



Section 5. Risk Assessment

5.22 Power Failure

2014 Plan Update Changes

- The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, probability of future occurrence, severity, warning time and secondary impacts of the power failure hazard.
- Details regarding power outages related to Superstorm Sandy are discussed.
- Potential change in climate and its impacts on the animal disease hazard are discussed.
- A vulnerability assessment has been completed and directly follows the hazard profile.
- The consequence analysis for power failure events is now located in Section 9 of this Plan Update.

5.22.1 Profile

Hazard Description

Power failure is defined as any interruption or loss of electrical service caused by disruption of power transmission caused by accident, sabotage, natural hazards, or equipment failure (also referred to as a loss of power or power outage). A significant power failure is defined as any incident of a long duration, which would require the involvement of the local and/or State emergency management organizations to coordinate provision of food, water, heating, cooling, and shelter.

Location

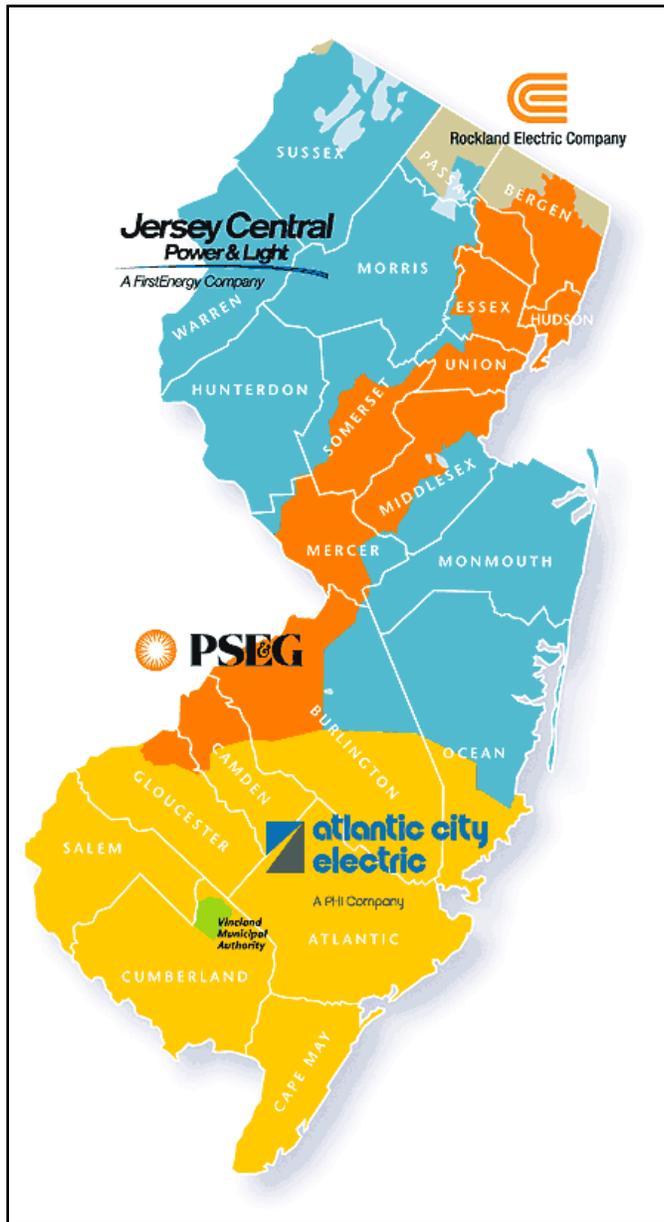
Power failures in New Jersey are usually localized and are usually the result of a natural hazard event involving high winds or ice storms. New Jersey's power systems are overseen by the State of New Jersey Board of Public Utilities. Under New Jersey law, consumers can shop for electric suppliers through a variety of third-party vendors. While the *supply* portion of energy is open to competition, the *delivery* of electricity is limited geographically to the following service providers:

- Atlantic City Electric
- Jersey Central Power and Light (JCP&L)
- Rockland Electric Company
- Public Service Electric and Gas (PSE&G)

These service providers are responsible for maintaining power throughout their respective regions. Figure 5.22-1 shows the locations of electric service delivery providers across New Jersey.



