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A Summary of Climate Change Impacts and Preparedness Opportunities for Telecommunications and Energy Utilities in New Jersey

This report is one of a series of working briefs prepared by the New Jersey Climate Adaptation Alliance to provide background information on projected climate impacts for six major sectors in New Jersey, including agriculture, built infrastructure (utilities and transportation), coastal communities, natural resources, public health, and water resources. These working briefs present information to be used throughout the Alliance's deliberations to develop recommendations for state and local public policy that will enhance climate change preparedness and resilience in New Jersey. These briefs are living documents that are periodically updated. This document updates a prior version from February 2013. For more information about the Alliance and its activities, visit *http://njadapt.rutgers.edu*.

This report provides an assessment of energy and telecommunication utility-based perspectives on the topic of adaptation planning for climate change in New Jersey. It includes a discussion of energy and utility infrastructure, including electricity, natural gas, and other alternative forms of energy. Current New Jersey efforts as well as current and planned adaptation practices and strategies in other states are presented as the basis for discussion and prioritization of comprehensive adaptation planning for New Jersey.

Energy in New Jersey

The three basic functions within the electric power industry are generation, transmission, and distribution. Generation of electricity typically occurs at power plants then travels over large transmission lines to local systems where it is distributed to customers. New Jersey is part of the larger power transmission grid of the Reliability First Corporation (RFC), which serves as a regional reliability organization whose primary responsibilities include developing reliability standards and monitoring compliance to those reliability standards and providing seasonal and long-term assessments of bulk electric system reliability.[1] The Pennsylvania-New Jersey-Maryland Interconnect (PJM) is the Regional Transmission Organization (RTO) that determines amount of capacity available to be transmitted to New Jersey based on RFC reliability requirements.

There are four investor-owned electric distribution companies responsible for the distribution of power transmitted in New Jersey: Public Service Electric and Gas (PSE&G), Jersey Central Power & Light Company (JCP&L), Atlantic City Electric Company, and Rockland Electric Company. Utilities are "natural monopolies", which means a single firm can serve the market more efficiently than multiple firms. Because utilities provide a critical public service but there is no competition to control prices or service quality, their rates, governance, and service quality are regulated by the New Jersey Board of Public Utilities (BPU).[2] In addition to the four EDCs, there are ten municipally-owned electric utilities that not regulated by the BPU. These include Butler, Lavallette, Madison, Milltown, Park Ridge, Pemberton, Seaside Heights, South River, Sussex Rural Electric Cooperative and Vineland.[3] The BPU regulates the EDCs and natural gas distribution companies, participates in the PJM planning process, and advocates for New Jersey's interests before the Federal Energy Regulatory Commission (FERC). FERC has jurisdiction over the interstate sale and transmission of electricity and natural gas, and regulates PJM (See Endnote I). The BPU also administers the Clean Energy Program, and other ratepayer-supported utility programs (such as consumer education programs).[4]

[1] Reliability First (2012)
[2] NJCAA (2013)
[3] NJBPU (2011)
[4] NJ OCE (2012

New Jersey generating capacity totals 17,227 MW, about 84% of New Jersey's peak load of 20,548 MW in 2010.[5] New Jersey's cumulative in-state generation was equivalent to about 75% of the State's 2010 total annual energy demand.[6] In 2011, nuclear plants generated the most energy, providing over 50% of the State's total generation.[7] The Salem and Hope Creek Nuclear Power Plants are the highest-capacity power generation sites in the nation and the Oyster Creek Nuclear Power Plant, whose reactor first came online in 1969, is the oldest operating nuclear plant in United States.[8] In 2011, natural gas-fired plants provided about 38%, and coal-fired plants provided a little over 8% of the state's generation. Renewable sources accounted for slightly more than 1% of power generated in the state in 2011.[9]

