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The Resilience Planning Landscape for Communities and Electric Utilities

Designing Resilient Communities: A Consequence-Based Approach for Grid Investment Report Series

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ABSTRACT

Synapse Energy Economics has conducted structured interviews to better characterize the current landscape of resilience planning within and across jurisdictions. Synapse interviewed representatives of a diverse group of communities and their electric utilities. The resulting case studies span geographies and utility regulatory structures and represent a range of threats. They also vary in terms of population density and size. This report summarizes our approach and the findings gleaned from these conversations.

All the communities and utilities we interviewed see increased interest in and commitment of resources for energy-related resilience. The risks and consequences these communities and utilities faced in the past, face now, and will face in the future drove them to improve engagement, advance processes, further decision-making, and in many cases invest in projects. While no process used by communities and utilities was the same, the different processes used by communities and utilities allowed each one to make progress in its own way. Several approaches are emerging that can provide good models for other communities and utilities with an interest in improving resilience.

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EXECUTIVE SUMMARY

In 2019, Synapse Energy Economics (Synapse) was contracted by Sandia National Laboratories (Sandia) to research the current landscape and level of integration of community and electric utility resilience investment planning. In this research, communities are municipal governments due to their broad lens into community efforts and investments and decision-making authority. Municipal governments include urban and rural and large and small communities. The research was funded by the U.S. Department of Energy and conducted as part of the Grid Modernization Laboratory Consortium (GMLC). GMLC's portfolio of projects includes the Designing Resilient Communities: A Consequence-Based Approach for Grid Investment (DRC) project.[1] The primary objective of this project is to understand the challenges and opportunities experienced by communities and electric utilities aligning their energy-related resilience efforts.

To accomplish this, Synapse conducted semi-structured interviews, guided by standardized interview questions, to better understand the landscape of resilience planning both within and across jurisdictions. Synapse interviewed representatives of six community and utility pairs with working relationships on energy-related resilience efforts. Synapse conducted one-hour interviews with one community representative and one electric utility representative from a diverse group of communities[2], for a total of 11 interviews.[3] The utility representatives we interviewed were utility managers, lead or principal power system engineers, or staff responsible for grid investment planning and modernization efforts and directly involved in resilience efforts at the utility. The community representatives we interviewed were leading resilience efforts for the municipal government and were Chief Resilience Officers or Mayors.[4] Figure 1 showing the community and utility participants is below.

[1] Department of Energy. *New GMLC Lab Call Awards for Resilient Distribution Systems*. September 4, 2017. Available at: https://www.energy.gov/articles/new-gmlc-lab-call-awards-resilient-distribution-systems

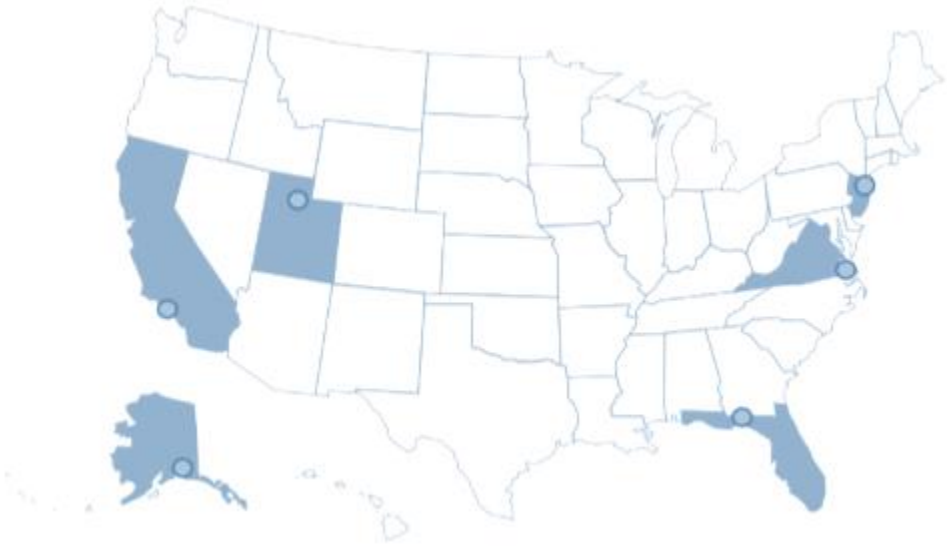
[2] The findings from this study are not generalizable because the sample is small and therefore not representative.

[3] The Mayor (community representative) of Cordova is also the General Manager for the utility. As a result, we conducted one interview representing both viewpoints for Cordova.

[4] Salt Lake City did not have a chief resilience officer, so we interviewed a community representative experienced with the City through her work at the state level.

Figure 1. Community and Utility Research Participants

The participants include: (1) Hoboken, New Jersey and Public Service Electric and Gas Company, (2) Norfolk, Virginia and Dominion Energy, (3) Salt Lake City, Utah and Rocky Mountain Power, (4) Tallahassee, Florida and the City of Tallahassee Electric Utility, (5) Los Angeles, California and the Los Angeles Department of Water and Power, and (6) Cordova, Alaska and the Cordova Electric Cooperative.



Synapse sought out a sample of communities and their utilities to represent diversity across four dimensions, including: utility regulatory structure, region, threat types, and community size. The standardized questions we asked during the community and electric utility interviews are provided in Appendices A and B for the utilities and the communities, respectively.

All the communities and utilities we interviewed are experiencing increased interest in and commitment of resources for energy-related resilience. The design of this research effort targeted a sample of communities and utilities with previous experience addressing multiple threats. While the types of threats they experienced varied widely, the risks and consequences these communities and utilities face in the past, now, and in the future drove them to improve engagement, advance processes, further decision-making, and in many cases invest in projects.

No process used by communities and utilities was the same. The different processes used by communities and utilities allowed each one to make progress in its own way.

- The resilience activities of communities located in Utah, Virginia, and New Jersey were propelled by state leadership.
- The cities of Norfolk, Tallahassee, Hoboken, and Los Angeles are leading by convening a broad group of stakeholders including utilities to develop resilience plans.
- Los Angeles and Norfolk are expanding existing processes to include resilience, such as sustainability and climate planning, economic development initiatives, and neighborhood revitalization projects.
- The utilities we interviewed are expanding their resilience services and offerings, particularly related to storm hardening, critical load prioritization, and backup power options. Grid modernization and non-wires alternatives proceedings in some jurisdictions are providing additional opportunities for more comprehensive planning.

Several of the emerging approaches identified can provide models for other communities and utilities, and other communities and utilities may benefit from exploring these existing resilience planning models. It will also be important for communities and utilities to move from reactive to proactive, ongoing planning.

Even more experienced communities and utilities continue to express resource challenges in getting to fully integrated planning that considers resilience, not least of which is that other initiatives and investments are competing for staff time and investment dollars. In most circumstances, resilience-related investments will need to provide benefits on blue and black sky days.

Communities and their utilities differ in their definitions of resilience and ways of assessing their performance on resilience. Given these different perspectives, coordination remains a challenge. Also, there is no framework that is available to and shared by utilities, utility regulators, and their communities for evaluating costs and benefits for a wide variety of potential resilience measures. An analytical framework and implementation resources can help communities and utilities work together to coordinate and prioritize investments.

In some cases, communities served by investor owed utilities (IOUs) have the resources to engage more in utility processes and in these cases they should do so. However, many communities served by IOUs with large service territories may face some logistical challenges working together on resilience planning. New processes may be needed for many communities that do not have the resources or the inclination to participate in existing processes. Utilities will also need to develop solutions that can be customized to better meet the needs and values of communities in different locations with very different levels of risk. A resilience framework can streamline processes and increase cost and resource efficiency for both communities and utilities. Communities can use the framework to design better investments and position these projects before utilities and regulators in ways that allow these entities to consider them more fully. The framework can be used by utilities to prioritize projects the utility identifies across its service territory as well as evaluate investments proposed by communities. Table 1 on the following pages summarizes the more detailed findings and opportunities identified through this research.

Table 1. Summary of Findings and Opportunities

	Findings	Opportunities
1	The communities and utilities interviewed describe how they consider energy-related resilience investments and efforts in planning and budgeting but recognize that utility and community definitions of resilience differ, as do the ways they assess performance.	There may be opportunities to increase engagement and communication between communities and their utilities (and regulators) on resilience, to the benefit of all parties. One outcome of these conversations may be increased alignment of resilience definitions and performance metrics. Greater overlap or transparency in goals and objectives may allow more solutions to emerge that best meet the needs of utilities, regulators, and communities. Regardless of the extent to which communities and utilities have shared resilience definitions and performance metrics, all parties can benefit from a better understanding of synergies and differences in priorities and needs.
2	Communities and utilities are currently working together on critical load prioritization and implementation of backup power solutions.	Within existing processes, further consideration could be given to resilience investments that decrease the consequence of major disruptions by prioritizing continuity of government/military operations, maintenance of life-sustaining products and services, and access to goods and services for vulnerable populations. Customer-sited backup power solutions can be targeted to these additional areas of special need. Alternatives to fossil fuel generators are available and can help achieve both sustainability and resilience goals.
3	The utilities interviewed stated that their regulators approved many measures that can be characterized as resilience investments. However, utilities have experienced regulatory barriers to implementing some resilience measures, including microgrids and advanced metering infrastructure.	It can be helpful to develop a list of measures that have resilience benefits and a catalogue of the types of costs and benefits for each of these measures. Also, a framework for evaluating the costs and benefits of resilience investments could help regulators, utilities, and communities screen solutions. The focused application of this evaluation framework to microgrids and advanced metering infrastructure (AMI) investments, for example, may be needed for the benefits of these types of resilience investments to be accounted for in decision making. For proposed resilience investments to compete, they may need to provide benefits on blue sky days as well as black sky days.
4	The utilities and communities with state- and community-level resilience-related policies stated that these policies supported local resilience investments.	State and local governments could work more with their stakeholders to understand their resilience priorities and needs. PUCs can then align their decision-making with overarching state direction. Local governments could consider resilience-related policies from other states and locales, as they may provide useful models. In the event that state-level leadership is a possibility, it can also help communities and utilities move from reactive to proactive, ongoing planning.

	Findings	Opportunities
5	Community-led resilience planning efforts are an effective way to initiate convenings by a group of diverse stakeholders, including municipal government departments and their electric utility, and advance investments in energy-related resilience.	Communities could consider leading more formal resilience planning and inviting their utilities to participate in these discussions as a way of initiating discussion and coordination. Resilience plans can provide for more coordinated planning, in advance of threat events, that captures the priorities of a diverse group of stakeholders including elected officials, heads of town and city departments, utilities, community and consumer organizations, local businesses, and local schools and universities. Resilience plans can also facilitate better alignment of key initiatives, including sustainability and resilience. While resilience plans are useful for initiating relationships and discussion, ongoing coordination may be needed to ensure continued prioritization, implementation and evaluation of resilience investments. Many resilience plans are focused on high-level goals and may be difficult to translate into concrete goals for grid investment planning.
6	In the communities we interviewed that are served by IOUs, the interest in and ability to engage in docketed proceedings before Public Utility Commissions varies greatly. However, community influence over utility decision making may not only be limited by process. Other factors limiting influence may include the scale of the smaller communities relative to larger utility service territories as well as the lower levels of risk presented by the types of assets located in certain communities relative to others.	For communities with the resources, intervening in formal PUC proceedings can be an effective way to ensure community perspectives are considered by utilities and regulators. Also, regulators often have public comment sessions on cases of public interest, which may provide an opportunity for communities to provide input on key issues. Less formal docketed and undocketed PUC proceedings, including technical sessions and working groups on grid modernization and power sector transformation, may be more accessible for some communities. Smaller communities may need to coordinate with one another to increase visibility before the IOU and PUC. Also, stakeholder groups typically include individuals who represent various customer interests such as consumer advocates. Community leaders can engage with consumer advocates to better represent their interests.
		Regulators can expand the scope of existing proceedings to incorporate the resilience goals of the community. Regulators could also use their convening power to initiate new proceedings focused on resilience. It may be reasonable to formally add a position on the PUC working groups for a community representative who can represent the interests of individual communities facing greater risks from threat events.