Figure 5.22-1. Electric Service Delivery Companies in New Jersey



Source: New Jersey Clean Energy Program 2013

Power systems across the State are supported by a vast network of delivery systems, which bridge the gap between supplier and customer. Table 5.1-11 in Section 5.1 (Risk Assessment Overview) lists the number of critical electric power facilities in New Jersey.

Power failure is particularly problematic for homes that are heated with electricity. Widespread power outages during the winter months can directly impact vulnerable populations such as the elderly and medically frail. According to the 2007 – 2011 American Community Survey, 340,617 homes across New Jersey are heated with electricity. This represents 10.7% of the total homes in the State. The number of homes heated with electricity per county are listed in Table 5.22-1 and illustrated on Figure 5.22-2.



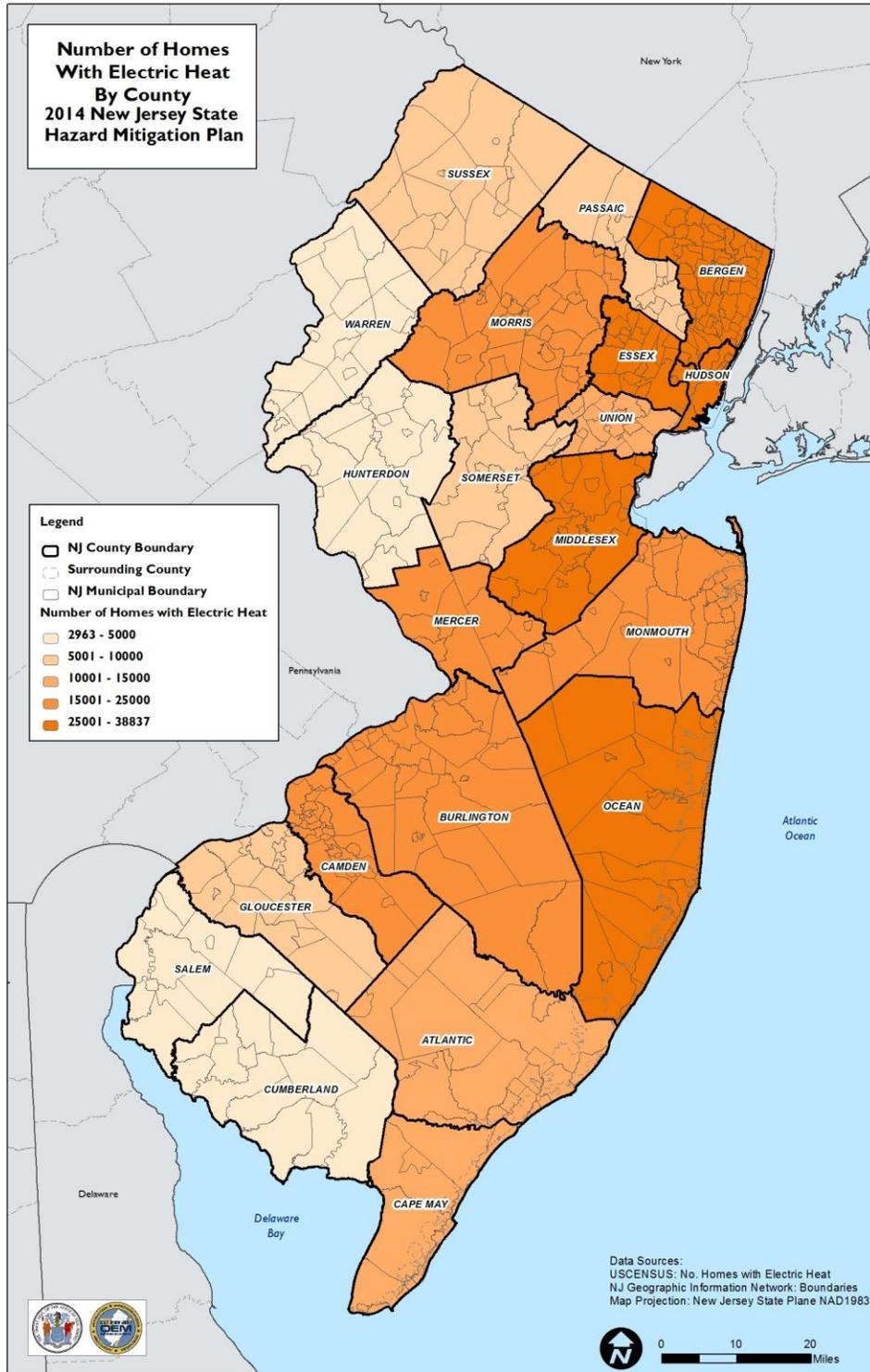
Table 5.22-1. Number of Homes Heated with Electric-Powered Heat