Natural gas supply to both consumers and industrial users is regulated by the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) Office of Pipeline Safety. PHMSA is responsible for the safety, reliability, and environmental soundness of the nation's interstate pipeline infrastructure. The State of New Jersey regulates and inspects all intrastate pipelines through the Bureau of Pipeline Safety within the New Jersey Board of Public Utilities.[10] New Jersey has one of the highest concentrations of natural gas use in the U.S; there are 2.9 million gas customers in New Jersey, 90% of which are residential customers. Four local distribution companies (LDCs) serve residential, commercial and industrial customers throughout the State, including natural gas-fired power plants that are served by LDCs instead of pipelines. The four LDCs are Elizabethtown Gas Co., New Jersey Natural Gas Co., Public Service Electric & Gas Co. and South Jersey Gas Co. Roughly two-thirds of natural gas sent out is for commercial and home heating applications, and the remainder is for power generation and industrial use. A small amount of natural gas is compressed for vehicle use.[11]

Most natural gas used in New Jersey is sourced from offshore and onshore production facilities in the Gulf Coast and transported by pipeline directly to New Jersey, or indirectly via major underground storage facilities in Pennsylvania along the pipeline routes. New Jersey has about 1,500 miles of interstate transmission pipeline within its geographic boundaries.[12] The interstate pipelines that transport natural gas to New Jersey include the Transcontinental Gas Pipe Line (Transco), Texas Eastern Transmission, Algonquin Gas Transmission, Tennessee Gas Pipeline, and Columbia Gas Transmission. While Transco and Texas Eastern are the primary transporters to New Jersey, the other pipelines play an integral role in maintaining deliverability across the state. New Jersey's LDCs are dependent on conventional underground storage facilities located in western Pennsylvania, and, to a lesser extent, West Virginia and New York, that provide incremental natural gas supplies to satisfy peak demands during the winter heating season, which runs from November through March. In addition, there are a number of competing new pipeline proposals that are expected to expand pipeline deliverability into the state and region, providing Marcellus Shale gas producers with improved access to these markets.[13] New Jersey's pipeline and LDC infrastructure is likely to be strengthened by the construction of these new pipelines.[14]

Telecommunications in New Jersey

Telecommunications infrastructure includes cable, phone, internet and wireless communication services throughout New Jersey. There are several providers of telecommunications service in New Jersey, many of which can be bundled under a single service provider. Cable television, internet, and phone services are offered through Verizon, Cablevision, Comcast or Time Warner. Verizon, AT&T and T-Mobile are primarily responsible for cellular phone tower coverage and service in New

[5] NJBPU (2011)
[6] NJBPU (2011)
[7] NJBPU (2011)
[8] ASCE (2007)
[9] NJBPU (2011)
[10] ASCE (2007)
[11] NJBPU (2011)
[12] NRC (2008)
[13] NJBPU (2011)
[14] NJBPU (2011)

Jersey. Oversight for these providers is undertaken the Federal Communications Commission (FCC) at the federal level.[15] At the state level, the BPU regulates limited aspects of the landline telecommunications business, including basic level rates, service quality, interconnection, inter-carrier compensation and corporate governance. However, the state does not regulate pricing for landline voice (telephone) or video (cable TV), nor does it regulate the provision of internet service or wireless telephone service.[16]

Potential Sector Impacts

The impacts of climate change are numerous and several could have an impact on energy infrastructure and telecommunications. The impacts are grouped into the following categories for discussion among all built infrastructure environments.

1. Sea Level Rise
2. Extreme Weather Events
3. Warming and Extreme Temperatures
4. Drought.

Sea Level Rise

A significant fraction of America's energy infrastructure is located near the coasts because of plant cooling or transportation needs. Rising sea levels are likely to lead to direct losses, such as equipment damage from flooding or erosion, and indirect effects, such as the costs of raising vulnerable assets to higher levels or building new facilities farther inland, increasing transmission and delivery costs. The U.S. East Coast and Gulf Coast have been identified as particularly vulnerable to sea level rise because the land is relatively flat and sinking in many places.[17] In the near term, adaptations are likely to emphasize protecting coastal energy and industrial infrastructures with barriers, but for the longer run, investment strategies for new infrastructures may consider shifts in location to less vulnerable areas.[18] In coastal and near-coastal areas, sea level rise in combination with coastal storm-surge flooding will also become a threat to some central offices and underground installations of telecommunications infrastructure.[19]