	Findings	Opportunities
		IOUs could approach and engage with communities of all sizes across their service territories. Additionally, IOU solutions are typically designed to meet the overarching needs of customers across the service territory. Solutions that can be customized to meet the varied needs of specific communities across their territory may be needed. IOUs could also proactively conduct service territory-wide screening for sites where a resilience solution makes sense and approach communities and regulators with these solutions.
7	Several communities and utilities we interviewed reported that funds and staff time for resilience efforts are limited and competition for these resources is a barrier they face in trying to be more resilient.	There may be a need for communities and utilities to access other funding resources and develop new partnerships to support resilience. FEMA is providing funding for resilience investments through its pre-disaster mitigation (PDM) program and a new program named Building Resilient Infrastructure and Communities (BRIC). The IRS/Treasury has created "opportunity zone" tax breaks that may also provide funding support. The U.S. Department of Housing and Urban Development Agency (HUD) recently announced that some electric utilities may explore using Community Development Block Grant (CDBG) funding to implement projects and conduct research and development to advance new technologies that support resilience in partnership with some communities. Funding may also be available from philanthropic and resilience-focused efforts. The resilience evaluation framework mentioned above can help prioritize the allocation of resources. Utilities and their regulators could work together to better define what investments and project designs can be supported by ratepayer funding and provide this information to communities.

ACRONYMS AND DEFINITIONS

Abbreviation	Definition
ABFE	Advisory Base Flood Elevation
Annual MWh Sales	From the U.S. Energy Information Administration. 2017. "Annual Electric Power Industry Report" (861 Data File).
AMI	Advanced metering infrastructure
ARMS	Advanced Resiliency Management System
Black sky days	A catastrophic event or events including a devastating natural disaster, cyber-attack, physical attack, act of war, or a combination of incidences which compromise electric reliability.
Blue sky days	A normal, routine operating day for an energy utility with manageable load expectations, and no abnormal weather, cyber, or physical incidents or emergencies.
BRIC	Building Resilient Infrastructure and Communities
CAIDI	Customer Average Interruption Duration Index. A measure of the duration and frequency of electric grid outages calculated by dividing the total duration of customer interruptions by the total number of customers interrupted.
CDBG	Community Development Block Grant
CEC	Cordova Electric Cooperative
Community to Utility Size Ratio	Calculated by dividing the community population by the number of utility customers.
Co-op	Cooperatively owned utility
Customers	From the U.S. Energy Information Administration. 2017. "Annual Electric Power Industry Report" (861 Data File).
EMP	Electromagnetic pulse
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
GMD	Geomagnetic disturbance
GTSA	Grid Transformation and Security Act
HUD	United States Department of Housing and Urban Development
IOU	Investor owned utility
ISO	International Organization for Standardization
LADWP	Los Angeles Department of Water and Power
MAIFI	Momentary Average Interruption Frequency Index. A measure of the frequency of brief electric grid outages calculated by dividing the total number of momentary interruptions by the total number of customers served.
Muni	Municipally owned utility
PDM	Pre-Disaster Mitigation

Abbreviation	Definition
Population	From the U.S. Census Bureau, "American FactFinder – Community Facts." We defined communities with a population of at least one million as large, ones with populations of less than 50,000 as small, and ones with populations between 50,000 and one million as medium.
PSC	Public Service Commission
PSE&G	Public Service Electric and Gas Company
PUC	Public Utilities Commission
RADIANCE	Resilience Alaskan Distribution System Improvements using Automation, Network Analysis, Control, and Energy Storage
SAIDI	System Average Interruption Duration Index. A measure of the duration of electric grid outages calculated by dividing the total duration of customer interruptions by the total number of customers served.
SAIFI	System Average Interruption Frequency Index. A measure of the frequency of electric grid outages calculated by dividing the total number of customer interruptions by the total number of customers served.
SCC	State Corporation Commission
STEP	Sustainable Transportation and Energy Plan Act

1. INTRODUCTION

1.1. Purpose

Synapse Energy Economics (Synapse) was contracted by Sandia National Laboratories (Sandia) to research the integration of community and electric utility resilience investment planning. In this research, communities are municipal governments due to their broad lens into community efforts and investments and decision-making authority. Municipal governments include urban and rural and large and small communities. This research is funded by the Department of Energy and conducted as part of the Grid Modernization Laboratory Consortium (GMLC). The GMLC was established as a strategic partnership between the United States (US) Department of Energy (DOE) and the national laboratories to bring together leading experts, technologies, and resources to collaborate on the goal of modernizing the nation's electric grid. GMLC's portfolio of projects includes the Designing Resilient Communities: A Consequence-Based Approach for Grid Investment (DRC) project.[5] As part of the DRC project, Sandia is partnering with a variety of government, industry, and university partners to develop and test a framework for community resilience planning focused on modernization of the electric grid. To address the gap between community and electric utility resilience planning, this project investigates how coordinated grid investment can support resilient community design, and how electric utilities of various configurations can plan for resilience and benefit from resilience investments.

The project's goal is to demonstrate an actionable path toward designing resilient communities through consequence-based approaches to grid planning and investment, and through field validation of technologies with partners that enable distributed and clean resources to improve community resilience. To achieve this goal, the project will pursue the following objectives:

(1) Design, validate, and release a framework for alignment of community resilience planning and grid investment planning (i.e., the "Resilient Community Design Framework")

(2) Demonstrate—with city/utility pairs—how to overcome the most critical technical challenges

(3) Analyze alternative regulatory frameworks and utility business models that may better internalize resilience benefits

(4) Build one or more community resilience nodes enabled by distributed energy resources

The primary objective of this project is to understand the challenges and opportunities experienced by communities and electric utilities coordinating energy-related resilience efforts. To accomplish this, Synapse conducted semi-structured interviews, guided by standardized interview questions to better understand the landscape of resilience planning both within and across jurisdictions. Synapse interviewed representatives of several communities currently working on energy-related resilience efforts with their electric utilities.

The purpose of this report is to summarize the lessons learned from these interviews and advance next steps. More specifically, Sandia and Synapse will use these findings to enable better coordination of community and utility resilience efforts moving forward and inform Sandia's

[5] Department of Energy. *New GMLC Lab Call Awards for Resilient Distribution Systems*. September 4, 2017. Available at: https://www.energy.gov/articles/new-gmlc-lab-call-awards-resilient-distribution-systems

framework. Sandia coordinates bi-annual meetings of a stakeholder working group (SAG) on resilience. The group consists of community members, representatives of electric utilities, and local, state, and federal regulators. The findings from this report will be shared and discussed during the SAG's January 2020 meeting.

1.2. Report Organization

The remainder of this report is organized as follows:

- Section 2 provides a description of Synapse's approach to the community and utility interviews.
- Section 3 provides case studies from the community and utility pair interviews.
- Section 4 discusses the findings and opportunities identified from these interviews, with a focus on commonalities in the challenges and successes encountered.
- Section 5 summarizes the conclusions.

2. DESCRIPTION OF THE APPROACH

Synapse selected six pairs of communities (defined as municipal governments) and utilities working on energy-related resilience efforts. Synapse conducted one-hour interviews with one community representative and one electric utility representative, for a total of 11 interviews. We interviewed: (1) Hoboken, New Jersey and Public Service Electric and Gas Company, (2) Norfolk, Virginia and Dominion Energy, (3) Salt Lake City, Utah and Rocky Mountain Power, (4) Tallahassee, Florida and the City of Tallahassee Electric Utility, (5) Los Angeles, California and the Los Angeles Department of Water and Power, and (6) Cordova, Alaska and the Cordova Electric Cooperative. The utility representatives we interviewed were utility managers, lead or principal power system engineers, or staff responsible for grid investment planning and modernization efforts and directly involved in resilience efforts at the utility. The community representatives we interviewed were leading resilience efforts for the municipal government and had job titles such as Chief Resilience Officers or Mayors.[6] The standardized questions we asked during the community and electric utility interviews are provided in Appendices A and B.[7, 8]

Synapse focused on the sample of communities and their utilities to achieve diversity across four dimensions, including:

- Utility regulatory structure: Electric utilities included municipal utilities, cooperatives, vertically integrated investor-owned utilities (IOU), and deregulated IOUs. We acknowledge that other structures exist but focused on the most common arrangements for this research effort.

  A municipal utility or "muni" is a publicly or community-owned and -operated utility. The community that owns and operates the utility could be a city, county, public utility district, or a state. The municipal utility operates as a division of the local or regional government and is run by elected or appointed government officials who are accountable to the citizens of the community. Municipal utilities can provide water, sewer, trash removal, wholesale telecommunications, natural gas, and/or electric services. We interviewed two municipal utilities that provide electric services: City of Tallahassee Electric in Florida and the Los Angeles Department of Water and Power in California.

  Cooperative utilities or "co-ops" are private, not-for-profit businesses with broader community governance and involvement rather than direct local government involvement. Co-ops are owned by and are in business for their members or shareholders, with excess revenues typically distributed to these individuals. The one cooperative we interviewed, Cordova Electric Cooperative in Cordova, Alaska, provides an interesting example as the co-op was formed to improve resilience.

  An IOU is a private, for-profit electricity provider with a shareholder-elected board that appoints the management team. In addition to shareholders, IOUs are overseen by Public Utility Commissions (PUCs) in each state which oversee IOU rates and services. Some IOUs are vertically integrated which means that they can own and operate generation in addition to transmission and distribution. Others are deregulated, meaning they are often only permitted to own and operate transmission and distribution assets. We interviewed four IOUs including: Dominion Energy, Entergy, Rocky Mountain Power, and PSE&G. Only PSE&G is deregulated.

[6] Salt Lake City did not have a chief resilience officer, so we interviewed a community representative experienced with the City through her work at the state level.

[7] The findings from this study are not generalizable because the sample is small and therefore not representative.

[8] The Mayor (community representative) of Cordova is also the General Manager for the utility. As a result, we conducted one interview representing both viewpoints for Cordova.

- Region: Communities are situated in the west, east, and central parts of the country.
- Threat types: Communities are exposed to a wide range of threats as shown in Table 2below. The table shows the threats the community and electric utility representatives selected from a standardized list provided. These representatives also had the opportunity to identify any additional threats they experienced that were not on the standardized list.
- Community size: Synapse interviewed representatives of small, medium, and large communities. We defined a large community as one with a population of at least one million. Small communities had a population of less than 50,000. Mid-sized communities had a population between 50,000 and one million.

Table 2 below characterizes the participating communities and utilities by these dimensions.

Table 2. Characteristics of Participating Communities and Electric Utilities

	1	2	3	4	5	6
Community	**Norfolk, VA**	**Salt Lake City, UT**	**Hoboken, NJ**	**Tallahassee, FL**	**Los Angeles, CA**	**Cordova, AK**
Utility	**Dominion Energy**	**Rocky Mountain Power**	**PSE&G**	**City of Tallahassee Electric Utility**	**Los Angeles Dept. of Water and Power**	**Cordova Electric Cooperative**
Utility regulatory structure	IOU – Vertically Integrated	IOU – Vertically Integrated	IOU – Deregulated	Muni	Muni	Co-op
Geography	Eastern	Central	Eastern	Eastern	Western	Western
Human-Made Threats						
Cyber	X	X	X	X	X	X
GMD / EMP [9]	X	X	X	X	X	
Physical / kinetic	X	X	X	X	X	X
Human error	X	X	X	X	X	X
Natural Threats						
Major storm	X	X	X	X	X	X
Flooding	X		X			X
Earthquake	X	X			X	X
Tornado	X			X		X
Extreme temperature	X		X	X	X	X
Landslide					X	X
Tsunami					X	X
Wildfire	X	X		X	X	
Volcanos						X [10]
Other Threats						
Other [11]		Air quality, drought				
Community Size	Medium	Medium	Medium	Medium	Large	Small

[9] GMD is geomagnetic disturbance; EMP is electromagnetic pulse.
[10] Added by the community representative.
[11] Other threats were provided by the representatives interviewed.