County	Number of Homes	Homes Heated with Electricity	Percentage of Homes Heated with Electricity
Atlantic	101,418	14,917	14.7%
Bergen	333,073	28,339	8.5%
Burlington	165,727	23,593	14.2%
Camden	190,337	21,578	11.3%
Cape May	44,788	10,042	22.4%
Cumberland	50,868	4,767	9.4%
Essex	276,441	25,258	9.1%
Gloucester	103,548	9,664	9.3%
Hudson	240,526	38,837	16.1%
Hunterdon	47,455	4,333	9.1%
Mercer	129,933	15,929	12.3%
Middlesex	278,513	25,126	9.0%
Monmouth	233,120	23,280	10.0%
Morris	179,581	15,406	8.6%
Ocean	222,863	33,301	14.9%
Passaic	161,488	9,829	6.1%
Salem	25,004	2,963	11.7%
Somerset	114,348	9,647	8.4%
Sussex	55,554	7,753	14.0%
Union	184,584	12,619	6.8%
Warren	41,685	3,463	8.3%

Source: US Census 2011



Figure 5.22-2. Number of Home Heated with Electricity per County



Source: US Census 2011



Aside from the importance of power to heat homes, power is vital to maintain out-of-hospital lifesaving systems for patients such as oxygen concentrators and ventilation machines. Across the State thousands of individuals rely on power to sustain their health. Without power, these individuals will require shelter at a medical-needs shelter or admission to a hospital. Although systems are in place to locate these individuals during disasters, such as New Jersey's Register Ready system, the number of individuals who require these services across the State is not definitively known.

Extent

Power failures can range in duration and also in the extent of impacts, from minor loss of communication systems at a facility to catastrophic loss of lifelines such as water and electricity. Utility interruptions usually occur because of, or in combination with, other emergency or disaster incidents, such as severe weather and flooding, and can exacerbate such emergencies.

Power failures often result from damage to or electrical hazards within an electric power system. System components include: power generation plants, substations, circuits, switches, transformers, power lines, and power poles. Due to the varied nature of power outage causes ranging from vehicle accidents to severe weather, utility interruptions can happen at any time.

Power disruption can lead to significant consequences, including service disruption, disruption to infrastructure operations, and loss of heat or cooling that can cause further disturbance or injury.

Previous Occurrences and Losses

New Jersey has experienced several widespread power outage incidents. These incidents have been caused by both natural and non-natural hazards. Recent and significant power outages are summarized below, followed by a list of other significant power failure incidents that have affected New Jersey.