Extreme Weather Events

The number of electric disturbance events along the bulk transmission system caused by extreme weather, such as from ice storms, thunderstorms, and hurricanes, has increased tenfold since 1992.[20] During that time, the portion of all disturbance events caused by weather-related phenomena has more than tripled from about 20 percent in the early 1990s to about 65 percent.[21] These weather-related events are also more severe, with an average of about 180,000 customers affected per event compared to about 100,000 for non-weather-related (e.g. equipment failure, low fuel supply) events.[22] In the summer heat wave of 2006, for example, electric power transformers failed in several areas of the U.S. (including St. Louis, Missouri, and Queens, New York) due to high temperatures, causing interruptions of electric power supply.[23] Telecommunication service delivery, like power delivery, is also vulnerable to severe wind, icing, snow, hurricanes, lightning, floods, and other extreme weather events, some of which are projected to increase in intensity due to a changing climate.[24]

Pipelines may also be affected by the increased intensity of precipitation, which can erode soil cover and/or cause subsidence (i.e., sinking of the earth underneath the pipeline) thereby causing underground infrastructure to fail. Federal regulations currently require that pipelines carrying hazardous materials in the lower 48 states be buried with a minimum of 3 feet of cover—up to 5 feet near heavily populated areas. Scour and shifting of pipelines are a major problem in shallow riverbeds, where pipelines are more exposed to the elements.[25]

[15] NJBPU (2011a)
[16] NJCAA (2013)
[17] Bull et al (2007)
[18] Bull et al (2007)
[19] NYSERDA ClimAID Team (2010)
[20] USGCRP (2009); Wilbanks et al (2007)
[21] USGCRP (2009); Wilbanks et al (2007)
[22] USGCRP (2009); Wilbanks et al (2007)
[23] USGCRP (2009); Wilbanks et al (2007)
[24] NYSERDA ClimAID Team (2010)
[25] NRC (2008)

Warming and Extreme Temperatures

Climate change is anticipated to adversely affect energy system operations, increase the difficulty of ensuring adequate supply during peak demand periods, and exacerbate problematic conditions, such as the urban heat island effect.[26] Warming will be accompanied by decreases in demand for heating energy and increases in demand for cooling energy, which can result in higher peak demands during summer months.[27] As nearly all of the cooling of buildings is provided by electricity use, while the majority of heating is provided by natural gas and fuel oil, the projected changes imply increased demands for electricity; especially where the population is growing and where relatively little space cooling has been needed in the past.[28] Thus, rising temperatures are expected to increase energy requirements for cooling and reduce energy requirements for heating.[29] The efficiency of thermal power plants, fossil or nuclear, is sensitive to ambient air and water temperatures; higher temperatures reduce power outputs by affecting the efficiency of cooling. Although this effect is not large in percentage terms, even a relatively small change could have implications for total national electric power supply.[30]

Drought

The need for water used in energy generation is significant and the generation of electricity in thermal power plants (coal, nuclear, gas, or oil) is water intensive. Power plants rank only slightly behind irrigation in terms of freshwater withdrawals in the United States.[31] In some regions of the United States, reductions in water supply due to decreases in precipitation and/or water from melting snowpack are likely to be significant, increasing the competition for water among various sectors including energy production.[32] Parts of the United States could experience limited power plant electricity production because of drought, growing populations, and increasing demand for water for various uses. For example, while water supplies in the Delaware River Basin are considered to be abundant in relation to most regions of the Country, concern about the upward migration of the salt line in the estuary following the significant drought of the 1960's led to a requirement for the electric generators to construct and operate Merrill Creek Reservoir to offset consumptive uses during drought periods. In some areas of the country large coal and nuclear plants have been limited in their operations by reduced river levels caused by higher temperatures and thermal limits on water discharge to maintain water quality and habitat. In addition, seasonal water shortages in many regions of the country could threaten supplies of cooling water for thermal power plants, as well as higher air and water temperatures could reduce the efficiency of power plant operations by a margin that is small for an individual power plant but can add up at a regional scale.[33]

Vulnerable Groups

The NYSERDA ClimAid Team identified a number of different groups that could be at risk to changing climate.[34] These groups included:

- Lower-income residents - increased energy costs associated with air conditioning may be difficult to afford. Low-income residents living in urban areas, which are already subject to urban heat island effects, may be especially vulnerable to higher energy costs.
- Environmental Justice Communities - New energy facilities to power the increased demand for air conditioning may place burdens on communities located nearby if improperly sited.
- Elderly, disabled, and health-compromised residents – these groups are especially vulnerable to power outages, communications loss, and the

[26] NYSERDA ClimAID Team (2010)
[27] USGCRP (2009)
[28] USGCRP (2009)
[29] Wilbanks et al (2007)
[30] Bull et al (2007)
[31] USGCRP (2009)
[32] USGCRP (2009)
[33] USGCRP (2009)
[34] NYSERDA ClimAID Team (2010)

Table 1: New Jersey Impacts and Risk for Water Resources as a result of climate change

Climate Impacts	New Jersey Risks
Sea Level Rise	• Inundation of low-lying systems and facilities • Infrastructure damage and washouts
Extreme Weather Events	• Damage to infrastructure from intense precipitation events (e.g. scour and shifting of pipelines) • Physical damages and losses to public and private property from flooding • Downed power lines as a result of falling trees
Warming and extreme temperatures	• Decreased performance of thermal power plants • Equipment failures (e.g. electrical transformers) • Power outages resulting from increased energy demand
Drought	• Loss of cooling capability from decreased flow and/or water level • Increased requirements on process waste water flow and quality • Impacts to water supply intakes due to increases in salt content

resulting limitations to mobility and access to emergency services.

- Populations in underserved and remote rural areas - may have difficulty reporting outages during extreme events as a result of little system redundancy.

The communities above, and others, may experience disproportionate direct and indirect effects from changes to the availability of power and telecommunications. These communities are worth specific focus and efforts for identification and outreach in order to mitigate detrimental effects on the population.

New Jersey Specific Impacts

New Jersey is especially vulnerable to climate change because of a densely populated coastline and the location of critical infrastructure in low-lying areas.

Sea Level Rise and Storm Surge

As a result of needing water for cooling purposes, many power plants in New Jersey (and around the country) are located in areas that are vulnerable to flooding and storm surge and therefore at risk for impacts such as such as equipment damage from flooding and/or erosion.[35] Facilities located in these vulnerable areas include power plants located on the Atlantic Coast, its tidal estuaries and on the tidal portions of the Delaware River and estuary. Generally, nuclear plants are less affected by sea level or other weather challenges due to the conservatisms included in the original licensing bases for the plants and specific design features.[36] However, during Hurricane Sandy in 2012, an alert was declared at the Oyster Creek nuclear power plant due to water in the plant's water intake structure exceeding certain high water level license criteria.[37] Transmission and distribution facilities located in coastal areas are also vulnerable. Of PSE&G's 294 switching stations and substations, 108 were affected by the storm surge during Hurricane Sandy. PSE&G's proposed Energy Strong program calls for $3.9 billion in investments to harden utility infrastructure, including raising, relocating, or protecting flood-prone switching and substations.[38]

[35] Neumann and Price (2009)
[36] USNRCa (2012)
[37] USNRCb (2012)
[38] PSE&G (2013)

Extreme Weather Events and Flooding

Extreme weather events represent a significant risk to the energy infrastructure of New Jersey. During Hurricane Irene in 2011, statewide approximately 1.9 million of the 3.9 million total electricity customers were affected by outages due to this storm with extended outages from flood water inundation.[39] During Hurricane Sandy, the four EDCs reported 2.9 million outages in New Jersey, representing 73% of electric customers in the state.[40] A report issued by the BPU in 2011 in response to Hurricane Irene recommended several studies to the power and telecommunications infrastructure in New Jersey. One in particular was targeted at determining what physical protection was in effect or was placed in effect for the event at each substation constructed at or below the 100-year floodplain and to develop plans to mitigate potential flooding of these substations (where deemed inadequate by the consultant) for future events.[41] High winds during storms can also cause more frequent and extensive downing of electric transmission and distribution lines.[42] The susceptibility of aerial infrastructure to tree damage was underscored by the massive amount of outages caused by vegetation during Hurricane Irene and Hurricane Sandy; over 100,000 trees and 9,000 utility poles fell down during Sandy.[43]

