Oregon
Kate Brown, Governor

OREGON DEPARTMENT OF ENERGY
550 Capitol St. NE
Salem, OR 97301
Phone: 503-378-4040
Toll Free: 1-800-221-8035
FAX: 503-373-7806
www.oregon.gov/energy

MEMORANDUM

To: Governor Kate Brown

From: Janine Benner, Director
Oregon Department of Energy

Date: December 31, 2018

Re: Executive Order 17-20
Evaluation of Energy and Resiliency Efforts

The Oregon Department of Energy is pleased to submit this report evaluating the role of distributed energy resources and energy efficiency in improving energy resilience to help Oregon recover from a disaster situation. The report also includes a brief review of existing efforts in the state to improve energy resilience.

This report is a component *Executive Order 17-20: Accelerating Efficiency in Oregon's Built Environment to Reduce Greenhouse Gas Emissions and Address Climate Change,* issued in November 2017 as a targeted directive to state agencies to address energy and climate impacts of buildings in Oregon. Through EO 17-20, ODOE and the Oregon Public Utility Commission (PUC) were directed to evaluate the state's distributed energy resources and the efficiency of energy systems needed to improve Oregon's recovery from a disaster situation.

To develop this report, ODOE and PUC leveraged ongoing work on the topic of energy resilience, including development of the Fuel Action Plan; engagement with Central Lincoln People's Utility District, the Office of Emergency Management, and the State Resilience Officer on two different projects sponsored by the National Governors Association on this topic; and additional stakeholder outreach and engagement as part of the development of Chapter 5 of the ODOE's Biennial Energy Report. Implementation of this directive, along with other elements of EO 17-20, has been coordinated and discussed through the Built Environment Efficiency Working Group (BEEWG)[i].

The agencies are available to respond to any questions or comments about this report or broader efforts and strategies to improve energy resilience in the state. We will continue to work in partnership with other state agencies, industry stakeholders, and local governments to evaluate strategies for improving energy resilience to help Oregonians recover from a disaster situation.

---

[i] The BEEWG is comprised of state agencies tasked with EO 17-20 implementation, including the Oregon Department of Energy, Oregon Public Utility Commission, Oregon Department of Administrative Services, Oregon Housing and Community Services, and the Building Codes Division of the Oregon Department of Consumer and Business Services. For more information, please visit the BEEWG website: https://www.oregon.gov/energy/Get-Involved/Pages/BEEWG.aspx

Oregon Department of Energy and Public Utility Commission

Executive Order 17-20
Role of Efficiency & Distributed Energy Resources in Resilience

January 2019

Table of Contents

I. Executive Summary

On November 6, 2017, Governor Kate Brown issued **Executive Order 17-20**: **Accelerating Efficiency in Oregon's Built Environment to Reduce Greenhouse Gas Emissions and Address Climate Change.**[1] This Executive Order established directives for energy efficiency leadership in state buildings, increasing energy and water efficiency in new construction, and increasing energy efficiency through retrofits of existing buildings. The Executive Order identified a need to evaluate the role of distributed energy resources and efficiency in increasing energy resilience to improve Oregon's recovery from a disaster situation. The Order included a specific directive, *5.D. Evaluation of Energy and Resiliency Efforts*, for the Oregon Department of Energy (ODOE) and the Public Utility Commission (OPUC) to make these evaluations.

Excerpt from EO 17-20

5. Increasing Energy Efficiency through Retrofits of Existing Buildings Across the State

D. Evaluation of Energy and Resiliency Efforts. ODOE and PUC are directed to evaluate the state's distributed energy resources and the efficiency of energy systems needed to improve Oregon's recovery from a disaster situation. ODOE and PUC are directed to provide the Governor with a report of their analysis and

This report serves to fulfill this directive by providing an overview of energy resilience efforts to date in Oregon, and an evaluation of the role of distributed energy resources and of efficiency in improving the state's ability to recover from a disaster situation. This report also identifies several data gaps that, if addressed, would help the state to better leverage distributed energy resources and efficiency investments to improve energy resilience in the future.

The Built Environment Efficiency Working Group (BEEWG) is a collaboration among state agencies working to implement Executive Order 17-20. The BEEWG includes representatives from the Department of Administrative Services, Oregon Department of Energy, the Building Codes Division, the Public Utility Commission, and Oregon Housing and Community Services. Each agency in the BEEWG works within its existing authority to implement the directives of EO 17-20; this report has been written to reflect the authority of the respective state agencies.

ODOE, under ORS 469.010, is charged with providing impartial and objective information to promote the efficient use of energy resources and to develop permanently sustainable energy resources. ORS 469.030 provides that ODOE be a repository for energy resources, inform the public on energy conservation, and engage in research related to energy resources.

