?*
    - *What, if any, additional benefits might they provide? What are these worth?*
    - *Are there options for recourse?*

Metrics for Resilience in Theory and Practice (Joe Eto, LBNL, 2018)

Pathway #2 *Integrate planning and preparedness across disciplines and geographies addressing the interdependencies of energy, communications, and other systems*

- Integrate energy/communications resilience considerations into emergency management and land use planning frameworks
  - This includes identification of critical facilities as a focus for efforts to maintain and restore energy and communications functions
- Conduct joint preparedness exercises simulating loss of energy, communications, and other critical infrastructure

"The water-energy nexus is a critical factor in resilience. Water is used for energy generation in hydro-electric plants and in cooling systems for nuclear plants. Simultaneously, energy is used for treating and pumping water supplies. Technical solutions ranging from making power-generation plants more efficient, to using clean-energy technologies, and designing systems to utilize gravity-fed options can enhance resilience of both energy and water systems."

-Distributed Energy Planning for Climate Resilience. NREL, 2018

Pathway #3 *Develop a comprehensive framework for defining, evaluating, and measuring energy and communications resilience solutions*

- Establish framework for valuing resilience investments and metrics for measuring impacts (e.g., ICE and POET calculators)

	Reliability	Resilience
Common features/ characteristics	Routine, not unexpected, normally localized, shorter duration interruptions of electric service Larger events will make it into the local headlines	Infrequent, often unexpected, widespread/long duration power interruptions, generally with significant corollary impacts Always front page news, nationally

Location scales	Time scales: Minutes	4-23 Hours	1-2 Days	3 days+
Building				
Circuit				
Substation				
Town				
Load zone				
State				

Metrics for Resilience in Theory and Practice (Joe Eto, LBNL, 2018)

https://www.nrel.gov/resilience-planning-roadmap/

Pathway #4 *Pursue near-term, no-regrets, foundational investments in energy and communications resilience to serve rural communities*

- Deploy foundational technology statewide to enable and optimize storage and other grid management technologies (e.g., GridLogic, Virtual Peaker, DERMS)
- Update interconnection standards to:
  - Enable full smart inverter functionality and distributed energy resource interoperability to maximize benefits and use cases (including islanding) and minimize risks (such as cascading trips) from integration of high penetrations of DERs
  - Maximize storage contribution and use cases while maintaining system stability and reliability.
- Review state and local permitting and inspection processes and standards to encourage greater deployment of distributed energy resources that enhance resilience
- Identify low-cost/effort "upgrades" to normal utility reliability investments that would also support resiliency goals
- Identify modifications to policies and programs that would enhance resilience, while also seeking to align benefits/beneficiaries with costs/cost causers

"DERs can be configured to support resiliency of the electric grid. DERs capable of islanding—continuing to supply power while electricity from the distribution utility is no longer present—may be able to counter generation issues, including fuel shortages Some DERs, particularly when aggregated, are also capable of providing similar capacity and ancillary services that traditional, centralized generators do, including demand response, voltage regulation, and other grid services."

-Zitelman, Kiera: Advancing Electric System Resilience with Distributed Energy Resources: A Review of State Policies. NARUC, 2020.

Pathway #5 *Seek funding to implement cost-prohibitive projects that improve rural energy and communications resilience*

- Seek federal stimulus (ARPA), infrastructure bill, and other non-ratepayer funding to defray costs of resilience upgrades that exceed benefits to ratepayers, such as:
  - Ubiquitous communications networks that enable full utilization and participation of distributed energy resources in an interactive grid.
  - Resiliency Zones: batteries installed at or near critical facilities, potentially paired with solar (and/or small wind) and with a microgrid /islanding where possible, to allow them to continue to operate in the event of extended disruptions to electric service.
  - Strategic upgrades to substations, distribution, and transmission capacity across the Vermont grid needed to enable the state's renewable and electrification goals, after first exploring feasibility of any lower-cost options, e.g. flexible load management, curtailment, and storage.
  - Emerging non-wires technologies that address major challenges system resilience (e.g. long-duration outages).

"…DER metering and monitoring communications will allow interoperability and the capability to provide system operators with situational awareness necessary for reliable operation of the interconnecting utility facilities. As more DER is employed and base load generation is replaced with DER resources, it will be important for the Distribution Provider (DP) or interconnecting utility to be able to monitor the availability and production of electricity (power output and energy delivered) from the DER resources."

-*NPCC DER Guidance Document, Distributed Energy Resources (DER) Considerations to Optimize and Enhance System Resilience and Reliability. NPCC, 2020*