Telecommunications services were also affected during recent extreme weather events in New Jersey. Approximately 25% of cell sites and cable services experienced outages in areas affected by Sandy.[44] Extreme weather events can also dislodge underwater pipelines from the seabed and cause structural damage to pipelines (e.g., dents and kinks and separation of pipelines from risers).[45] This is also the case for telecommunications infrastructure and transatlantic pipelines, many of which have United States landings along the New Jersey coast.[46]

Drought

The generation of electricity in thermal power plants (coal, nuclear, gas, or oil) is water intensive and because power plants typically require significant amounts of water for cooling purposes, reduced water availability in some areas could limit generation at existing plants and constrain the siting of new capacity.[47] In assessing water vulnerabilities for coal plants, the United States Department of Energy National Energy Technology Laboratory (NETL) evaluated both supply and demand factors affecting power generation. The NETL found that although some New Jersey power plants are subject to demand pressures from areas projected to have large population and water consumption increases, the overall vulnerability of the plants was ‘moderate’ compared to the national portfolio of coal generation units.[48]

Warming and extreme temperatures

Extreme temperature changes could result in an increased demand for cooling in summer and a decreased demand for heating in winter, stressing energy providers during peak periods of demand.[49] Such events may become more frequent as both average temperatures and extreme temperature events are predicted to increase.[50] Increased warming can also affect the efficiency of generation units.[51] Therefore, to the extent that climate change increases ambient temperature it would also reduce available generating capacity from both operating and peak units.[52] In addition, electricity tends to be more expensive to supply at peak times.[53]

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39 Emergency Preparedness Partnerships (2012)
40 NJOLS (2013)
41 Emergency Preparedness Partnerships (2012)
42 Neumann and Price (2009)
43 NJOLS (2013)
44 FCC (2013)
45 Neumann and Price (2009)
46 Neumann and Price (2009), Telegeography (2012)
47 Neumann and Price (2009)
48 NETL (2010)
49 EEEA and the Adaptation Advisory Committee (2011)
50 USGCRP (2013)
51 Bull et al (2007)
52 Neumann and Price (2009)
53 USGCRP (2013)

State Benchmarking

Several states in the Northeast have formalized processes that account for climate adaptation at the state agency level. Entities in New Jersey have undertaken some initiatives to understand and plan for the impacts of climate change and how they might adapt to such changes, though there are currently no formal processes for addressing climate adaptation for energy infrastructure at the state level. The NJDEP has also provided analyses and recommendations for climate change adaptation planning. Such recommendations express that New Jersey understand both a public and private focus on vulnerability and resilience to climate change.[54] During the inaugural workshop of the NJ Climate Adaptation Alliance, there was consensus that although the public is historically reluctant to support long term strategic planning for infrastructure investments, ways to address these challenges need to be identified. Some alternatives that could be considered include ensuring sound communication between infrastructure planners and scientists along with stakeholders and development of a statewide plan complemented by specific strategy development for small projects.[55]

The Maryland Commission on Climate Change (MCCC) is charged with developing an action plan to address the causes of climate change and prepare for the likely impacts. The MCCC's Adaptation and Response Working Group developed an adaptation report detailing, among other recommendations, several strategies to manage the demand of energy from individuals in addition to hardening infrastructure against extreme weather events.[56] Additionally, the adaptation committee suggested that the state also focus on enhancing the education and preparedness of those needing to respond to events caused by increasing numbers of weather hazards. Maryland requires updates each year detailing each applicable agency's activities in addressing their respective comprehensive climate plans, including the adaptation component, and plans for the coming year.[57] For energy and efficiency issues, the Maryland Energy Administration (MEA) provides guidance, policy, standards and technical assistance to local jurisdictions and citizens, and works with the private energy utility companies and others to create energy conservation programs. The Long-Term Electricity Report assessed future electric energy use requirements and peak electric demand requirements, including a scenario that incorporated climate change projections.[58]