The OPUC's general responsibilities are set forth in ORS Chapter 756. That chapter authorizes the OPUC to "represent the customers of any electric and natural gas utility, telecommunications utility, water utility and the public generally in all controversies respecting rates, valuations, service and all matter of which the Commission has jurisdiction." Additionally,

[1] https://www.oregon.gov/gov/Documents/executive_orders/eo_17-20.pdf

with respect to regulated utilities, the OPUC is authorized to set rates and determine the terms and conditions of service offered; investigate the management and records of regulated utilities; investigate complaints; and to take other actions to protect consumers. ORS Chapter 756 requires that the OPUC "balance the interests of the utility investor and the consumer in establishing fair and reasonable rates."

II. Defining Energy Resilience

Improving the resilience of the state's energy systems has emerged as a topic of significant interest within Oregon's energy industry in recent years. This interest stems from several independent factors, including an increased awareness of threats to Oregon's energy systems and rapid advancements in distributed energy resources with the potential to improve community energy resilience.

While resilience has become a commonly used term, there is no widely agreed-upon definition within the energy sector. Most definitions, however, include similar themes. For the purposes of this report, resilience is defined as: "the ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions. Resilience includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents."[2]

RESILIENCE IN THE ENERGY SECTOR

Resilience: the ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions, including the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents.

Energy Resilience: the ability of energy systems – from production through delivery to end-users – to withstand and restore energy delivery rapidly following non-routine disruptions of severe impact or duration.

Community Energy Resilience: the ability of a specific community to maintain the availability of energy necessary to support the provision of energy-dependent critical public services to the community following non-routine disruptions of severe impact or duration to the state's broader energy systems.[3]

[2] Presidential Policy Directive (PPD) 21, https://obamawhitehouse.archives.gov/the-pressoffice/2013/02/12/presidential-policy-directive-critical-infrastructure-security-and-res

[3] Oregon Department of Energy *2018 Biennial Energy Report*. Chapter 5: Resilience, p. 3. Available online: https://energyinfo.oregon.gov/ber

The lack of clarity around what energy resilience means specifically is further complicated by the frequent conflation of the term with another that has a longer history in the electric sector: reliability. Resilience and reliability are not interchangeable. In the electric sector, reliability is a well-defined technical attribute for which there is significant government oversight to ensure compliance with established metrics and standards.[4]

These metrics and standards ensure that utilities provide reliable electric service — e.g., avoiding outages or significant disruptions to power quality — to end-use customers under conditions reasonably expected to occur within the grid. These conditions can range from infrequent but predictable events, such as geomagnetic storms that can damage electrical equipment, to routine seasonal weather-related extremes or storms that may affect electricity load or transmission and distribution.

To track service reliability, Oregon's investor-owned electric utilities, for example, file annual reliability reports with OPUC. Portland General Electric, PacifiCorp, and Idaho Power measure and track the overall reliability of their systems using industry standard metrics focused on measuring the frequency and duration of outages and causes.[5] Resilience has no similar oversight mechanisms, nor does it have metrics or standards against which a system can be evaluated for compliance.

Lack of definitions and regulatory oversight notwithstanding, entities across Oregon have been starting to take steps to enhance the resilience of the energy sector to threats posed by climate change and a future Cascadia earthquake. For example, state government has called attention to the need to improve the resilience of the Critical Energy Infrastructure Hub in the Portland metro area. Meanwhile, both investor-owned and consumer-owned electric utilities have been taking proactive steps to reinforce and move infrastructure to make it more resilient to anticipated threats. And lastly, local governments are increasingly thinking about the concept of community energy resilience and about the interdependencies of many of their communities' critical public services on the continued delivery of energy following a major disruption to the state's broader energy systems. These efforts are detailed below; there is also a need to build upon these efforts through a collaborative process to define a community energy resilience vision for the state.

Resilience to Identified Threats

While reliability standards are focused on how energy systems operate under reasonably expected conditions, energy resilience concerns the ability of energy systems to maintain

---

[4] For more background on the development of technical reliability standards in the electric sector, including a history of the regulatory system that enforces those standards, please see Reliability Primer: An Overview of the Federal Energy Regulatory Commission's Role in Overseeing the Reliable Operation of the Nation's Bulk Power System. Available online: https://www.ferc.gov/legal/staff-reports/2016/reliability-primer.pdf

[5] Investor-owned utilities report to the OPUC the following indices that are based upon methodologies established by the Institute of Electrical and Electronics Engineers (IEEE) Standard 1366: System Average Interruption Duration Index (SAIDI), System Average Interruption Frequency Index (SAIFI), and Momentary Average Interruption Frequency Index (MAIFI).

operation during and to recover following an acute non-routine event, typically one of severe impact and/or duration. When evaluating investments to improve energy resilience, it is important to first consider potential non-routine threats that could have severe impacts on energy systems. An entity making such investments should consider the likelihood of these threats occurring and the location-specific impacts expected from the threats. The **Cascadia Subduction Zone** earthquake is perhaps the clearest example of the type of non-routine event that could have severe impacts on the state's energy systems. Other threats include **cyber and physical attacks** on key energy infrastructure and **climate change**.