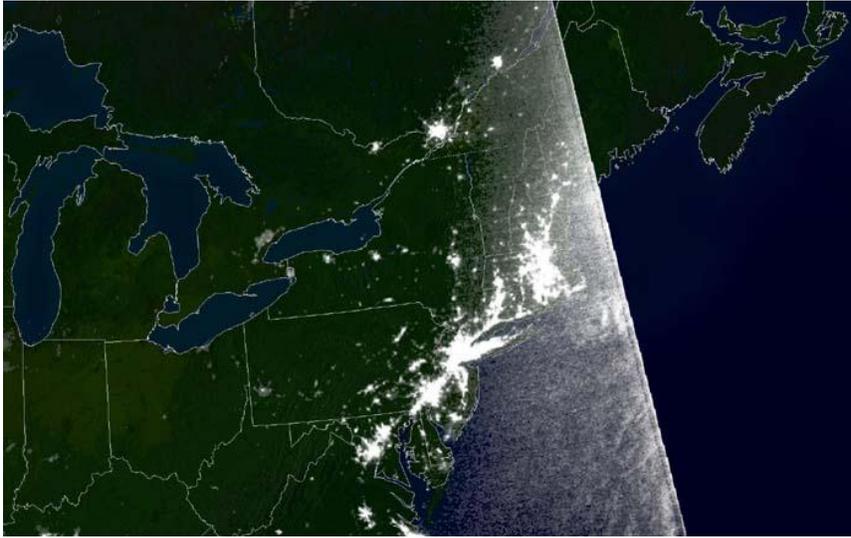
2003 Northeast Blackout

In August 2003, a surge of electricity to western New York and Canada triggered a series of widespread power outages that affected eight states in the Northeast. The grid that distributes power to the eastern portion of the United States became overloaded, tripping circuit breakers from Michigan to New York. The power outage forced numerous businesses to close. Also, the outage affected mass transportation, forcing the evacuation of subway systems in New York City (Barron 2003).

The outage affected an area with an estimated population of 50 million people, cutting off the supply of 61,800 megawatts (MW) of electricity in the states of Ohio, Michigan, Pennsylvania, New York, Vermont, Massachusetts, Connecticut, New Jersey, and the Canadian province of Ontario. In some parts of the United States, power was not fully restored for 4 days. Estimates of total costs in the United States ranged between \$4 billion and \$10 billion (United States dollars) (United States-Canada Power System Outage Task Force 2004). The following figures illustrate the impact of the 2003 Northeast Blackout.



Figure 5.22-3. Northeast Before 2003 Blackout



Source: NOAA 2003

Figure 5.22-4. Northeast During 2003 Blackout



Source: NOAA 2003

2011 Hurricane Irene

According to the New Jersey Board of Public Utilities (NJBPUB), Hurricane Irene disrupted service to 1.9 million customers in the State. Residents were without power for as long as eight days after the storm. The following outlines the number of customers affected per service provider:

- Atlantic City Electric: 273,898 customers
- JCP&L: 780,000 customers
- PSE&G: 872,792 customers
- Rockland Electric Company: 27,220 customers (New Jersey Board of Public Utilities 2011)



2012 Superstorm Sandy

One of the most significant power failure incidents in New Jersey occurred as a result of Superstorm Sandy in 2012. In total, the incident caused approximately 2.5million power customers across the State to lose power for an extended period of time, forcing many shelters to remain open several weeks (United States Department of Energy 2012a). Power crews from across the country converged in the region to assist with power restoration efforts. Restoration efforts were hampered by the extent of the outages, and the sheer number of customers without power. For example, approximately 90% of JCP&L’s customers were without power following the storm (Rose 2012). In many cases it took weeks to fully restore power to the entire State. Table 5.22-2 provides a summary of the power outages across the State as a result of Superstorm Sandy. On November 7, 2012 a Nor’Easter began to impact the northeast bringing strong winds, rain and coastal flooding. As of December 3, 2012, all customers who are able to receive electricity had power restored due to Superstorm Sandy and the subsequent Nor’Easter.