3. CASE STUDY SUMMARIES

The case studies below provide an integrated summary of the interviews for each community.

3.1. Cordova, Alaska and the Cordova Electric Cooperative

ALASKA

Cordova
&
Cordova Electric Cooperative

COMMUNITY STATISTICS

Region	Western
Threats, Intentional	cyber, EMP, physical/kinetic, human error
Threats, Natural	major storms, flooding, earthquakes, tornados, extreme temperatures, landslides, tsunamis
Threats, Other	volcanos
Population	2,239 (small)
Community to Utility Size Ratio	1 to 0.7

UTILITY STATISTICS

Utility Structure	Cooperative Utility
Services	Electric only
Electric Services Provided	Distribution and generation
Regulatory Structure	Board of Directors, elected
Customers	1,629
Annual MWh Sales	26,368

Background

Cordova is a small city on the south coast of Alaska. It is home to a large seafood industry[12] as well as the Cordova Community Medical Center. Having no roads connecting it to other Alaskan towns, it is an isolated community with limited access to outside resources.

[12] In the last 10 years, it ranked 11th largest in the US by dollar value.

Recurring resilience-related issues led to the formation of the Cordova Electric Cooperative (CEC) in 1978, with the goal of being an independent, flexible, and resilient operation.

Cordova regularly experiences a wide variety of threats. In the past few years, it has experienced a 7.9 magnitude earthquake, two tsunamis, avalanches, volcanic activity, flooding, and high winds and heavy snowfall from major storms. August and October 2006 precipitation events produced 48 inches of rain in 72 hours and resulted in extreme flooding. During the 2011-2012 winter, referred to as "snowpocalypse", the community received approximately 30 feet of snow in 3 months and required national guard assistance. According the individual interviewed for this report who provided both the utility and city perspective, recurring resilience-related issues led to the formation of the Cordova Electric Cooperative (CEC) in 1978, with the goal of being an independent, flexible, and resilient operation.[13] In practice, this means increasing self-sufficiency as access to aid from nearby communities is often jeopardized.

As a cooperative, CEC is owned jointly by its members. The membership elects a seven-member Board of Directors who each serve a three-year term. CEC reports directly to its membership and its community for which it is the sole provider of electricity. In 1981, the membership voted to deregulate the cooperative providing it with more flexibility and self-determination.[14] Today, CEC operates as a community-islanded microgrid. The interviewee noted that the city and its cooperative face very few structural barriers due to the community's remoteness and fact that the utility is deregulated. As CEC owns the entirety of its energy system—generation and distribution—it does not have to manage assets installed or operated by other entities.

The utility and community define resilience as an organization taking measures to protect itself from similar incidents after experiencing an event that damages or wounds it. After implementing these measures, the organization should come out stronger and more able to withstand and recover from future events. CEC's investments in resilience measures are prioritized with the communities' interests in mind, which include affordability, safety, and environmental responsibility.

Community and Utility Interactions & Efforts

According to the interviewee, interest in resilience comes from the citizens themselves. As a member organization, the cooperative pursues initiatives and makes decisions based on the collective will of its membership. After purchasing the electric utility from the City of Cordova several decades ago, the cooperative prioritized an undergrounding initiative. It was costly and took 40 years to move all overhead powerlines underground, but through that time the community remained committed to the project. The project's completion in September 2011 was timely, as a series of snowstorms dropped 30 feet of snow in three months. The community endured this massive accumulation of snow without losing power.

Cordova is a small, close knit community and community leaders often convene and share ideas with each other. For example, the Mayor is working on resilience with a stakeholder group that includes leaders from Alaskan Tribes, Cordova's Telephone Cooperative, the Prince William Sound Science Center, the U.S. Forest Service, the U.S. Coast Guard, and CEC as well as the city's school

[13] May 17, 2019 interview with Clay Koplin, Mayor of Cordova and the Chief Executive Officer (CEO) of Cordova Electric Cooperative.

[14] Regulatory Commission of Alaska, Deregulation/Reregulation Elections, available at: http://rca.alaska.gov/RCAWeb/RCALibrary/DeregulationElections.aspx

district and medical center. Cordova also has an Emergency Management Office (EMO) that facilities resilience-building across the community.

In October 2017, CEC initiated a project led by Idaho National Laboratory, Sandia National Laboratories, and Pacific Northwest National Laboratory called the Resilience Alaskan Distribution System Improvements using Automation, Network Analysis, Control, and Energy Storage (RADIANCE). The project is a partnership between the City of Cordova, CEC, the Alaska Center for Energy and Power, the Alaska Village Electric Cooperative, Washington State University, Florida State University, New Mexico State University, Siemens Corporation, and Microgrid Solutions. Awarded $6.2 million over three years, with $1.5 million from CEC, the project's objective is to "enhance the resilience methods for distribution grids under harsh weather, cyber-threats, and dynamic grid conditions using multiple networked microgrids, energy storage, and early-stage grid technologies."[15] The project aims to modernize Alaska's local microgrids and develop technologies to improve the resilience and security of the national grid, for the benefit of all. A core deliverable of this project are resilience metrics and this project will develop a baseline and a methodology for measuring resilience before and after the project is implemented.[16],[17],[18],[19]

The interviewee stated that during the work on the RADIANCE project, staff from the national laboratories visited Cordova and CEC visited the national laboratories. There are also broader quarterly RADIANCE technical interchange meetings held in the community or at the laboratories, and leaders from many stakeholder and community groups are encouraged to attend.

During the interview, the community and utility representative mentioned two recent efforts identified and prioritized by the RADIANCE working group. Peter Larson of Lawrence Berkeley National Laboratories assessed of the social value of the CEC initiative to convert all CEC lines from overhead to underground. The analysis showed a value of $65 million over a conversion period of 40 years. The working group has also ranked and prioritized critical electrical loads. Now, the group is tackling the more challenging question of how CEC will reconfigure the system to improve service for these critical loads.

Another solution the RADIANCE project prioritized and implemented is a grid-scale battery that will be used to balance the inconsistency between the communities' load and the availability of its hydro resources which supply the bulk of its electricity needs. The project was selected for ability to reduce costly use of fossil fuels, but the additional value of resilience was a factor as well. The battery can also act as an automated emergency power supply for the hospital during an extended outage.[20]

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[15] Department of Energy. *Resilient Distribution Systems Lab Call Awards*. Available at: https://www.energy.gov/grid-modernization-initiative-0/resilient-distribution-systems-lab-call-awards

[16] Cordova Electric Cooperative Online Portal. *Radiance Project*. Available at: https://www.cordovaelectric.com/cordova/radiance-project/

[17] See https://www.energy.gov/eere/water/project-profile-resilient-alaskan-distribution-system-improvements-using-automation

[18] See https://inl.gov/article/grid-resilience

[19] See https://gmlc.doe.gov/projects/1.5.02

[20] News article by Sara Tewksbury, *Cordova cuts ribbon on new energy future,* June 10, 2019, available at: https://www.webcenter11.com/content/news/Cordova-cuts-ribbon-on-new-energy-future-511104161.html

Next Steps and Opportunities

One of CEC's goals is to become 90 percent renewable by 2025 as it is economic and will help the community become more self-sufficient. The battery will allow for better utilization of the community's hydro power resource and reduce reliance on costly and polluting diesel fuel. Another project that will help CEC meet this goal is the Crater Lake Water and Power Project. A 2016 feasibility study indicated that electricity generated by water released from the lake, situated at a higher elevation than the community, can provide 8 percent of the community's renewable resource requirements. [21]

Looking forward, the community faces three challenges in its effort to be more resilient: time constraints, financial constraints, and technological limitations.

Looking forward, the community faces three challenges in its effort to be more resilient: time constraints, financial constraints, and technological limitations. Many of the tools CEC would like to deploy are still in early development. For example, there is the potential to use the Internet of Things (IoT) to add value to CEC's members by developing a transactive grid based on a local-area cloud that is more resilient than a global cloud. IoT devices might be water or fuel tank meters that can communicate using CEC's advanced metering infrastructure to connect/disconnect services and better enable people to conserve. CEC is also exploring using vehicle to grid technologies, smart city shared infrastructure resources and value streams to leverage underutilized capacity, and smarter investments in shared technologies. Dispatchable load devices, especially thermal and storage, will be critical and likely more cost effective than supplier side solutions.

3.2. Hoboken, New Jersey and Public Service Electric and Gas Company

[21] See Crater Lake Project Overview, available at: https://www.cordovaelectric.com/cordova/crater-lake/

NEW JERSEY

Hoboken & Public Service Electric & Gas

COMMUNITY STATISTICS

Region	Eastern
Threats, Intentional	cyber, EMP, physical/kinetic, human error
Threats, Natural	major storms, flooding and extreme temperatures
Population	50,005 (medium)
Community to Utility Size Ratio	1 to 40

UTILITY STATISTICS

Utility Structure	Investor-owned Utility
Services	Electric and gas
Electric Services Provided	Transmission, distribution
Regulatory Structure	Public Utilities Commission
Customers	2,243,761
Annual MWh Sales	40,748,693

Background

Hoboken is a medium-sized city on the New Jersey coast across the East River from New York City. While Hoboken has long contended with the challenge of urban flooding, a recent run of major storms spurred interest in resilience. Over a 13-month period in 2011 and 2012, three major storms struck Hoboken. First came Hurricane Irene and the Halloween snowstorm in 2011. Hurricane Sandy struck one year later. During Hurricane Sandy, much of the city flooded including the city's three substations.

Community and Utility Interactions & Efforts

The City representative interviewed stated that resilience is a priority for the state of New Jersey and the community of Hoboken since the storms.[22] As much of New Jersey was impacted by these storms, resilience was also a focus at the state level. The New Jersey Board of Public Utilities launched an investigation into grid performance during Hurricane Sandy and issued a directive to

[22] May 29, 2019 interview with Caleb Stratton, Chief Resilience Officer for the City of Hoboken

improve utility performance including preparation for and response to major weather events.[23] The Federal Emergency Management Agency (FEMA) issued Advisory Base Flood Elevation (ABFE) maps for 10 New Jersey counties where the existing Flood Insurance Rate Maps (FIRMs) did not adequately represent flooding risk. New Jersey adopted these maps and used them to guide elevation of new and reconstructed buildings and structures, including 21 electric utility substations.[24,25]

Developments in state-level policy supported resilience goals in Hoboken. At the time, there was no existing process for considering resilience in Hoboken and both city government and PSE&G initiated efforts. Hoboken created a position for a Chief Resilience Officer to oversee resilience efforts. This office is housed in and funded by the Department of Transportation—the largest city department. The resilience officer does not oversee staff, but rather works collaboratively with 6 to 12 city officials. The officer acts as an intermediary between different departments and ensures that key priorities and relevant information are properly factored into planning processes.

Developments in state-level policy supported resilience goals in Hoboken.

The resilience officer recently helped draft the resilience chapter in the 2018 update to the Complete Guide to Planning in New Jersey.[26] There are several other documents produced by different actors that address resilience. These include the city's master plan,[27] the state's hazard mitigation plan,[28] state and local emergency response plans, building resilience design guidelines,[29] and post-Sandy

The City intervened before the BPU in support of the project and won the support of the ratepayer advocate.

recovery planning efforts.[30]

The utility representative interviewed stated that resilience planning is driven by reliability metrics and standards.[31] Reliability metrics are used to assess system performance with and without major events included. In addition to the Energy Strong program, PSE&G also hardened certain transmission facilities and infrastructure in Hoboken that are regulated by FERC.