After a location-specific assessment of the threats, an evaluation must be made of whether or not there are cost-effective solutions available that could improve energy resilience to those threats. The section that follows reviews some of the current efforts underway in the state – from statewide planning efforts to the deployment of innovative new technology solutions – to improve energy resilience to these threats.

III. Current Energy Resilience Efforts in Oregon

Currently, there is no single state or federal agency charged with evaluating or planning comprehensive improvements to the overall resilience of Oregon's energy systems, inclusive of the production and delivery systems for liquid fuels, electricity, and natural gas. Given this reality and the absence of widely accepted standards or metrics to measure energy resilience, it is difficult to evaluate the current level of resilience of energy systems in the state today. Regardless, as noted above, entities across the state have begun taking actions to address concerns about energy resilience. This section provides a snapshot of some of the specific actions currently underway in Oregon at the state level, and within individual communities and utilities to improve the resilience of the energy sector and plan for an organized response to a major event.

Energy Assurance Plan

Supported by federal stimulus funding in 2009, ODOE, in collaboration with OPUC, developed an Energy Assurance Plan.[6] The plan provides an overview of the state's energy infrastructure and overall energy profile; at a high level, evaluates the role of renewables and smart grid technologies in energy assurance planning; describes different types of energy emergencies that could occur in Oregon; and explains how the state would respond to energy emergencies.

ODOE and OPUC are the designated primary state agencies for planning, preparedness, response, and recovery to energy emergencies with potential impacts to Oregonians. OPUC is responsible for developing and maintaining emergency response plans for electricity and

[6] Oregon Department of Energy and Oregon Public Utility Commission. Oregon State Energy Assurance Plan. 2012. Salem, OR. https://www.oregon.gov/energy/Data-and-Reports/Documents/2012%20Oregon%20State%20Energy%20Assurance%20Plan.pdf

natural gas emergencies, while ODOE is responsible for developing and maintaining a fuel sector emergency response plan.

In 2017, ODOE released the Oregon Fuel Action Plan, which details how the state will respond to an event that causes severe shortages of liquid fuels.[7] ODOE developed the Plan pursuant to ORS 175.750-785 to ensure that adequate fuel supplies will be provided to the state's emergency and essential service providers in the event of a severe or long-term fuel disruption or shortage. The Plan, the first of its kind in the nation, identifies nine priority actions ODOE would take to arrange acquisition and delivery of fuel in support of the state's response and recovery efforts in times of crisis. The Plan is a working document and will be updated as needed to ensure that all response strategies remain current and sync with those of our federal, tribal, military, state, local, and industry partners.

There is no single State of Oregon agency with regulatory authority over the petroleum terminals located within the Critical Energy Infrastructure (CEI) Hub northwest of Portland. These terminals are expected to be severely damaged by a CSZ earthquake,[8] yet no single state agency can require these facilities to invest in seismic upgrades to their aging tanks, pipeline systems, and other facilities. The Oregon Department of Environmental Quality, meanwhile, is responsible for working with industry to develop and maintain the Oil Spill Prevention Program to reduce the risk of spills and minimize damage to human health and the environment when responding to spills.[9] DEQ's authority for developing this program is based on legislation adopted in 1991 that did not address seismic resilience, and its authority is limited to marine oil transfer facilities, which is a subset of the facilities located within the CEI Hub.

Oregon Resilience Plan

The Oregon Resilience Plan (ORP) was developed in 2013 by the Oregon Seismic Safety Policy Advisory Commission at the direction of the Oregon Legislature.[10] The ORP evaluates the expected effects of a CSZ earthquake and tsunami to different sectors and regions of Oregon, with recommendations to reduce risk and improve recovery. These recommendations were formulated with the intention that, if implemented over the next 50 years, the state could achieve resilience targets as identified by the ORP with regards to reducing timelines for the restoration of certain services following a CSZ earthquake. Chapter 6 of the ORP is focused on the state's energy sector, and identifies ten recommendations for the state to improve its resiliency.

---

[7] Oregon Department of Energy. Oregon Fuel Action Plan: Plan, Prepare, Respond, & Recover from Severe Fuel Shortages. 2017. Salem, OR. https://www.oregon.gov/energy/safety-resiliency/Documents/OregonFuel-Action-Plan.pdf

[8] Oregon Seismic Safety Policy Advisory Commission, 2013, Oregon Resilience Plan: Reducing Risk and Improving Recovery for the Next Cascadia Earthquake and Tsunami. https://www.oregon.gov/oem/Documents/Oregon_Resilience_Plan_Final.pdf

[9] Oregon Revised Statutes 468B.340 – 468B.415

[10] *See*, Oregon Resilience Plan.