New York State's NYSERDA report cites a number of adaptation strategies to be pursued by the State relating to energy and telecommunications.[59] Treating energy infrastructure and telecommunications as separate areas of risk, the report focuses on the large amount of dependence that each of the infrastructures have on one another. These dependencies create much concurrent vulnerability, which consequently can be considered as co-benefits when working to develop adaptation strategies that will benefit a number of stakeholders. For example, increasing the resilience of the power distribution system inherently increases the resilience of the telecommunications system, as the two infrastructures often share the same distribution rights of way and equipment. The recommendations also focus on the necessity of energy and power for responding to natural disasters, mitigating public health concerns, water management, and several other sectors that are impacted by changing climate.[60] Con Edison, the major power generation and distribution company for New York City, was involved in the development of the strategy, and has been continually looking to implement the recommendations of the report.[61] New York City's "A Stronger, More Resilient New York" report, written to address the need for additional resiliency planning following Hurricane Sandy, includes localized climate change projections and a risk assessment of how these changes will impact the city's infrastructure. The report identifies strategies to make the city's utilities more resilient, including developing a cost-effective system upgrade plan, reflecting climate risks in system design and equipment standards, hardening key generation,

54 NJDEP (2009)
55 NJCAA (2011)
56 ARWG (2011)
57 ARWG (2011)
58 Exeter Associates (2011)
59 NYSERDA ClimAID Team (2010)
60 NYSERDA ClimAID Team (2010)
61 NYSERDA ClimAID Team (2010)

distribution, and transmission infrastructure against flooding, implementing smart grid technology, and reducing energy demand.[62]

Pennsylvania's Climate Adaptation Plan also develops recommendations specifically targeted at energy and telecommunications infrastructure. After identifying a number of vulnerabilities to climate change, Pennsylvania recommendations included: the use of renewable energy generation as an adaptation strategy. The plan noted the feasibility of this option especially during times of drought. It recommended the development of on-site renewable resources as distributed generation, thereby reducing reliance on the transmission grid, lowering peak demand, which would result in lower congestion costs and power prices. The recommendations went further suggesting regional adaptation planning strategies to incorporate new climate change weather data in PJM's load forecast to better model energy demand and ensure appropriate electric transmission planning. The report suggested PJM, FERC and NERC should also work with states in the region to develop climate change adaptation strategies since weather extremes such as drought could cause curtailments at nuclear, coal, and natural gas plants potentially impacting reliability of the grid.[63]

Discussion and Recommendations

Conclusions determined by the Massachusetts Adaptation Advisory Committee, are instructive here: with more intense storm events and extreme temperatures, damage to key infrastructure could become more frequent, take longer to repair, and entail more costly repairs and economic disruption.[64] Adaptation efforts in leading states currently focus on identifying vulnerabilities and determining how best to approach climate change in the future. Certain states and municipalities have been able to implement "no-regrets" actions, particularly in developing better data collection protocols and vulnerabilities.[65] In addition, smart grid technologies and distributed energy generation strategies are being explored for resilience purposes, in addition to their potential to better manage power systems during normal operations. PJM Interconnection (PJM) and 12 member transmission owners are deploying synchrophasor measurement devices and implementing a data collection network, expected to be operational in Q2 of 2013. These devices increase grid operators' visibility of bulk power system conditions in near real time, enable earlier detection of problems that threaten grid stability, and facilitate information sharing with neighboring control areas.[66] At Princeton University, the Princeton cogeneration plant on campus was able to provide utility services to students during outages caused by Hurricane Sandy, offering an example of the potential of distributed power generation to provide resilience to extreme weather events.[67] New Jersey can develop a coordinated approach to assessing the vulnerability of the energy and telecommunications infrastructure of the state. Understanding the vulnerability of the infrastructure can also help to develop more targeted investments in infrastructure to create more resilient systems. Table 2 provides a summary of areas where New Jersey might consider for further investigation based on recommendations or initiatives undertaken in other states.