Table 5.22-2. New Jersey Customer Outages from Superstorm Sandy

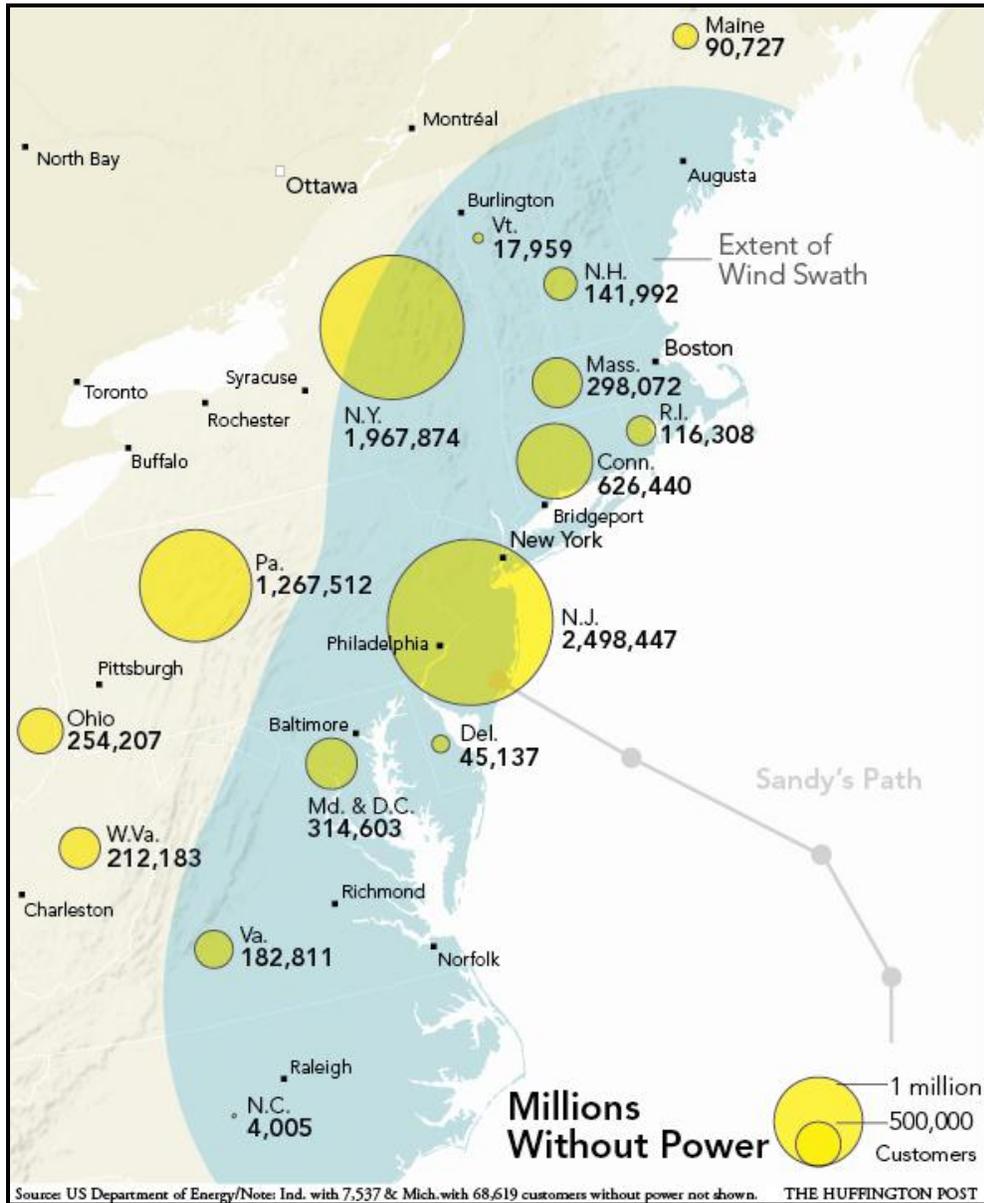
Date	Customer Outages
October 30, 2012	2,498,447
October 31, 2013	2,040,195
November 1, 2013	1,733,202
November 2, 2013	1,587,584
November 3, 2013	1,284,381
November 4, 2013	968,613
November 5, 2013	756,774
November 6, 2013	537,089
November 7, 2013	383,143