The ORP also recommended that the state legislature create a new position in state government — a State Resilience Officer — to "provide leadership, resources, advocacy, and expertise in implementing a statewide resilience plan." The legislature followed this recommendation, creating the position with the passage of House Bill 2270 in 2015.[11] With the subsequent appointment and confirmation of the state's first Resilience Officer in 2016, Oregon became one of the first states in the nation with a cabinet-level position in state government charged with coordinating resilience efforts.[12]

Community- and Utility-Level Actions

Consistent with state-level planning, many local governments and utilities are making investments designed to improve energy resilience at the local level. These actions vary, from evaluating whether buildings and energy infrastructure are seismically sound, to relocating key assets, to deploying advanced energy technologies. This section highlights several of these community-level activities.

Assessing and Hardening Infrastructure

Particularly with regard to the threat of a CSZ earthquake, many utilities across Oregon have taken steps to assess and address the vulnerabilities of their buildings and infrastructure.[13] **Central Lincoln People's Utility District** is one of the state's 36 consumer-owned utilities; its service territory stretches over 100 miles of central Oregon coastline. Given risks to its service territory, in 2017 the utility completed construction of a new Northern Operations Center in Newport. The previous operations center was in an area of Newport at lower elevation and within the tsunami zone (i.e., the area expected by geologists to be affected by a tsunami following a major rupture of the CSZ fault). The new operations center has been built at higher elevation, outside of the tsunami zone, and constructed to seismic standards designed to withstand the ground forces from a CSZ earthquake.

Blachly-Lane Electric Cooperative, a consumer-owned utility located northwest of Eugene in the southern end of the Willamette Valley, is seismically retrofitting its headquarters to withstand a CSZ earthquake. The **Eugene Water and Electric Board**, meanwhile, is working with a team of engineers at Oregon State University to evaluate how its concrete electric transmission towers — utilized in some locations on its system — will hold up to a CSZ earthquake. **Portland General Electric** has also been working to reinforce or replace unreinforced masonry buildings, particularly those associated with older hydroelectric facilities.

In addition, the **Bonneville Power Administration** has been working for decades to improve the resilience of its transmission network to a major seismic event. For example, BPA has bolted the transformers at all of its transmission substations to their foundations. This helps to prevent

---

[11] Oregon Laws 2015, Chapter 762 (House Bill 2270 (2015)), encoded in Oregon Revised Statutes as ORS 401.913

[12] Office of Governor Kate Brown. (2016, May 25). Senate Confirms Oregon's First Resilience Officer [Press release]. https://www.oregon.gov/newsroom/Pages/NewsDetail.aspx?newsid=1122

[13] The examples cited in this subsection are based on statements made by representatives of Central Lincoln PUD, Blachly-Lane Electric Cooperative, Eugene Water and Electric Board, Portland General Electric and the Bonneville Power Administration either at public events, or in meetings with ODOE staff, in 2017-18.

these large pieces of equipment from sliding off of their foundations during a seismic event. BPA and many of the state's distribution utilities have replaced inflexible substation components, often made of porcelain, with more flexible components made of polymers. BPA is also currently in the process of seismically retrofitting the control house buildings at each of its transmission substations. BPA and other federal agencies have also evaluated seismic risks to the federal hydroelectric dams themselves, finding those risks to be minimal.

ENERGY RESILIENCE GUIDEBOOK

The Oregon Department of Energy will soon publish a ***Guidebook to Enhance Local Energy Resilience in the Consumer-Owned Utility Sector***. The *Guidebook* is the culmination of two years of work by ODOE staff in collaboration with the Governor's Office and Central Lincoln People's Utility District. The work was made possible by the support of the National Governors Association Center for Best Practices, through its Policy Academy on Grid Modernization.

The *Guidebook* is designed specifically for staff working at the state's consumer-owned utilities who have been tasked with developing plans to enhance the resilience of their utility. With that audience in mind, the *Guidebook*:

- Identifies actions that electric utilities in Oregon and across the nation are taking to improve continuity of operations planning;
- Proposes a framework for consumer-owned utilities to utilize to prioritize investments in distributed energy resources to enhance community energy resilience; and
- Identifies the role of local electric utilities within the context of the field of emergency management at the county, state, and federal level.

Deploying Distributed Energy Resources

Several Oregon utilities are also deploying distributed energy resources (DERs) as part of projects that enhance energy resilience at the local level. To the extent that these projects have the ability to operate independently from the rest of the grid, they can provide some improvement to community energy resilience in the event of a wider disruption to the state's larger energy systems.

WHAT IS A "DISTRIBUTED ENERGY RESOURCE"?

Distributed Energy Resource is an umbrella term used to refer to any resource interconnected to the distribution grid of a local utility. While definitions vary on the range of resources include, the Oregon Department of Energy considers DERs to be inclusive of the following:[14]

- Generation sources (e.g., rooftop solar or diesel generators)
- Technologies that modify demand on the distribution system (e.g., energy efficiency and demand response)
- Electric vehicles and associated charging infrastructure
- Energy storage technologies (e.g., distributed batteries)
- Hardware or software control systems utilized to community with the grid and/or optimize the usage of DERs.