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[23] NJ Storm Hardening Recommendations and Review/Comment on EDC Major Storm Response Filings. Prepared for: State of NJ, Board of Public Utilities, Office of Clean Energy; Center for Energy, Economic and Environmental Policy, Bloustein School, Rutgers, The State University of New Jersey. Prepared by GE Energy Consulting. November 26, 2014. Available at: https://www.nj.gov/bpu/pdf/reports/NJ_Major_Storm_Response-GE_Final_Report-2014.pdf

[24] Federal Emergency Management Agency (FEMA). 2013. "Hurricane Sandy Recovery Advisory RA5: Designing for Flood Levels Above the BFE After Hurricane Sandy." Available at: https://www.fema.gov/media-library-data/1381405016896-8bdeadf634c366439c35568a588feb24/SandyRA5DesignAboveBFE_508_FINAL2.pdf

[25] State of New Jersey. 2013. "Local Flood Damage Prevention Ordinance– Adoption of Advisory Base Flood Elevation Maps." Letter published February 4, 2013. Available at http://www.nj.gov/dep/floodcontrol/docs/20130204community-abfe-letter.pdf.

[26] See https://www.njfuture.org/2018/10/12/new-jersey-future-resiliency-chapter-planning-guide/

[27] 2018 Hoboken Master Plan, available at: http://masterplan-cityofhoboken.opendata.arcgis.com/

[28] State of New Jersey, Office of Emergency Management, Hazard Mitigation Plans, available at: http://ready.nj.gov/mitigation/hazard-mitigation-plans.shtml

[29] Resilient Building Design Guidelines at: https://betterwaterfront.org/wp-content/uploads/2016/05/Resilient-Buildings-Design-Guidelines.pdf

[30] State of New Jersey Department of Community Affairs, Sandy Recovery Program Dashboard at: https://www.renewjerseystronger.org/transparency/sandy-recovery-program-dashboard/

[31] May 31, 2019 interview with Edward Gray, PSE&G's Director of T&D Engineering

PSE&G brought its Energy Strong programs to the New Jersey Board of Public Utilities (BPU) for regulatory approval.[32] The Energy Strong resilience improvements included increased sectionalizing of distribution infrastructure, improving supply to critical facilities (i.e. hospitals, etc.),, elevating substations, and substation automation and network control upgrades. To mitigate the risk of a disallowance of cost recovery, the utility sought BPU approval of resilience-related proposals. The state's ratepayer advocate—the Division of the Rate Counsel—initially opposed a proposal to combine and raise two substations on the west side of the city to one foot above the base flood elevation, due to cost concerns. The City intervened before the BPU in support of the project and won the support of the ratepayer advocate. The BPU ultimately granted approval for this project. In total PSE&G eliminated one and raised the two other substations in Hoboken that had flooded during Hurricane Sandy.

The BPU has an ongoing program to fund the engineering and evaluate microgrids in New Jersey. The city also invested about $2.5 million in backup natural gas generation for the city hall, police and fire stations, and the city's pump houses. .

The City representative stated the city has developed a good relationship with PSE&G and the community and utility have complementary views of what resilience requires. The community supported PSE&G's proposed investments to eliminate the flood risk to the three substations in Hoboken. The community then wanted further resilience investments and PSE&G worked with them to determine how they could implement what they wanted.

The City representative stated the city has developed a good relationship with PSE&G and the community and utility have complementary views of what resilience requires.

Next Steps and Opportunities

The utility is continuing to invest in strengthening the existing grid including automated monitoring and control of the distribution system to provide a greater level of protection against intrusion into control systems. Other non-storm related resilience initiatives include investments in facility hardening to guard against human attacks and efforts to improve cybersecurity as identified by NERC.[33] Other resilience challenges include aging infrastructure, an increasing portion of line workers nearing retirement, and a crowded service territory with high real estate values and little room for new facility development. With many priorities, there is a perpetual challenge in determining the appropriate trade-off between risk and cost.

The city is currently working on developing a resilience plan to provide a more systematic and comprehensive approach with an overarching strategy as well as specific guidance at the building, neighborhood, and city levels. The plan will consider many sectors and threats, including energy security, transportation, sea level rise, stormwater management, and coastal flooding. The plan will also provide an annual account of required actions, a preparedness checklist, and an inventory of investments made since Hurricane Irene. A draft of the plan is expected in late 2019 or early 2020.

[32] Including Energy Strong parts I and II
[33] See NERC CIP Standards at https://www.nerc.com/pa/Stand/Pages/CIPStandards.aspx

3.3. Tallahassee, Florida and the City of Tallahassee Electric Utility

FLORIDA

Tallahassee
&
City of Tallahassee
Electric Utility

COMMUNITY STATISTICS

Region	Eastern
Threats, Intentional	cyber, EMP, physical/kinetic, human error
Threats, Natural	major storms, tornadoes, extreme temperatures, wildfires
Population	181,376 (medium)
Community to Utility Size Ratio	1 to 0.6

UTILITY STATISTICS

Utility Structure	Municipally owned Utility
Services	Electric only
Electric Services Provided	Transmission, distribution, and generation
Regulatory Structure	Utility board, elected
Customers	115,556
Annual MWh Sales	2,617,331

Background

Tallahassee is a mid-sized city on the Gulf coast of Florida that is served by a municipally owned electric utility. In addition to owning its electric utility, the city owns its gas, water, sewer, and stormwater utilities as well as the public bus system and the airport. As the state capital and county seat, Tallahassee is home to critical physical infrastructure and government functions.

The city government is run by a City Manager who is appointed by an elected five-person City Commission, consisting of four Commissioners and the Mayor. The City Commission oversees decision-making for the City Departments, including reviewing and approving the city government and electric utility annual budget and providing a conduit for citizen input. The utility is a department of the City and the utilities' General Manager reports directly to the City Manager.

Community and Utility Interactions & Efforts

Following an extended lull in major storms, Tallahassee experienced three hurricanes in succession, with Hermine in 2016, Irma in 2017, and Michael in 2018. According to the city and utility representatives interviewed for this report, utility reliability and environmental sustainability was a priority for the city and its residents prior to these storms. Community organizations, including Sustainable Tallahassee[34] and ReThink Energy Florida[35], were active advocates for reductions in greenhouse gas emissions as part of the portfolio of resilience action. The Blueprint Intergovernmental Agency[36] was formed in 1989 to administer infrastructure projects funded by a one cent sales tax. In 2000, residents voted to extend the tax to 2019, with the emphasis on stormwater and flood control projects, greenspace acquisition and parks/recreation improvements, and additional transportation projects. The city capital budget annually funds capital improvement projects, many of which support stormwater infrastructure, and the City frequently pursues supplemental funding through the external sources such as Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program (HMGP). [37] Still, the aftermath of hurricane Hermine spurred additional public interest in and support for resilience investments.[38, 39]

After the first of the three recent hurricanes in 2016, Hurricane Hermine, Tallahassee residents were vocal in their concern about the city's vulnerability, leading the city to launch listening groups and other forums. The city representative described several initiatives that developed from these forums. Citizens expressed interest in promoting individual and neighborhood self-sufficiency in the face of threats which led to the "Build Your Bucket" initiative,[40] a training program to teach residents about hurricane preparedness. The city leadership commissioned a Community Resilience planning effort, hired a resilience officer to lead the effort, and adopted a comprehensive Community Resilience Plan on July 2019.

The city representative stated that it may be easier for Tallahassee to comprehensively plan, invest in, and engage stakeholders on resilience given it owns all its utilities.

The city representative stated that it may be easier for Tallahassee to comprehensively plan, invest in, and engage stakeholders on resilience given it owns all its utilities. The utility representative pointed out that the electric utility and the broader community have somewhat differing definitions of resilience.

From the utility's perspective, resilience is the ability to maintain electric grid operational capability during major storm events and recover quickly. Electric utility resilience planning is informed by key performance indicators including traditional reliability metrics such as SAIDI and SAIFI as well as reporting on outages by circuit. The utility is also bound by the NERC bulk power system requirements and its set of metrics that track preparation for threats such as electromagnetic pulse

[34] See https://www.sustainabletallahassee.org/
[35] See https://www.rethinkenergyflorida.org/
[36] See http://blueprint2000.org/
[37] See https://www.fema.gov/hazard-mitigation-grant-program
[38] May 24, 2019 interview with Abena Ojetayo, Chief Resilience Officer & Director of Sustainability and Community Preservation for the City of Tallahassee.
[39] May 31, 2019 interview with David Byrne, Assistant General Manager at the City of Tallahassee's Electric and Gas Utility.
[40] See https://www.sustainabletallahassee.org/event-3397861

and geomagnetic disturbances and physical and cyber-attacks. The city representative discussed how resilience includes public safety and preparedness, hazard mitigation and climate adaptation. Socioeconomic factors and equity implications are also important to the city in formulating resilience interventions.

Most utility decision-making in Tallahassee is not subject to state-level regulatory review. However, the state's Power Plant Siting Act[41] and Transmission Line Siting Act[42] compels Florida Public Service Commission (PSC) review of certain projects—namely, new generation assets at or above 75 megawatts and transmission lines that are greater than 230 kilovolts, longer than 15 miles, or that cross a county line. Smaller projects are reviewed and approved by the City Commission.

The utility representative pointed out that the electric utility and the broader community have somewhat differing definitions of resilience.

The electric utility promotes reliability, used interchangeably with the term resilience, through several avenues, including:

- long-term planning with sensitivities for abnormal weather;
- design criteria that provide for redundancies in the transmission and distribution system;
- diversity of generation unit size to mitigate the impacts of unit failures;
- utilization of distributed generation;
- distribution system automation to improve response time and reduce the number of people affected by outages;
- maintaining adequate reserve power supply and backup plant fuel;
- improvements in field activity management systems; and,
- tree trimming to reduce the risk of outages.

The utility representative stated that the city has been undergrounding distribution system lines for all new subdivisions built since the 1980s. Today, half of the distribution lines are underground, though undergrounding is costly, and it has been important to balance need with costs. The utility achieves this balance through a unique cost share with developers, contributing up to 25 percent of the expense of undergrounding.

The utility representative also discussed a recent investment in a backup natural-gas generation unit for a substation at risk for outages serving critical loads, including a hospital and its adjacent medical facilities and a police facility. The situation of the substation in a dense urban neighborhood made installation of a new transmission line construction untenable. Instead, the utility installed an island-able 19-megawatt reciprocating combustion engine for use during threat events as well as daily operations.[43]

[41] See https://floridadep.gov/air/siting-coordination-office/content/power-plant-siting-act
[42] See https://floridadep.gov/air/siting-coordination-office/content/transmission-line-siting-act
[43] See https://www.wartsila.com/media/news/30-03-2017-wartsila-to-supply-two-power-plants-to-the-city-of-tallahassee-usa

Next Steps and Opportunities

In 2017, the city created a new position for a Chief Resilience Officer with a broad charge that includes sustainability strategy, planning, implementation, and community preservation. The Chief Resilience Officer's initial core task was to develop a resilience plan by convening a resilience working group with representation from city government departments and other stakeholders. The Community Resilience Plan was adopted by the City Commission on July 10, 2019.[44]

In early 2019, the utility adopted a 100 percent renewable energy goal.[45] A community clean energy plan and utility integrated resource plan are also currently under development.

3.4. Los Angeles, California and the Los Angeles Department of Water and Power

[44] City of Tallahassee. 2019. "Tallahassee Community Resilience Plan." Talgov.com. Available at Talgov.com/Resplan
[45] See https://go.boarddocs.com/fla/talgov/Board.nsf/files/B9KTU963E005/$file/Clean%20Energy%20Resolution.pdf

CALIFORNIA

Los Angeles & Los Angeles Department of Water and Power

COMMUNITY STATISTICS

Region	Western
Threats, Intentional	cyber, EMP, physical/kinetic, human error
Threats, Natural	major storms, earthquakes, extreme temperatures, landslides, tsunamis, wildfires
Population	3,999,759 (large)
Community to Utility Size Ratio	1 to 0.3

UTILITY STATISTICS

Utility Structure	Municipally owned Utility
Services	Electric and water
Electric Services Provided	Transmission, distribution, and generation
Regulatory Structure	Utility board, appointed
Customers	1,426,865
Annual MWh Sales	22,678,466

Background

The City of Los Angeles and its municipal utility, the Los Angeles Department of Water and Power (LADWP), have been working to improve their resilience for a long time due to the many threats the city faces and the age of its infrastructure. LADWP is a 100-year old agency that built aqueducts and power distribution systems for a city that has grown substantially over this timeframe. These systems range from a century old to brand new.