Source: United States Department of Energy 2012 a – g

Figure 5.22-5 shows the number of power outages reported in the immediate aftermath of Superstorm Sandy. As the figure illustrates, New Jersey, New York, and Pennsylvania were the hardest hit during Sandy in terms of power failure. Each of these three states had power outages in excess of one million customers.



Figure 5.22-5. Power Outages as a result of Superstorm Sandy 2012



Source: Huffington Post 2012

To date, Superstorm Sandy remains as the most devastating natural disaster to impact the State, and the most extensive power failure incident.

Several other widespread power failure incidents have occurred in New Jersey. The following table outlines the history of significant power failure incidents across New Jersey. It is worth noting that power failure incidents occur frequently, often on smaller scales associated with high winds, ice storms, and power grid issues. Data were not readily available on the frequency of smaller power outages across the State.



Table 5.22-3. Power Failure Events That Have Affected New Jersey

Date(s) of Event	Event Type	Counties Impacted	Description
November 9, 1965	Northeast Blackout of 1965	Statewide	The Northeast Blackout of 1965 was a significant disruption in the supply of electricity, affecting parts of Ontario in Canada and Connecticut, Massachusetts, New Hampshire, Rhode Island, Vermont, New York, and New Jersey in the United States. Over 30 million people and 80,000 square miles (207,000 square kilometers) were left without electricity for up to 12 hours. The cause of the failure was human error that happened days before the blackout.
July 14, 1977	New York City Blackout 1977	Statewide	On July 14, 1977, lightning hit two Con Edison transmission lines north of New York City, tripping relays that soon shut down power plants in the New York metropolitan area. Parts of the City were dark for more than 25 hours, and there was widespread looting.
December 10 -12, 1992	December 1992 Nor'Easter	Statewide	The December 1992 Nor'Easter produced record-high tides and snowfall across the northeastern United States. Throughout New Jersey, the Nor'Easter damaged about 3,200 homes and caused an estimated \$750 million in damage. Additionally, The storm left 102,000 customers of Jersey Central Power and Light without power. Damage to short circuits caused house fires in Monmouth County.
August 14, 2003	Northeast Blackout of 2003	Hudson, Morris, Essex, Union, Passaic, and Bergen	The Northeast Blackout of 2003 was a widespread power outage that occurred throughout parts of the northeastern and midwestern United States and Canada. The blackout's primary cause was a software bug in the alarm system at a control room of the FirstEnergy Corporation in Ohio. Affected areas in New Jersey included most of Hudson, Morris, Essex, Union, Passaic, and Bergen Counties, including the major cities of Paterson and Newark, although some sections of Newark and East Orange still had power, as well as small sections of Essex and Hudson Counties.
March 14, 2010	Severe Windstorm	Statewide	A severe windstorm knocked out power to hundreds of thousands of customers primarily in southwestern Connecticut as well as parts of Westchester County and Long Island, in New York State, and New Jersey. The outage lasted as long as six days for some customers in the hardest-hit communities.
August 27-28, 2011	Hurricane Irene	Statewide	Hurricane Irene caused a power outage to over five million customers throughout the mid-Atlantic and northeast regions of the United States. Approximately 1.9 million New Jersey residents were without power as a result of this storm.
October 28 - 30, 2011	2011 Halloween Nor'Easter	Statewide	The 2011 Halloween Nor'Easter started as a large low-pressure area that produced unusually early snowfall across the northeastern United States. Snow fell on trees that were often still in leaf, adding extra weight. Trees and branches that collapsed under the weight of the snow caused considerable damage, particularly to power lines. In New Jersey, 700,000 customers were without power as a result of the storm.
October 28-30, 2012	Superstorm Sandy	Statewide	Superstorm Sandy brought high winds and coastal flooding to a large portion of the eastern United States, leaving an estimated 8 million customers without power. In New Jersey, 2.7 million customers were without power for a period of several days and weeks.
November 7, 2012	Winter Storm Athena	Statewide	A winter storm left thousands across the east coast of the United States without power, adding to the blackouts after Superstorm Sandy. An estimated 60,000 people lost electricity as the Nor'Easter moved through New Jersey, New York, and Connecticut.