Portland General Electric is involved in several energy projects around the Portland metro area with resilience benefits. First, PGE manages a Dispatchable Standby Generation (DSG) program that partners with large customers, many of them hospitals, which already have on-site diesel generators.[15] Through the DSG program, PGE upgrades the customers' control and communications equipment, assumes most routine maintenance and fuel costs, expands on-site fuel storage capabilities, and regularly tests the generator. In exchange, the customer agrees to allow PGE to rely on the customer's generator to supply extra capacity to meet system needs if there is ever an emergency need for capacity. PGE benefits by having an additional emergency capacity resource, while the customer benefits through a more robust on-site energy resilience solution.

PGE is also involved in the deployment of microgrid projects that combine solar and storage to enhance resilience. In 2017, the utility partnered with the City of Portland's Fire Station 1 through its Renewable Development Fund grant program to deploy a solar and storage project that can provide resilient back-up power for the fire station following a grid disruption. PGE is also seeking authorization from OPUC to develop a customer and community microgrid pilot that would deploy up to 12.5 MW of energy storage across two to five customer sites.

---

[14] Oregon Department of Energy *2018 Biennial Energy Report*. Chapter 5: Resilience, p. 5-11. Available online: https://energyinfo.oregon.gov/ber

[15] Portland General Electric. Dispatchable Standby Generation: Put your backup generators to work and save. Portland, OR. Available online: https://www.portlandgeneral.com/business/get-paid-to-help-meetdemand/dispatchable-standby-generation

Meanwhile, the **Eugene Water and Electric Board**, which serves about 93,000 electric customers and 53,000 water customers in the Eugene area, has partnered with the two Eugene-area school districts to install back-up power capability and install or upgrade water well equipment at district-owned facilities.[16] Many Eugene-area schools have existing rooftop solar that could provide on-site power for pumping water in addition to the back-up power sources. EWEB is investigating several possible back-up power sources, and is installing a microgrid back-up battery power source at Howard Elementary School in 2018 and a new water well and pump station in the spring of 2019. This microgrid is sized to run the water well pump at the site for up to three weeks, while the existing solar array will be configured to allow for charging of the battery bank. EWEB's project, which is designed to increase resiliency and support research and design, was funded through a grant with ODOE, Sandia National Laboratories, Advanced Grid Research and Clean Energy States Alliance.[17] EWEB's goal is that five schools will be water resource-ready within five years. Within 5-10 years, microgrids may become more cost-effective, which may result in penetration of these power sources to the electrical grid, due to an increase in customer owned battery storage systems. Research from this first project and the following efforts will inform future policies, and will be used for planning purposes to better understand how integration with these systems will benefit the grid and the customer.

[16] . Eugene Water and Electric Board. (2018, September 26). First Emergency Water Station Debuts Oct. 6 [Press release]. http://www.eweb.org/about-us/news/emergency-water-stations

[17] Oregon Department of Energy. (2015, December 16). ODOE Energy Storage Grant to Spur Eugene Water & Electric Board Toward a Cleaner, More Resilient Energy System [Press release]. https://energyinfo.oregon.gov/blog/2015/12/16/odoe-energy-storage-grant-to-spur-eugene-water-electricboard-toward-a-cleaner-more-resilient-energy-system

MICROGRIDS

A microgrid is a "group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode." (USDOE)

- **Size and Location.** A microgrid can range in size from a single home or building to an entire campus or even a city.
- **Energy Efficiency.** The first step in designing a microgrid is to evaluate ways to reduce energy demand for the microgrid by improving energy efficiency.
- **Isolate Critical Loads.** All system loads should be evaluated to identify and isolate only those that are critical to support essential functions.
- **Technology Selection.** A microgrid can include virtually any type of technology. Additional efficiencies can often be achieved through combining complementary technologies.
- **Control Equipment.** The key distinguishing characteristic of any microgrid involves its ability to disconnect or "island" from the larger grid. Advanced control equipment can automatically island microgrids and optimize the use of resources within the microgrid.[18]