The utility's regulatory body is a five-member LADWP Commission appointed by the Mayor and approved by the City Council. A ratepayer advocate participates in Commission meetings to protect the interest of all ratepayers and is separate from the Commission.

In 2007, the city launched Greater LA Grid Alternatives[46] to look at microgrids and other distributed energy resources such as solar to provide energy to customers that have traditionally been served through fossil fuel-based generation. In 2013, LADWP deployed a Power System Reliability Plan,[47] which is a multi-year effort to invest over $1 billion in ratepayer funds to strengthen energy infrastructure over the next 5–15 years. The city also engaged in federal programs such as the Promise Zone in 2014,[48] developed a Sustainability Plan in 2015 (updated in 2019)[49] and created a Resilience by Design plan in 2016[50] focused on improving the resilience of buildings, water, and telecommunication infrastructure during earthquakes.

According to the city representative interviewed, the 2015 LADWP rate increase—stemming largely from the need to increase funding for energy efficiency, renewable energy, and electric vehicle programs—required a new level of community engagement and paved the way for the utility and community coordination in effect today.

Community and Utility Interactions & Efforts

An electricity rate increase in 2015 and a series of heat storms and wildfires in recent years increased government and public attention on resilience, involved the municipal utility more directly in resilience planning, and brought community and utility efforts on resilience into greater alignment. While there were many groups advocating for resilience-related efforts in Los Angeles—including elected officials, community organizations, local businesses, and local universities—there was no comprehensive plan to mitigate or adapt to threats. This changed in 2018 when the Mayor released the Resilient LA Plan[51] and hired a Chief Resiliency Officer to lead implementation of this plan. Resilience is now a top priority for the Mayor, the Commission, and the utility. The issue is driven and supported by the ratepayers who elect the Mayor and City Council and who nominate, confirm, and/or hire those that work at and oversee the municipal utility.

According to the city representative interviewed, the 2015 LADWP rate increase—stemming largely from the need to increase funding for energy efficiency, renewable energy, and electric vehicle programs—required a new level of community engagement and paved the way for the utility and community coordination in effect today.[52] LADWP visited every neighborhood in the city and organized hundreds of meetings with neighborhood councils and other community groups to provide information on the reason for the rate increase and solicit community input. Resilience was a topic of discussion in these meetings as one rationale for investments in smart grid, microgrids, and smart meters was to have a more modern grid that can withstand more frequent disturbances and increasing reliance on electricity for heating and transportation.

Currently, LADWP's General Manager and many of his staff are regularly in contact with the Mayor's Office on resilience efforts and the General Manager has monthly meetings with both the assigned Deputy Mayor and a group of General Managers and Chief Resilience Officers from departments across the City. Also, the utility submits an annual budget to the Mayor and City

[46] See https://gridalternatives.org/gla
[47] See http://prp.ladwp.com/
[48] See https://www.hud.gov/sites/documents/SOUTH_LOS_ANGELES_ZONE_3RD.PDF
[49] See https://www.discoverlosangeles.com/travel/the-sustainable-city-plan-of-los-angeles
[50] See https://www.lamayor.org/resilience-design-building-stronger-los-angeles
[51] See https://www.lacity.org/sites/g/files/wph1101/f/ED%2022%20-%20Resilient%20Los%20Angeles.pdf
[52] May 23, 2019 interview with Aaron Gross, Chief Resilience Officer for Mayor Eric Garcetti.

Council that details the department's infrastructure investments and regularly reports to various City Council committees on various topics including resilience.

There is a vocal group of stakeholders in Los Angeles who participate in these and other discussions about resilience. Climate Resolve, the U.S. Green Building Council, Grid Solutions, and the L.A. Business Council are large organizations that are strong advocates for more local renewable resources and investments in cool pavements, cool roofs, and tree canopies. These organizations are focused on renewable energy, the urban heat island effect, and climate change. Youth, including university students, high school students, and young professionals, are also very concerned and involved in the resilience discussion. People who are concerned about the poor air quality, including the local Air Quality Board, are also interested in resilience. There are also advocacy groups involved from low-income neighborhoods and neighborhoods near the port.

Different communities face different threats. While hillside neighborhoods are concerned with wildfires, lower income populations and populations residing in older housing stock situated in the valley and in south Los Angeles are concerned with urban heat island effect and minimizing the effects of climate change. Coastal communities such as the port and Venice are particularly concerned with sea level rise and storms.

As there are numerous stakeholders facing a wide variety of threats, the department partners with local nonprofits to market programs and facilitate communication with these diverse groups. Nonprofits bring proposals to the department on ways to engage the community, which range from hosting meetings with small businesses to performing telenovelas at a local park. Resilience is integrated in materials presented to all constituents on energy efficiency, electric vehicles, and renewable energy efforts. As a public utility it is essential to be transparent about how and why the LADWP spends its funds, so all materials and programs refer to the City goals around resilience, sustainability, reliability, and efficiency. The City is looking to expand its community partnerships to include business leaders and religious groups as well.

According to the utility representative interviewed, the LADWP Board has been open to and supportive of resilience investments though most of these investments have been related to the implementation of the Power System Reliability Plan.[53] In addition to replacing substations, wires,

According to the utility representative interviewed, the LADWP Board has been open to and supportive of resilience investments though most of these investments have been related to the implementation of the Power System Reliability Plan.

and poles, investments have included piloting the automation of the distribution system and investing in microgrids. To date, there is one microgrid that was installed at a fire station that previously suffered many outages. LADWP is now looking into adding microgrids to police stations.

LADWP substantiates its investments through a cost-benefit analysis with consideration for community benefits as well as a CalEnviroScreen[54] score. As part of the LADWP Rate Action approved in March 2016, the LADWP established the Equity Metrics Data Initiative (EMDI) to track, measure, and report on how its programs services, and resources are distributed and used

[53] May 20, 2019 interview with Vincent Zabukovec, Power Engineering Manager at the Los Angeles Department of Water and Power.
[54] See https://oehha.ca.gov/calenviroscreen

throughout the city, both geographically and demographically, to see whether any disparities exist. With input from key stakeholders, LADWP identified 15 equity metrics in four categories. [55]

LADWP is also beginning to consider the costs of outages for different types of customers. For example, a data center reported losses of $1 million for each minute electricity service is down.

In addition to LADWP efforts:

- the Housing Department has been promoting local solar development and leveraging Transformative Climate Community grants [56] to improve resilience of lower income communities;
- the airport is building its own energy generation facility so the airport can island in case of a power outage;
- the Department of Parks and Recreation and the Department of Aging have been working together to create microgrid systems that would allow for cooling centers or recreation centers to be able to function and provide services in a heat-related emergency;
- LADWP and the zoo have initiated a program provide a solar canopy over part of the zoo's parking lot paired with battery storage to provide power to meet the basic needs of the animals in the event of an outage. The City is looking into connecting it to the electric vehicle charging station already at the zoo – which is among the most used electric vehicle charging stations in the country; and
- the port is developing a microgrid to enable a specific terminal to island and continue functioning if the electric grid goes down, which would enable cranes to bring in emergency supplies.

Next Steps and Opportunities

In Los Angeles, resilience is defined several ways. The utility defines resilience as how flexible the power system is in the face of human attacks and natural events, such that it can deliver safe electrical service to customers. The city defines resilience as the capacity to survive, adapt, and thrive in the face of chronic stresses and acute shocks, and even transform when conditions require it.

Common themes in all these definitions are flexibility and change. Because Los Angeles is a large, densely populated, and geographically diverse service area, there is a constant reevaluation of priorities. Efforts follow public opinion, awareness, or outcry. Thus, if a certain stressor or threat is having a greater impact on the city at present, more attention will be needed to respond to, recover from, or mitigate future impacts of that type of event.

However, a consistent driver of resilience efforts now and in the future is environmental sustainability. The community is looking to:

- Move away from fossil fuel-based generation. Microgrid are using renewable resources including solar, wind, thermal energy storage, and battery storage. LADWP is also looking to deploy solar and electric vehicles to provide power to more remote locations where there may not be the space to install a new substation and related electric grid infrastructure. If manufacturer warrantee issues can be resolved in the future, EVs have the potential to provide battery storage around the city.

[55] See LADWP's Equity Metrics Data Initiative at: https://www.ladwp.com/equitymetrics
[56] See http://sgc.ca.gov/programs/tcc/

- Electrify the transportation sector to improve air quality and increase the volume of electricity sales to mitigate rate increases. The bus fleet will be mostly electrified by 2025. This underscores the need for improvements to the electrical grid, because the amount of electricity the City will need in the long run is projected to double.

An obstacle for LADWP and the City is the level of resources it will take to improve resilience. Resources need to be allocated to upgrade infrastructure, as well as pilot and implement new technologies.

An obstacle for LADWP and the City is the resources it will take to improve resilience. Resources need to be allocated to upgrade infrastructure, as well as pilot and implement new technologies.

For example, depending on prioritization a microgrid could take resources away from investments in distribution system upgrades. Another obstacle for LADWP is addressing how utility operations need to adapt with the adoption of new technologies such as renewables, battery storage, and electric vehicles and how to prioritize and fund the additional infrastructure costs needed to operationalize these new technologies.

In addition to investments in infrastructure, the City plans to invest in knowledge building and training for individuals. Building a culture around resilience is a key part of resilience efforts. For example, the LA Economic Development Corporation put together a brochure in conjunction with the Mayor's office that is intended to help businesses continue to provide income for employees and economic growth for the city. Other types of resilience toolkits and materials may follow.

LADWP is also placing greater emphasis on data analysis including identifying how the utility can utilize new power resources and developing metrics to measure performance.[57]

LADWP plans to reach out to communities and find out which services are most essential. Different constituents have different priorities, so the City is working on prioritizing initiatives and providing a transparent explanation of this prioritization process.

3.5. Norfolk, Virginia and Dominion Energy

[57] See the Mayor's Dashboard at: https://sites.google.com/a/lacity.org/mayors-dashboard

VIRGINIA

Norfolk
&
Dominion Energy

COMMUNITY STATISTICS

Region	Eastern
Threats, Intentional	cyber, EMP, physical/kinetic, human error
Threats, Natural	major storms, flooding, earthquakes, tornados, extreme temperatures, wildfires
Threats, Other	geomagnetic induced currents (GIC)
Population	242,803 (medium)
Community to Utility Size Ratio	1 to 10

UTILITY STATISTICS

Utility Structure	Investor-owned Utility
Services	Electric and gas
Electric Services Provided	Transmission, distribution, and generation
Regulatory Structure	State Corporation Commission, elected
Customers	2,454,142
Annual MWh Sales	76,628,564

Background

Norfolk is a mid-sized city on the coast of Virginia, served by Dominion Energy . The city is home to Virginia Port Authority's Norfolk International Terminals, the largest navy base in the world (Naval Station Norfolk), and a large regional hospital. As a result, Norfolk serves as a national security hub and provides economic and health benefits to the surrounding region.

Dominion Energy is an IOU with generation assets in other states that supply energy to customers in several states in addition to Virginia. Dominion Energy owns and manages transmission and distribution assets in Virginia and is regulated by Virginia's State Corporation Commission (SCC) and its Division of Public Utility Regulation.

The City, along with other local governments in Dominion Energy's service territory, negotiates multi-year contracts directly with Dominion through the Virginia Energy Purchasing Governmental Association. The City's rates and other provisions concerning electric service, undergrounding, streetlighting, renewable energy, net metering, and upcoming Smart City opportunities are determined by negotiation.

In 2003, Norfolk was impacted by Hurricane Isabel, which caused widespread damage and outages and led to several resilience initiatives.

Community and Utility Interactions & Efforts

According to the community representative interviewed, the City of Norfolk introduced several resilience initiatives to address the problems it faced during and after Hurricane Isabel.