FEMA Disaster Declarations

Between 1954 and 2012, the Federal Emergency Management Agency (FEMA) declared one disaster in the State of New Jersey related to power outage. The following table summarizes the disaster declarations related to power outages in New Jersey, and the counties affected. However, not all counties were included in the disaster declarations as determined by FEMA. Figure 5.22-6 illustrates the number of FEMA disaster declarations by county.



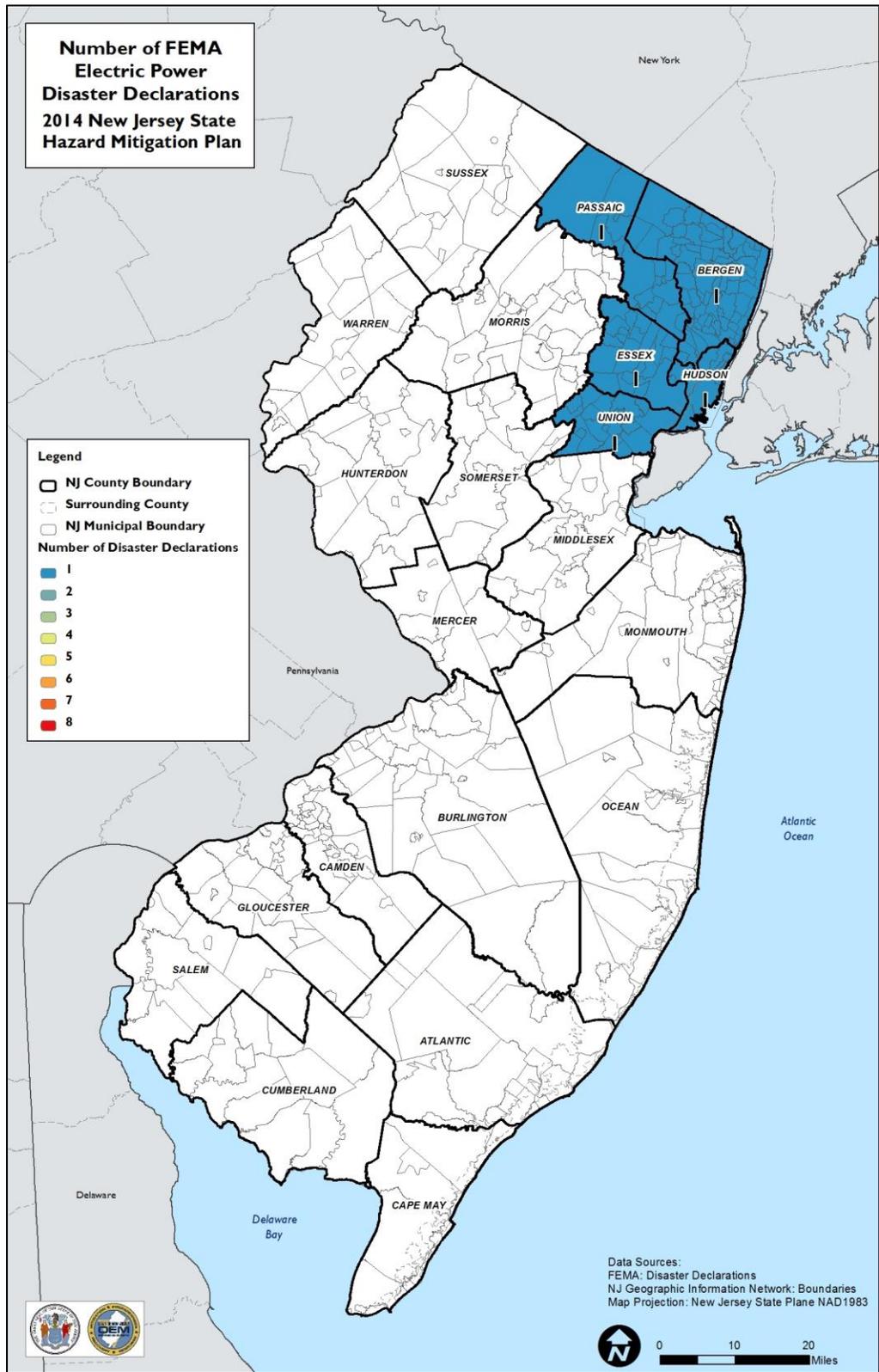
Table 5.22-4. FEMA Power-Outage-Related Disaster Declarations (1954 to 2012)