IV. Evaluation of the Role of Distributed Energy Resources

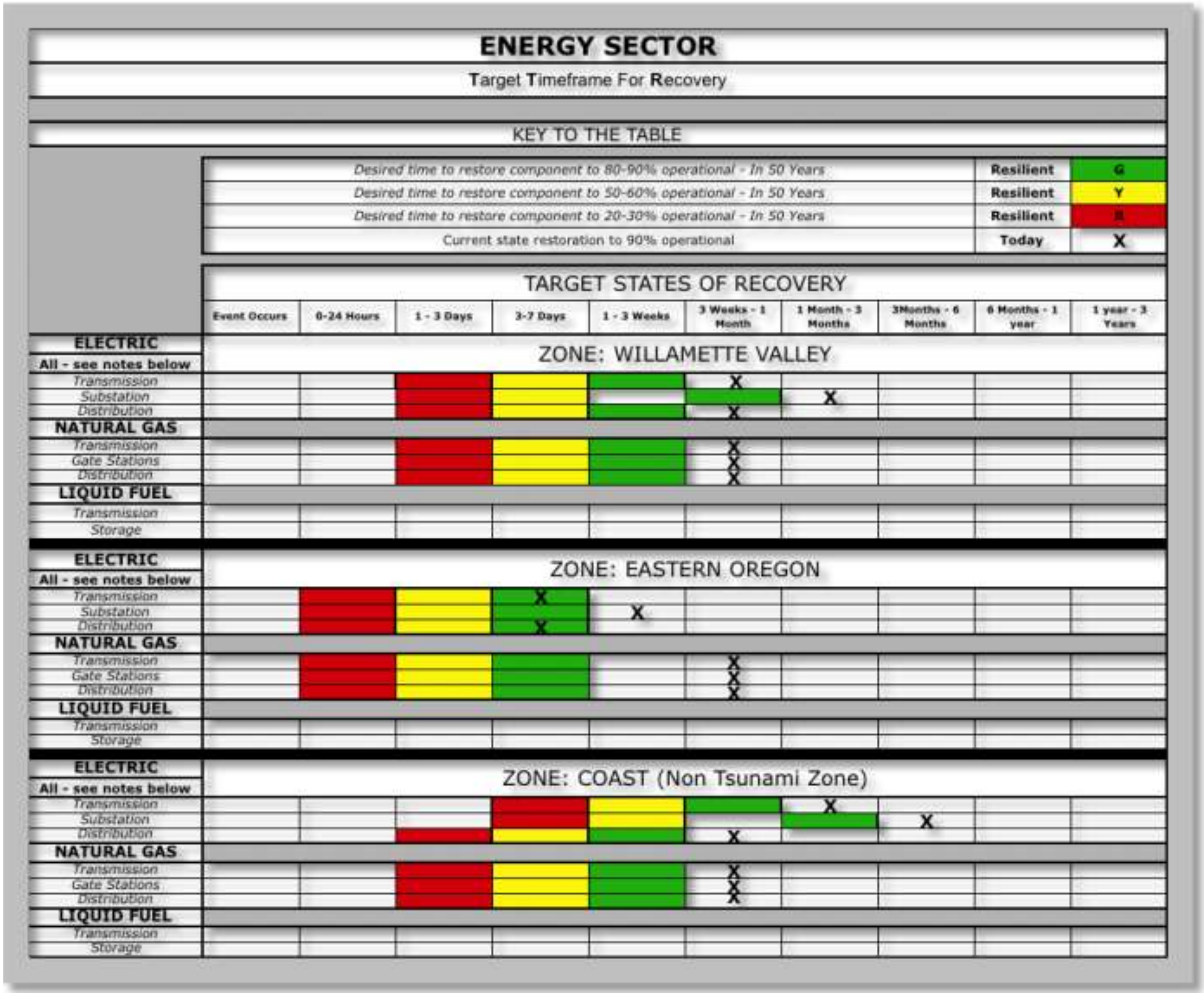
The Role of DERs in the Context of Disruptions to Oregon's Bulk Energy Systems

As identified in the previous sections of this Report, there are a number of disasters that could result in severe impacts to the state's energy systems. The CSZ earthquake, in particular, is expected to cause widespread damage to infrastructure across Oregon, and the energy sector is no exception.

For example, the Oregon Resilience Plan estimated the timeline to recovery of 90 percent of current operations following a CSZ earthquake for the electric, natural gas, and liquid fuel sectors across three different geographic zones of the state: Willamette Valley, Eastern Oregon, and Coastal Oregon (non-tsunami zone). That timeline is identified on the following table from the Oregon Resilience Plan,[19] with the timeline under today's conditions denoted by an "X":

[18] Oregon Department of Energy *2018 Biennial Energy Report*. Chapter 5: Resilience, p. 5-12. Available online: https://energyinfo.oregon.gov/ber

[19] Oregon Resilience Plan, p. 176



Note that this table does not estimate a timeline for expected recovery of liquid fuel transmission and storage infrastructure. Oregon imports 100 percent of its refined petroleum products via pipeline or barge, with 90 percent of that supply coming from refineries in the Puget Sound region to a liquid fuels hub located along the banks of the Willamette River northwest of downtown Portland.[20] As identified in the Oregon Fuel Action Plan, a CSZ earthquake is expected to devastate the region's petroleum supply and distribution system with restoration likely to take "months if not longer."[21]

The table above estimates that recovery of the electric and natural gas sectors will likely be measured in weeks (for Eastern Oregon) to months (for the Willamette Valley and Coastal Oregon). Meanwhile, it is expected to take months to restore liquid fuel infrastructure. All of these efforts are expected to be hampered by severe impacts to non-energy critical infrastructure, namely the transportation road network.