- Norfolk became a member of the Rockefeller Foundation's 100 Resilient Cities and adopted its definition of resilience, which is, "the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience"[58]
- The city also created an Office of Resilience which then led to development of a Resilience Strategy.[59] The strategy includes goals related to flood risk adaptation, economic resilience (tied largely to the Department of Defense), and neighborhood resilience with a focus on alleviating poverty and connecting neighborhoods.
- The city also updated its zoning policies, including requiring new construction to earn a specific number of points for resilience measures such as becoming LEED-certified, installing solar panels, and building several feet above ground to obtain building permits.[60]
- In 2018, the city adopted an economic development vision for the community called Reimagine Norfolk.[61]

Norfolk is not interested in engaging with the SCC as it can be perceived to be lobbying. However, the city intervenes in utility regulatory proceedings.

Norfolk is not interested in engaging with the SCC as it can be perceived to be lobbying.[62] However, the city intervenes in utility regulatory proceedings including electric utility proceedings. For example, though there is widespread support within the city for undergrounding electrical cables, the costs of a recent Dominion undergrounding proposal may be disproportionately high for Norfolk and the city wants to ensure that the benefits of undergrounding outweigh the costs. The City had regular meetings with Dominion to discuss new construction and converting overhead lines to underground service for new developments and, the conversion of the approximately 31,000 streetlights in Norfolk to energy efficient LEDs. The city has a council that represents industrial customers before the Commission that may intervene on Dominion's proposed undergrounding.

According to the representative interviewed at Dominion Energy, the utility defines a resilient grid as one that can self-heal and prevent a cascading failure. The company's interest in resilience is multi-faceted.

- The core responsibility of the utility is to provide safe and reliable service at reasonable rates. If a major event tarnishes the reputation of the utility and calls into question its ability to

[58] See https://www.100resilientcities.org/resources/
[59] See http://100resilientcities.org/wp-content/uploads/2017/07/Norfolk_Resilient_Strategy_October_2015.pdf
[60] See https://www.norfolk.gov/zoning
[61] See https://norfolkdevelopment.com/
[62] Kyle Spencer, the Deputy Resilience Officer to Norfolk and Gerald Spivey, a Program Manager for Norfolk

perform its core responsibility, the utility risks bankruptcy and potentially state takeover. Also, a resilient utility can maintain a reasonable rate of return because it will be viewed as a less risky investment by investors.

- Dominion is driven by its interest in maintaining customer satisfaction and reducing lost revenues by avoiding outages.
- As a regulated utility, Dominion must demonstrate to regulators at the SCC that the benefits from resilience initiatives are worth their costs.
- In 2018, the General Assembly enacted the Grid Transformation and Security Act (GTSA),[63] which contains orders on grid hardening, cybersecurity, renewables, and energy efficiency. Dominion is addressing the requirements in the GTSA and decisions made by regulators at the SCC align with the GTSA's requirements.[64]
- As Dominion is a multi-state utility, the company has incorporated resilience into the design of its planning and operations on both the transmission and distribution side of its business to meet requirements established by the FERC.

In addition to the utility's obligations and motivations to provide reliable service, there are several ratemaking mechanisms that encourage the utility to make prudent investments in infrastructure that supports resilience. First, Dominion Energy can recover the costs of certain resilience investments through riders, which provide immediate cost recovery rather than delaying the recovery until the utility's next rate case. The Garasonville underground transmission line is an example of this type of cost recovery. By expediting cost recovery, the riders serve as an incentive to invest in resilience. Second, FERC allows utilities a return on investments for the betterment of the grid. These mechanisms have encouraged the utility to actively invest in new technologies such as Mobile, GIS,

There are several ratemaking mechanisms that encourage the utility to make prudent investments in infrastructure that supports resilience.

SVCs, STATCOMs, synchrophasors, and flexible AC transmission devices.[65,66,67]

Next Steps and Opportunities

Norfolk has several ongoing resilience initiatives through its Office of Resilience. These include increasing funding for energy efficiency in new buildings to reduce energy use and greenhouse gas emissions, installing solar on municipal buildings, and ensuring critical facilities have generators. To achieve the city's resilience goals, Norfolk meets with Dominion Energy on an annual basis to review critical loads. Dominion Energy provides the city with a list of facilities that it classifies as critical, including hospitals, wastewater treatment plants, municipal buildings, and pumping stations.

[63] See http://lis.virginia.gov/cgi-bin/legp604.exe?181+sum+SB966
[64] May 21, 2019 interview with Mark McVey, Principal Engineer with Dominion Virginia.
[65] T&D World. Dominion Energy to Use Mobile SVC STATCOM Technology, October 24, 2017, available at: https://www.tdworld.com/statcom/dominion-energy-use-mobile-svc-statcom-technology
[66] Synchrophasors provide a real-time measurement of electrical quantities from across the power system. For more detail, see https://www.energy.gov/articles/how-synchrophasors-are-bringing-grid-21st-century
[67] Flexible AC Transmission devices (FACTs) are static power-electronic devices installed in AC transmission networks to increase power transfer capability, stability, and controllability of the networks. For more detail, see https://www.sciencedirect.com/topics/engineering/flexible-ac-transmission-systems

The city and Dominion Energy then update the list together. When there is an outage event, the city can use a web portal that allows it to track the status of the critical loads, including how long it will take to restore services at the critical facilities.

The Office of Resilience is beginning a feasibility project to look at an area of the city called the St. Paul's area. The area is being revitalized,[68] and the city recently met with a developer and equipment provider Schneider Electric to learn more about microgrids and explore what it would take to implement a microgrid in this district.

Dominion Energy has designed substations to be ready for sea-level rise and severe weather events, and it has also replaced transformers on the transmission system with ones that are designed to withstand geomagnetic currents. It continues to deploy mobile and rapid restoration assets to speed up the service restoration to customers after an event. In the future, the utility hopes to convince regulators at the SCC that smart meters will provide distribution operators with valuable information that will enable them to predict flows on the distribution system and increase resilience.

[68] See http://www.nrha.us/content/st-pauls-area

3.6. Salt Lake City, Utah and Rocky Mountain Power

UTAH

Salt Lake
&
Rocky Mountain Power

COMMUNITY STATISTICS

Region	Central
Threats, Intentional	cyber, EMP, physical/kinetic, human error
Threats, Natural	major storms, earthquakes, wildfires
Threats, Other	air quality, drought
Population	186,440 (medium)
Community to Utility Size Ratio	1 to 5

UTILITY STATISTICS

Utility Structure	Investor-owned Utility
Services	Electric only
Electric Services Provided	Transmission, distribution, and generation
Regulatory Structure	Public Service Commission, appointed
Customers	892,849
Annual MWh Sales	24,132,846

Background

Salt Lake City is a mid-sized city situated close to the Great Salt Lake and the Wasatch Mountains. It is Utah's capitol, and therefore serves as a critical political hub for the state. The city's electricity is provided by the Rocky Mountain Power business unit of PacifiCorp. PacifiCorp is a subsidiary electric power company of Berkshire Hathaway Energy and has two business units: Pacific Power and Rocky Mountain Power. PacifiCorp owns and manages transmission, distribution, and generation assets in Utah, as well as Oregon, Wyoming, Washington, Idaho, and California. In Utah, Rocky Mountain Power is regulated by the Utah Public Service Commission.

Salt Lake City's most recent major threat was a bout of wildfires in 2017 and 2018. A 2003 snowstorm caused widespread outages with some outages lasting multiple weeks.

According to the community representative interviewed, there is no designated City lead on resilience efforts.

Community and Utility Interactions & Efforts

According to the individual interviewed at Rocky Mountain Power,[69] resilience is incorporated into its business through a grid resilience team. This team focuses on GMD, EMP, and nuclear events. The utility has also developed protocols for wildfire zones, which includes inducing outages. The utility works with customers in wildfire zones to help them understand the need for outages during wildfire events by meeting with community leaders and hosting town hall meetings. PacifiCorp is developing a wildfire mitigation plan and is the only utility in the country with an ISO certification for cybersecurity.

As there is no designated lead for the City on resilience efforts, we interviewed a community representative familiar with the City through her work at the state level.[70] . She noted that the City has an Emergency Preparedness Plan which identifies the implementation of distributed solar and storage assets on critical facilities as a core component of emergency preparedness. The City also has an Office of Sustainability that works directly with Rocky Mountain Power on electric vehicle and renewable energy procurement initiatives. Additionally, Salt Lake County is working on earthquake responsiveness.[71]

The utility and community representatives interviewed both mentioned that recent collaboration between Salt Lake City and Rocky Mountain Power on resilience is driven by state and county policies.

The utility and community representatives interviewed both mentioned that recent collaboration between Salt Lake City and Rocky Mountain Power on resilience is driven by state and county policies. Enacted in 2016, the Utah Sustainable Transportation and Energy Plan (STEP) enabled the utility to investigate and implement new technologies with resilience benefits.[72,73] Rocky Mountain Power requested $16 million from the Commission for the Advanced Resiliency Management System (ARMS) project to implement advanced metering infrastructure (AMI) meters and deploy line system automation technology on Rocky Mountain Power's distribution system, especially in areas with critical customers like hospitals, trauma centers, and critical data centers. Rocky Mountain Power also received $250,000 to work with Utah State University to create a microgrid test facility to explore how microgrid components impact the grid and how a utility can improve interconnection standards and policies to make microgrid interconnection less onerous. The microgrid consists of 120 kW of solar and 100 kWh of battery storage, as well as a natural gas generator and multiple electric vehicle chargers.

In 2018, Salt Lake County Council passed a resolution requiring Salt Lake City to rely on 100 percent renewable energy by 2030. Rocky Mountain Power is leveraging STEP to invest in research and development of renewable technologies to achieve the 100 percent renewable energy goal. The

[69] June 27, 2019 interview with Rohit Nair, Grid Solutions Manager for Rocky Mountain Power.
[70] June 15, 2019 interview with Sara Baldwin, Vice President of Regulatory for the Interstate Renewable Energy Council (IREC).
[71] See: https://slco.org/emergency-services/Resilient-Salt-Lake-County-Conference/.
[72] See: https://le.utah.gov/~2019/bills/static/HB0107.html
[73] See: https://le.utah.gov/interim/2019/pdf/00003186.pdf

community representative noted that Salt Lake City has been involved in utility regulatory proceedings related to clean energy and energy efficiency.

The City is also building out supporting infrastructure to keep critical infrastructure such as hospitals and community centers online during major events. For example, the Public Safety Building was built to serve as a command center if a significant event happens in the City by centralizing fire and police dispatch in one place that is built to withstand a major event. The city is also implementing solar and battery backups on City buildings such as fire stations.

Next Steps and Opportunities

Rocky Mountain Power continues to pursue funding provided through STEP along with Department of Energy (DOE) matching funds. For example, the utility is leveraging $10 million of STEP funding to access an additional $4.5 million in DOE funding to support investments in electric vehicle charging infrastructure in the City. The utility representative also mentioned that Rocky Mountain Power is interested in working with cities such as Salt Lake City on resilience plans, with a focus on cybersecurity and distribution automation technology. The community representative we interviewed agreed that continued collaboration is important and noted the need to better align the renewable conversation with resilience objectives.

In 2019, the state passed HB 411 authorizing other Utah municipalities and counties to achieve a net 100 percent renewable energy portfolio by 2030. Communities can now opt-in to a new Rocky Mountain Power municipality-specific service agreement by passing a local ordinance. Individual customers in each jurisdiction may opt out. The Utah Public Service Commission Rulemaking is in process under Docket 19-R314-01.

4. FINDINGS AND OPPORTUNITIES

Each community and utility had a unique story to tell and a unique context for that story. However, commonalities exist that provide useful insights for other jurisdictions as they move forward. The following section presents these findings and proposes opportunities to address these findings.

Finding 1

The communities and utilities interviewed describe how they consider energy-related resilience investments and efforts in planning and budgeting but recognize that utility and community definitions of resilience differ, as do the ways they assess performance.