[62] PlaNYC (2013)
[63] PDEP (2011)
[64] EEEA and the Adaptation Advisory Committee (2011)
[65] ARWG (2011), EEEA and the Adaptation Advisory Committee (2011)
[66] USDOE (2011)
[67] Borer (2014)

Table 2 : Specific areas for investigation based on leading practices

New Jersey Adaptation Need	*Potential Initiatives for Investigation and Projects*
Understand Energy and Telecommunication System Vulnerability and Resilience	• Develop a work plan with local and regional scientists to improve understanding of climate change and projections • Quantify the vulnerability of the system to potential climate impacts from demonstrated risks such as saltwater intrusion, storm surge and inland flooding • Understand and promote resilience of critical facilities through partnerships with businesses • Perform engineering-based risk assessments of assets and operations and complete adaptation plans based on these assessments, including financing. • Increase the capability and capacity of entities to monitor impacts on the energy and telecommunications systems • Assess the role microgrids can play in improving energy resiliency • Review current regulation with a focus on climate adaptation including: o Project permitting o Capital planning and land use regulation o Design and construction standards
Integrate Climate Adaptation with Planning and Regulation Processes	• Develop a stakeholder group to organize and coordinate state-level adaptation planning and implementation for energy and telecommunications infrastructure • Investigate methods to incorporate climate change into long-term capital improvement plans, facility designs, maintenance practices, operations, and emergency response plans • Research investment analysis methods and design approaches that account for uncertainty, and clearly communicate tradeoffs to decision makers for funding authorization • Encourage the development and implementation of monitoring technologies • Study interdependencies between sectors to ensure that capital planning and asset management strategies are coordinated to support overall resilience • Investigate methods to incorporate climate change into federal planning for the development of public-sector infrastructure and collaboration in plan development with agencies responsible for land use, environmental protection, and natural resource management • Review protocols for inspection and maintenance of existing systems to account for long term climate impacts • Investigate incentives and financing programs for infrastructure improvements and maintenance • Power generators and utilities may benefit from the creation of an authoritative climate risk database to ensure that State regulators and other agencies rely on the same information in their rulemaking.

Prioritize and invest in infrastructure	• Investigate adjustments to design and construction standards in highly vulnerable locations, including o Construction of berms and levees o Investment in saltwater resistant components o Provide reliable backup power for telecommunications equipment with sufficient fuel supply for extended grid power outages. • Relocate critical systems to higher ground out of future flood zones. o Substations o Cell towers • Equipment replacement cycles present opportunities to improve system resiliency • Investigate the impacts of derating transformers and wiring as a function of higher temperatures. • Invest in tree-trimming programs to protect power lines from wind, ice, and snow damage. • Invest in demand-side management and energy efficiency initiatives that offer "no regrets" benefits to the state energy system regardless of how the climate changes. o Solar gain in buildings can be reduced by shading buildings and windows, using highly reflective roof paints and surfaces, and installing green roofs. • Place electricity and telecommunication cables underground where technically and economically feasible. • Replace segments of the wired network most susceptible to weather (e.g., customer drop wires) with low-power wireless solutions. • Reassess industry performance standards combined with appropriate, more uniform regulation across all types of telecommunication services, and uniformly enforce regulations, including mandatory instead of partially voluntary outage reporting to the regulatory agencies.

Notes

I. The Federal Energy Regulatory Commission (FERC) is an independent agency that regulates the interstate transmission of electricity. The U.S. Energy Policy Act of 2005 authorized the creation of a self-regulatory "electric reliability organization" for North America, with FERC oversight in the U.S. The North American Electric Reliability Corporation (NERC) was certified as the Electric Reliability Organization (ERO) in the United States, with the ability to delegate authority for the purpose of proposing and enforcing reliability standards. ReliabilityFirst is one of the eight approved Regional Reliability Organizations (RRO) in North America, whose primary responsibilities include developing reliability standards and monitoring compliance for the bulk electric system and providing seasonal and long-term assessments of bulk electric system reliability. PJM Interconnection, also established under FERC, is a regional transmission organization (RTO) that coordinates the movement of wholesale electricity in all or parts of 13 states and the District of Columbia and operates the region's power grid and wholesale electric market.

For additional information, please refer to:

1. EIA: http://www.eia.gov/energyexplained/
2. FERC: https://www.ferc.gov/
3. NERC: http://www.nerc.com/page.php?cid=1|7|11
4. ReliabilityFirst Corporation: https://www.rfirst.org
5. PJM Interconnection: http://www.pjm.com/

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