[20] Oregon Fuel Action Plan, p 9.

[21] Oregon Fuel Action Plan, p 5.

In this worst case scenario, when deliveries from the state's bulk energy system are disrupted for weeks (or longer), DERs have the potential to make critically needed energy available at the local level. It is important to recognize, however, that it is not practical to expect DERs to be able to replace bulk energy deliveries in all circumstances. Rather, it is useful to think about what role DERs can play to supplement the state's bulk energy systems in strategic ways that are intentionally deployed to maximize benefits to Oregonians following a disaster.

In its 2018 Biennial Energy Report, the Oregon Department of Energy explored this concept in greater detail and defined the concept of **community energy resilience** as the ability of a specific community to maintain the availability of energy necessary to support the provision of energy-dependent critical public services to the community following non-routine disruptions of severe impact or duration to the state's broader energy systems.

Technology Advancements Creating Opportunities for Community Energy Resilience

On-site diesel or propane generators have been the primary source of back-up power at the customer level for decades. Hospitals, first responders, and many other large commercial and industrial customers have long utilized on-site diesel generators to ride through grid disruptions. In addition to the negative impact of emissions from these types of generators, they also depend on liquid fuel re-supply. Many diesel generators, for instance, only have sufficient on-site fuel to run for 48 to 72 hours – while the Oregon Resilience Plan found that liquid fuel deliveries could be disrupted for a period of weeks or months (depending on one's location in the state) following a CSZ earthquake.[22] Exclusive reliance on on-site diesel generators for resilient back-up power comes with significant limitations when considering a long duration event.

Technology advancements are creating new opportunities to enhance community energy resilience in a manner that can complement in some cases, or replace in others, the utilization of diesel or propane generators for on-site resilient energy needs. For example, distributed solar and battery storage systems could be more cost-effective options for back-up power capabilities. The increasing availability of electric vehicles creates new opportunities to deploy a more resilient transportation fleet that can be fueled with electricity produced on site. Advanced software and control systems are also creating new opportunities to incorporate a portfolio of technologies with different capabilities that can be optimized for maximum resilience to extend the amount of back-up power available.

Any utility, community, or customer considering investments in energy resilience technologies should also consider the capabilities of those technologies to provide resilience benefits irrespective of the type of event that might occur. For example, while a solar plus storage microgrid might be particularly effective in providing on-site resilient power during a long duration disruption like a CSZ earthquake, the same installation will also be able to provide resilient power following more routine, shorter duration disruptions, which may become more common due to climate change, for example: extreme heat events, drought, wildfires, and

[22] Oregon Resilience Plan, p 176.

severe winter storms. It is also important, of course, to consider whether these energy resilience solutions will physically survive anticipated threats and remain operable.

Benefits of DERs Under Routine Conditions

One key attribute of DER solutions is that they also have the potential to provide value under a variety of different scenarios. A microgrid system intended to provide long duration back-up power following a major disruption can also provide back-up power during more routine power outages. These systems also have the potential to provide value during "blue sky" conditions (e.g., routine conditions). For example, distributed microgrid systems can help to meet a utility's peak capacity need, provide ancillary services that can help maintain grid stability, and contribute additional carbon-free energy to the state's resource mix. DERs also have the potential to offset the need for larger capital investments in the right circumstances.

One of the challenges for DERs, however, is identifying ways to monetize these types of values. PGE's Dispatchable Standby Generation program (see page 9 above) is a local example where the electric utility splits costs with a customer by compensating them for the capacity their on-site diesel generator can provide to the utility under certain conditions. This helps those customers offset the costs of owning and maintaining the diesel generator for its primary intended purpose as resilient back-up power. In other parts of the country, organized wholesale markets exist that allow projects to develop revenue streams by selling these types of services into active markets. And at least one state, Hawaii, has recently initiated a process that will require its electric utilities to develop a tariff that compensates these types of microgrid projects for the benefits that they can deliver to the grid. These types of mechanisms can create sufficient revenue streams that allow communities to finance the deployment of resilient microgrid projects for which the resilience benefit that the project confers becomes an added value.

Next Steps: Leveraging DERs to Improve Energy Resilience

As described above, emerging DER technologies (from solar and storage systems, to the widespread availability of electric vehicles and EV charging) are creating new opportunities to improve energy resilience at the local level. There is significantly more, however, that can be done to better leverage existing DERs and to strategically deploy new DER solutions to improve the state's energy resilience to help communities recover from a disaster situation.

The following summarizes several key actions that could be taken to enable entities within the state to better leverage DERs to improve energy resilience:

Inventory of DERs: There is currently no statewide data inventory that identifies where DERs (including diesel generators, distributed solar, and storage systems) are deployed. Identification of these resources, irrespective of ownership, would allow utilities or local governments to consider innovative and targeted strategies (e.g., PGE's DSG program) to leverage these deployments to improve energy resilience.