For utilities, resilience is an extension of reliability. For example, the utility representative we interviewed at Los Angeles Department of Water and Power noted that the Board has been open to and supportive of resilience investments, though most of these investments have been related to the implementation of the Power System Reliability Plan. Furthermore, transmission providers[74] are regulated by FERC, which protects the reliability of the high voltage interstate transmission system by adopting reliability standards issued by NERC among other duties.[75,76,77] The utilities we interviewed also have one or more distribution system performance metrics for reliability such as SAIFI, SAIDI, CAIDI, and MAIFI.

While all the utilities with which we spoke have standards and performance metrics for reliability, none reported standards or performance metrics for resilience. Also, no IOU we interviewed reported performance incentives for reliability or resilience.

The communities we consulted take a broader view of resilience. Many of the communities we interviewed mentioned resilience values such as environmental sustainability, health, safety, and equity. Like other communities in this study, the City of Tallahassee wants to improve sustainability, climate adaptation, and climate mitigation, while addressing equity. Communities are also working on nurturing resilient behaviors and responses through education and tool kits for residents and businesses. The City of Norfolk is considering resilience in plans to revitalize a neighborhood in its community.

It is also important to note that communities often have resilience goals that are not electric grid focused but could be supported by utility grid investments. For example, Salt Lake City is concerned with air quality issues and the resilience of the city's water systems in the face of potential drought. Many other critical systems depend on electricity to function, including transportation and communication networks.

OPPORTUNITY: There may be opportunities to increase engagement and communication between communities and their utilities (and regulators) on resilience, to the benefit of all parties.

One outcome of these conversations may be increased alignment of resilience definitions and performance metrics. Greater overlap or transparency in goals and objectives may allow more solutions to emerge that meet the needs of utilities, regulators, and communities. Regardless of the extent to which communities and utilities have shared

[74] Most transmission companies are investor-owned utilities, although there are transmission cooperatives (primarily in the Intermountain West) and publicly owned transmission providers such as the Tennessee Valley Authority.
[75] See https://www.nerc.com/pa/stand/Pages/ReliabilityStandardsUnitedStates.aspx?jurisdiction=United%20States
[76] See https://www.ferc.gov/legal/staff-reports/2016/reliability-primer.pdf
[77] See https://www.ferc.gov/about/ferc-does.asp

resilience definitions and performance metrics, all parties can benefit from a better understanding of synergies and differences in priorities and needs.

Finding 2

Communities and utilities are currently working together on critical load prioritization and implementation of backup power solutions.

All utilities and communities we interviewed emphasized the importance of reenergizing critical loads in their communities after an event. Utilities and communities have also invested in backup power solutions for some of these critical loads. In general, they prioritize support for first responders, medical centers, security infrastructure, communications networks, government operations, and community shelters. Dominion Energy is focused on resilience and has received support from regulators for doing so because its service territory includes Norfolk's naval base as well as Virginia's data centers and government facilities. Some utilities mentioned consideration of certain residential customers who depend on electricity for life-sustaining medical devices. However, after restoring service to the most critical buildings, many utilities restore service to equipment that serves the largest number of customers.

No utility or community had a plan in place to consider outage restoration for certain entities providing life-sustaining products and services such as water, food, or medical treatment for less acute injuries and medicine. Also left out of the plans were residential customers who are more vulnerable to a loss of electricity than other customers, such as seniors, children, and persons with disabilities. Furthermore, diesel generators were traditionally the only backup power solution available to and implemented by residents, businesses, and municipal governments.

OPPORTUNITY: Within existing processes, further consideration could be given to resilience investments that decrease the consequence of major disruptions by prioritizing continuity of government/military operations, maintenance of life-sustaining products and services, and access to goods and services for vulnerable populations. Customer-sited backup power solutions can be targeted to these additional areas of special need. Alternatives to fossil fuel generators are available and can help achieve both sustainability and resilience goals.

Finding 3

The utilities interviewed stated that their regulators approved many measures that can be characterized as resilience investments. However, utilities have experienced regulatory barriers to implementing a few resilience measures, including microgrids and advanced metering infrastructure.

The community of Hoboken, New Jersey noted that PUC approval of grid hardening investments was more forthcoming following Superstorm Sandy. In Los Angeles, energy efficiency, solar panels, and electric vehicles have been approved as resilience investments. Dominion is replacing aging transformers on its transmission system with transformers designed to withstand category 3 hurricanes as well as geomagnetic currents. The Los Angeles Department of Water and Power and PSE&G are concerned about the impact of increased loads from electrification on these systems without appropriate investment. Dominion, Cordova Electric Cooperative, and Rocky Mountain Power in Utah are also investing in distribution system automation. Collectively, these utilities demonstrate a range of investments that have resilience benefits.

Other utilities noted that their resilience investments were cost-effective before considering any additional monetary value for resilience. In fact, no utility or community had quantified the value of resilience benefits, though some utilities had discussed resilience benefits in recent filings before their PUCs.

Regarding projects that did not secure regulatory approval, push-back from regulators focused on especially costly investments and those for which benefits were not perceived to flow to all ratepayers. Dominion Energy reported that AMI did not receive regulator support as a resilience measure. Dominion's initial $6 billion undergrounding plan in Virginia was not approved by the Commission because the costs were deemed to be too great relative to the benefits. Concerns with solutions that produce benefits only in outages and not at other times were noted. Also, intervenors pushed back on the high costs of initial Energy Strong proposals in New Jersey.

OPPORTUNITY: It can be helpful to develop a list of measures that have resilience benefits and a catalogue of the types of costs and benefits for each of these measures. Also, a framework for evaluating the costs and benefits of resilience investments can help regulators, utilities, and communities screen solutions. The focused application of this evaluation framework to microgrids and AMI investments may be needed for the benefits of these types of resilience investments to be accounted for in decision making. For proposed resilience investments to compete, they may need to provide benefits on blue sky days as well as black sky days.

Finding 4

The utilities and communities with state- and community-level resilience-related policies stated that these policies supported local resilience investments.

Utilities and communities with legislation or other policy directed at resilience indicated it supported utility investments in resilience. For example, Utah's STEP program led Rocky Mountain Power to propose projects to its Commission related to the research and development of new renewable technologies. The utility and community representatives interviewed both mentioned that recent collaboration between Salt Lake City and Rocky Mountain Power on resilience is driven by state and county policies. This is true of Virginia's GTSA as well. The policy led Dominion to propose resilience investments related to grid hardening, cybersecurity, the use of increased renewables, and energy efficiency programs. The utility regulator in Virginia employs ratemaking mechanisms that encourage the utility to make prudent investments in infrastructure that support resilience, including cost recovery of certain resilience investments through riders which expedite cost recovery and rates of return. Hoboken, New Jersey also noted that developments in state-level policy helped advance resilience in the community.

OPPORTUNITY: State and local governments could work more with their stakeholders to understand their resilience priorities and needs. PUCs can then align their decision-making with overarching state direction. Local governments could consider resilience-related policies from other states and locales, as they may provide useful models. In the event that state-level leadership is a possibility, it can also help communities and utilities move from reactive to proactive, ongoing planning.

Finding 5

Community-led resilience planning efforts are an effective way to initiate convenings by a group of diverse stakeholders, including municipal government departments and their electric utility, and advance investments in energy-related resilience.

Tallahassee and Hoboken are in the process of developing resilience plans and did so by hiring Chief Resilience Officers to lead the planning effort and coordinate on an ongoing basis with the other stakeholders in the community. Electric utilities attended regular meetings to develop the plans, along with decision makers from other City Departments. In Norfolk—a community that previously developed a resilience plan—a neighborhood revitalization project may provide a more concrete opportunity to prioritize and implement resilience measures.

OPPORTUNITY: Communities could consider leading more formal resilience planning and inviting their utilities to participate in these discussions as a way of initiating discussion and coordination. Resilience plans can provide for more coordinated planning, in advance of threat events, that captures the priorities of a diverse group of stakeholders including elected officials, heads of town and city departments, utilities, community and consumer organizations, local businesses, and local schools and universities. Resilience plans can also facilitate better alignment of key initiatives, including sustainability and resilience. While resilience plans are useful for initiating relationships and discussion, ongoing coordination may be needed to ensure continued prioritization, implementation, and evaluation of resilience investments.

Finding 6

In the communities we interviewed that are served by IOUs, the interest in and ability to engage in docketed proceedings before Public Utility Commissions varies greatly. However, community influence over utility decision making may not only be limited by process. Other factors limiting influence may include the scale of the smaller communities relative to larger utility service territories as well as the lower levels of risk presented by the types of assets located in certain communities relative to others.

The City of Hoboken intervened before the Board of Public Utilities in support of its utilities' resilience efforts and won the support of the ratepayer advocate. In this case, the City worked to develop a good relationship with PSE&G and complementary views of what resilience requires. Salt Lake City has been involved in utility regulatory proceedings, including technical conferences, particularly those related to clean energy and energy efficiency. Other communities noted they do not have the resources to engage in resilience conversations through existing regulatory processes such as rate cases and integrated resource planning (IRP) or stated they were unlikely to intervene in a utility regulatory proceeding or docket, even if it were focused on resilience. The City of Norfolk stated it was generally not interested in engaging with its regulator, the State Corporation Commission (SCC), as it can be perceived to be lobbying. However, the city has occasionally intervened in utility regulatory proceedings, including those of its electric utility. While processes exist for communities to participate in IOU decision-making, some of these processes were not designed for community involvement and may not be effective at allowing access by communities.

Also, certain communities may have more influence than others. Larger communities may have more regular or direct contact with IOUs than smaller communities due to their size. For example, Norfolk, Virginia has its own account manager at Dominion. Community influence over their

electric utility's policies and practices may also be affected by their scale relative to the utility and the level of risk they represent. Interestingly, Norfolk is not a particularly large city, but it has assets that require more attention from the utility because they provide broader regional security benefits. These assets include the military base and a major port.

The munis and co-ops we interviewed did not report these issues. In fact, the representative we interviewed from the City of Tallahassee stated that it may be easier for Tallahassee to comprehensively plan, invest in, and engage stakeholders on resilience given it owns all its utilities. Munis and co-ops are overseen by boards consisting of community representatives, so a structure exists today for utility resilience priorities and efforts to reflect community interests. In these communities, utility staff meet with staff from local government departments throughout the year. Since utility and government offices are relatively close to one another, some meetings occur face to face. While the natural alignment between community members and regulators of munis and co-ops is helpful, so too is the geographic alignment of jurisdiction and utility service territory. For example, the service territories of the utilities in Tallahassee, Cordova, and Los Angeles overlap with the geographic boundaries of their communities.

It is also interesting to note that in the muni and co-op communities we interviewed, leaders who focus on resilience in muni and co-op service territories have worked in both utility and local government positions.[78] In Los Angeles, the chief resilience officer previously worked at the muni. In Cordova, the mayor is also the general manager of the co-op. In Tallahassee, the city manager also functions as the chief executive of the utility. It is unclear whether this is common nation-wide, however we note that when it occurs it may facilitate a greater understanding and transfer of knowledge and information between these communities and their utilities.

OPPORTUNITY:

For communities with the resources, intervening in formal PUC proceedings can be a way to ensure community perspectives are considered by utilities and regulators. Also, regulators often have public comment sessions on cases of public interest, which may provide an opportunity for communities to provide input on key issues. Less formal docketed and undocketed PUC proceedings, including technical sessions and working groups on grid modernization and power sector transformation, may be more accessible for some communities. Smaller communities may need to coordinate with one another to increase visibility before the IOU and PUC. Also, stakeholder groups typically include individuals who represent various customer interests such as consumer advocates. Community leaders can engage with consumer advocates to better represent their interests. Communities should take advantage of these opportunities to engage directly with utilities and regulators on resilience.

Regulators can expand the scope of these existing proceedings to incorporate the resilience goals of the community. Some states are expanding the range of their energy efficiency programs to include renewable energy and storage solutions and resilience could be considered as well. Regulators could also use their convening power to initiate new proceedings focused on resilience. It may be reasonable to formally add a position on the PUC working group for a community representative who can represent the interests of individual communities facing greater risks from threat events. Regulators will need to

[78] This could be true for IOUs as well, though we did not run across examples of this in our research and it may be that is it less common.

reach out to and engage with a more diverse group of stakeholders to be successful in these efforts.

IOU leadership and oversight personnel may be located far from the communities they serve. IOUs could approach and engage with communities of all sizes across their service territories. Additionally, IOU solutions are typically designed to meet the overarching needs of customers across the service territory. Solutions that can be customized to meet the varied needs and values of specific communities across their territory may be needed. IOUs could also proactively conduct service territory-wide screening for sites where a resilience solution makes sense and approach communities and regulators with these solutions.

Finding 7

Several communities and utilities we interviewed reported that funds and staff time for resilience efforts are limited and competition for these resources is a barrier they face in trying to be more resilient.

The City of Los Angeles and its municipal utility indicated it will take a large amount of resources for them to improve resilience. Resources need to be allocated to upgrade infrastructure, as well as pilot and implement new technologies. Though the community of Cordova, Alaska has a culture of resilience, it faces the same challenges in its effort to be more resilient. The community also noted technology development as a barrier.

Utilities and communities reported that they are working with partners and accessing grants and other funding resources to support resilience. Rocky Mountain Power is collaborating with Utah State University Sustainable Electrified Transportation Center and Hill Air Force Base to integrate generation, energy storage, and controls in a microgrid.[79] Cordova Electric Cooperative is partnering with three national laboratories, the City of Cordova, the Alaska Center for Energy and Power, the Alaska Village Electric Cooperative, Washington State University, Florida State University, New Mexico State University, Siemens Corporation, and Microgrid Solutions on the Resilience Alaskan Distribution System Improvements using Automation, Network Analysis, Control, and Energy Storage (RADIANCE) project to address the technological barriers the community and utility face in addressing resilience.

OPPORTUNITY: There may be need for communities and utilities to access other funding resources and develop new partnerships to support resilience. FEMA is providing funding for resilience investments through its pre-disaster mitigation (PDM) program and a new program named Building Resilient Infrastructure and Communities (BRIC).[80] The U.S. Department of Housing and Urban Development Agency (HUD) recently announced that some electric utilities may explore using Community Development Block Grant (CDBG) funding to implement projects and conduct research and development to advance new technologies that support resilience in partnership with some communities.[81] Funding may also be available through 100 Resilient Cities and other philanthropic and resilience-focused efforts. The resilience evaluation framework mentioned above could

[79] See: https://www.rockymountainpower.net/content/dam/pcorp/documents/en/rockymountainpower/rates-regulation/utah/filings/docket-16-035-36/8-15-17_phase_4_application_and_direct_testimony/01_Exhibit_B.pdf
[80] See: https://www.eesi.org/articles/view/new-fema-and-hud-grants-support-resilience-to-climate-change-impacts
[81] See: https://www.hudexchange.info/onecpd/assets/File/Basically-CDBG-State-Chapter-6-Public-Facilities.pdf

help prioritize the allocation of resources. Utilities and their regulators could work together to better define what investments and project designs can be supported by ratepayer funding and provide this information to communities.

5. CONCLUSIONS

All the communities and utilities we interviewed see increased interest in and commitment of resources for energy-related resilience. By design, the communities and utilities explored in this research effort had previous experience addressing multiple threats. Also, the types of threats they experienced varied widely. The risks and consequences these communities and utilities faced in the past, face now, and will face in the future drove them to improve engagement, advance processes, further decision-making, and in many cases invest in projects.

While no process used by communities and utilities was the same, the different processes used by communities and utilities allowed each one to make progress in its own way.

- The resilience activities of communities located in Utah, Virginia, and New Jersey were propelled by state leadership.
- The cities of Norfolk, Tallahassee, Hoboken, and Los Angeles are leading by convening a broad group of stakeholders including utilities to develop resilience plans.
- Los Angeles and Norfolk are expanding existing processes to include resilience, such as sustainability and climate planning, economic development initiatives, and neighborhood revitalization projects.
- The utilities we interviewed are expanding their resilience services and offerings, particularly related to storm hardening, critical load prioritization, and backup power options. Grid modernization and non-wires alternatives proceedings in some jurisdictions are providing additional opportunities for more comprehensive planning.

Several approaches are emerging that can provide good models for other communities and utilities with an interest in improving resilience. Other communities and utilities may benefit from exploring these existing resilience planning models. Communities and utilities should also move from reactive to proactive, ongoing planning.

There continue to be resource challenges in getting to fully integrated planning that considers resilience, not least of which is that other initiatives and investments are competing for staff time and investment dollars. For resilience investments to compete, they often need to provide benefits on blue and black sky days.

Coordination is also a challenge. Communities and utilities mentioned differing definitions of resilience and ways of assessing their performance on resilience. Also, there is no framework that is available to and shared by utilities, utility regulators, and their communities for evaluating costs and benefits for a wide variety of potential measures. Mechanisms to help communities and utilities work together to coordinate and prioritize investments will be useful.

Communities served by IOUs with large service territories may face some unique challenges working together on resilience planning. In some cases, communities have the resources to engage more in utility processes and in these cases they should do so. However, new processes are needed for many communities that do not have the resources or the inclination. Utilities also need to develop solutions that can be customized to better meet the needs and values of communities in different locations with very different levels of risk. A resilience framework can streamline processes and increase cost and resource efficiency for both communities and utilities. Communities can use the framework to design better investments and position these projects before utilities and regulators in ways that allow these entities to consider them more fully. The framework can be used by utilities to

prioritize projects the utility identifies across its service territory as well as evaluate investments proposed by communities.

APPENDIX A. UTILITY QUESTIONS

General

1. What is your current job title and role? How long have you been in your current role?
2. What types of resilience threats does your company face (indicate all that apply)?

Threat Category	Threat Name	Yes?	Comments
Human-Made	Cyber		
Human-Made	Electromagnetic pulse		
Human-Made	Physical/kinetic		
Human-Made	Human error		
Natural	Major storm (including derecho, nor'easter, bomb cyclone, hurricane)		
Natural	Flooding		
Natural	Earthquake		
Natural	Tornado		
Natural	Extreme temperature (including polar vortex)		
Natural	Landslide		
Natural	Tsunami		
Natural	Wildfire		
Natural	Volcano		
Other (please specify)			

Utility Perspective

3. How does your utility currently define resilience?
4. What are the benefits of a more resilient grid?
5. Does your utility currently incorporate energy-related resilience investments and efforts in its business strategy and processes? What types of energy-related resilience investments is your company making or planning on making? What is the status of each of these investments?
6. What mechanisms are being considered or used to address resilience (indicate all that apply)? Does your approach differ by threat or do you use an all hazards/threat-agnostic approach?

	Yes?	Comments
Assigning staff lead to address resilience		
Expanding scope of business to include resilience		
Expanding scope of specific filings to include resilience		
Responding to inquiries by one or more communities in our service territory		
Responding to directive(s) from PUC		
Other (please specify)		

7. From your perspective, what is driving your utility's interest/efforts/investment in resilience (indicate all that apply)?

Driver	Yes?	Comments
Recent event		
High risk of a future event		
Federal, regional, state or local energy policy		
Community initiative or effort		
Desire to improve electric reliability		
PUC requirement specific to resilience		
Utility customer interest		
Other (please specify)		

8. Are you aware of staff in other departments/areas of your utility who are interested in resilience? If so, what is driving that interest?
9. Do you have metrics that address resilience? If yes, how are they defined? What was the impetus for the metrics? How were they operationalized?
10. Does the utility receive incentives for making energy-related resilience investments? Are these incentives tied to any of the above metrics? How are the incentives valued?

Community Interactions

11. Has this community ever approached you or your company regarding resilience? If so, when, why and how?
12. Does your utility have coordinator for this community? Has this individual reached out to this community? How frequently and when has this contact occurred?
13. Are you aware if this community has a resilience plan? Did the utility have any input into the community resilience plan? If so, please describe the input.
14. Are you aware if this community has a chief resilience officer? Has your utility interacted with this individual? What was the substance of the interaction and the outcome?

Regulator Interactions

15. Has your utility ever been involved in a resilience-related electric utility docket before your public utilities commission? If so, which docket?
16. Does your public utility commission support resilience investments? What investments have they supported? What investments are they not supportive of? How does your public utility commission evaluate or propose to evaluate resilience investments?

Barriers

17. What obstacles/challenges does your utility face in trying to make your community be more resilient?
18. What barriers do you see to enhancing the interactions between your utility and individual communities in your service territory on energy-related resilience investments?

Solutions/Opportunities

19. Do you think that your focus on resilience will change in the future? In what way(s)?
20. Do you think the utility's resilience investments are providing cost-effective contributions to community resilience?
21. Do you see opportunities to coordinate your company's resilience investments with the interests and priorities of local communities and other stakeholders? Please describe these opportunities.

APPENDIX B. COMMUNITY QUESTIONS

General

1. What is your current job title and role? How long have you been in your current role?
2. What types of resilience threats does your community face (indicate all that apply)?

Threat Category	Threat Name	Yes?	Comments
Human-Made	Cyber		
Human-Made	Electromagnetic pulse		
Human-Made	Physical/kinetic		
Human-Made	Human error		
Natural	Major storm (including derecho, nor'easter, bomb cyclone, hurricane)		
Natural	Flooding		
Natural	Earthquake		
Natural	Tornado		
Natural	Extreme temperature (including polar vortex)		
Natural	Landslide		
Natural	Tsunami		
Natural	Wildfire		
Natural	Volcanos		
Other (please specify)			

Community Perspective

3. How does your community currently define resilience?
4. What are the benefits of a more resilient grid?
5. Does your community consider energy-related resilience investments and efforts in its planning and budgeting? What types of energy-related resilience investments are you making or planning on making? What is the status of each of these investments?
6. What mechanisms are being considered or used to address resilience (indicate all that apply)? Does your approach differ by threat or do you use an all hazards/threat-agnostic approach?

	Yes?	Comments
Assigning staff lead to address resilience		
Expanding scope of project/process to include resilience		
Collaborating with the electric utility		
Partnering with other groups/communities		
Executing land swaps		
Leveraging tax abatements		
Amending local zoning ordinances		
Other (please specify)		

Driver	Yes?	Comments
Recent event		
High risk of a future event		
Federal, regional, state or local energy policy		
Community initiative or effort		
Desire to improve electric reliability		
PUC requirement specific to resilience		
Utility customer interest		
Other (please specify)		

7. From your perspective, what is driving your community's interest/efforts/investment in resilience (indicate all that apply)?
8. Are you aware of staff in other government departments, community organizations and external groups who are interested in resilience? If so, what is driving that interest?
9. How do you fund resilience investments? Where do the funds come from? What are the eligibility requirements and values of each of these sources of funding?

Utility Interactions

10. Does the community have a point of contact with the electric utility? Has this electric utility coordinator approached you or anyone else in your community regarding resilience? If so, when, why and how? If you have developed a resilience plan, has the electric utility coordinator provided input into your resilience plan? If so, how did this occur?
11. Has your community approached your electric utility coordinator or any other contact at your electric utility on resilience? If so, when, why and how? What was the result of their efforts?

Regulator Interactions

12. Has your community ever approached your utility regulatory body on resilience? If so, when and why?

13. If your community has approached its utility regulatory body, how receptive was your regulator to your comments and concerns? What happened as a result of the intervention?

Barriers

14. What obstacles/challenges does your community face in trying to be more resilient?
15. What barriers do you see to enhancing the interactions between your community and its electric utility on energy-related resilience investments?

Solutions/Opportunities

16. Do you think that your focus on resilience will change in the future? In what way(s)?
17. What influence do the communities have over their electric utility's policies and practices? What is the structure that enables this influence? How does this structure influence utility actions?
18. Do you see opportunities to coordinate your community's energy-related resilience interests and priorities with your utilities' interests and priorities? Please describe these opportunities.

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