Mechanisms to Value Benefits of DERs: As noted above, DERs have the potential to provide a number of benefits separate from resilience, including energy and capacity benefits, and the ability to offset capital investments to make upgrades elsewhere on the electric grid. One of the challenges with valuing these benefits to utility ratepayers has to do with the location-specific nature of these resources and the benefits they deliver. This is an area of current significant investigation within the electric industry, both nationally and within Oregon.[23] Additional work, predominantly at the national labs, is occurring to quantify the societal value of the resilience benefits that DERs can provide.

Vulnerability and Risk Assessments: There would be value in conducting a comprehensive statewide vulnerability and risk assessment of energy generation and transmission infrastructure. This would allow individual utilities and communities to better understand how impacts to the state's bulk energy systems from various threats might be expected to affect them specifically. Similarly, there would be value in individual utilities and communities conducting similar assessments to understand particular vulnerabilities and risks to energy infrastructure at the local level (e.g., local generation and distribution system). Both of these types of assessments could be used to better inform investments in DERs to improve energy resilience.

Identification of Community Energy Resilience Needs: Identifying the energy needs (electric, natural gas, and liquid fuels) of critical service providers and other critical public infrastructure is an important step to improving community energy resilience. The state is in a position to help assist local governments and communities to identify clusters of critical facilities and energy infrastructure in areas with the least vulnerability or risk (e.g., areas within communities less prone to liquefaction or landslides from an earthquake). Particularly in these areas, it would be valuable to identify the potential to leverage existing DERs and/or deploy new DERs to improve community energy resilience.

Community Education & Outreach: Given the development of new DER technologies, combined with a better understanding of the expected impacts to the state's bulk energy systems from a major disruption like a CSZ earthquake, communities around the state would likely benefit from more direct outreach to learn more about these types of community energy resilience solutions.

[23] Examples of this include the Resource Value of Solar (UM 1716) at the Oregon PUC, and the work of the California PUC on the development of Distribution Resource Plans and the development of a Locational Net Benefits Analysis for DERs (R.14-08-013).

V. Evaluation of the Role of Energy Efficiency

Given the orientation of energy resilience solutions toward severe-impact, long-duration events, it is critical that entities consider the importance of energy efficiency before developing DER solutions to improve resilience. Reducing the need for on-site energy helps to reduce the size, and therefore the cost, of deploying the DERs necessary to provide back-up power.

Buildings that are likely to survive a severe event and that are to be served by DER can be assessed for opportunities to lower their energy requirements by installing cost-effective energy efficiency measures. This requires two key steps. First, an evaluation must be made about the criticality of loads within a building or community for which DERs are going to be deployed to improve energy resilience. For example, in the event of a CSZ earthquake, it may **not** be critical to have a building's air conditioning system and entertainment systems powered. On the other hand, the building's heating system, refrigeration, and communication equipment may be critical depending on the essential functions of the building. Ideally, critical loads within the building should be electrically isolated to lower the need for on-site energy by limiting demand only to those critical loads following a disaster. Second, once critical loads have been identified, it is important to consider opportunities for investments in energy efficiency within the building. Can investments be made to improve the energy efficiency of any those critical loads? If heating is identified as a critical load, can investments be made to improve the efficiency of the building envelope or the HVAC system? Can portions of the building be isolated so that the DER systems do not have to serve the entire building?

By engaging in these two steps first, entities seeking to make investment in DER solutions to improve energy resilience, can appropriately size the DER technologies necessary to provide the necessary level of resilient back-up power and lower the installed cost.

Next Steps: Leveraging Energy Efficiency to Enable Energy Resilience

As described above, the first step to improving energy resilience is to reduce the need for on-site energy generation through energy efficiency. The following identifies key actions that could be taken to better leverage energy efficiency to improve energy resilience:

Building Assessments: There is a need for communities to work with critical service providers to better understand what electric loads are critical to the essential functions of that particular building or facility, and evaluate whether and how those loads can be electrically isolated and served by DERs. Additionally, this type of assessment should also consider whether investments in energy efficiency measures could further reduce the building's or facility's amount of resilient back-up power needed on-site.

Community Education & Outreach: Similar to the action suggested above for DERs, there is likely significant value in engaging in outreach to communities to inform them about the importance of linking energy efficiency investments with energy resilience considerations.

VI. Conclusion

Significant statewide planning has occurred in recent years to consider resilience threats to the state's bulk energy systems. Particularly with regard to the severity of the impacts expected from a CSZ earthquake, there is a need for the state to think about the role that efficiency and DERs can play to improve energy resilience. As described in this Report, there are innovative new technologies that are creating opportunities for new DER solutions to improve energy resilience at the local level, but critical gaps remain. The state could make significant progress in improving the energy resilience of the state by addressing the next steps in this Report.