Disaster #	Disaster Type	Declaration Date	Incident Period	Atlantic	Bergen	Burlington	Camden	Cape May	Cumberland	Essex	Gloucester	Hudson	Hunterdon	Mercer	Middlesex	Monmouth	Morris	Ocean	Passaic	Salem	Somerset	Sussex	Union	Warren	# Counties Impacted
EM-3188	New Jersey Power Outage	9/23/2003	8/14/2003 – 8/16/2003		X					X		X							X				X		5

Source: FEMA 2013



Figure 5.22-6. FEMA PowerOutage-Related Disaster Declarations by County





Probability of Future Occurrences

While the probability of future power failure incidents in New Jersey is difficult to predict, the historic record indicates that significant power failures have occurred as a result of high winds, lightning, winter weather, and technological failures. Data were not readily available on the frequency of smaller power outages across the State; however, it is reasonable to assume that power failure events of shorter duration will continue to occur in the future. The potential for another major power failure that disrupts power for millions of New Jersey residents is always possible, yet are expected to occur less frequently than smaller incidents. In addition, future changes in climate may also impact the frequency and probability of future power failure occurrences.

Severity

Regional or widespread power outages are the most severe type of power failures. The severity of power failures can be linked to severe weather events, such as winter storms and hurricanes. Power failures lead to the inability to use electric-powered equipment, such as: lighting; heating, ventilation, and air conditioning (HVAC) and necessary equipment; communication equipment (telephones, computers, etc.); fire and security systems; small appliances such as refrigerators, sterilizers, etc.; and medical equipment. This all can lead to food spoilage, loss of heating and cooling, basement flooding due to sump pump failure, and loss of water due to well pump failure.

Warning Time

Widespread power outages can occur without warning or as a result of a natural disaster. Generally warning times will be short in the case of technological failure, such as a fire at a sub-station, traffic accident, human error or terrorist attack. In cases where a power failure is caused by natural hazards, greater warning time is possible. For example, high wind events such as tornados and hurricanes often cause widespread power failure, and are often forecasted before they affect a community. Additionally, severe winter weather conditions such as ice storms, blizzards, and snowstorms often cause power failure. Incidents such as these often have plenty of warning time, thus power response crews can stage resources to prepare for power failure.

Secondary Hazards

Power failures can cause secondary hazards and have an effect on the health of residents. One potential secondary hazard is chemical accidents that occur after power is restored to industrial facilities. Power interruptions at chemical handling plants are of particular concern because of the potential for a chemical spill during restart (EPA 2001). Chemical spills in turn can have significant health and environmental impacts.

Another secondary hazard that can result from power failure is a loss of communications capability by first responders, which may in turn have negative impacts on public safety. Backup systems such as amateur radio operators may be required during disaster to augment communications capabilities. Power outages can also lead to instances of civil disturbance, including looting.

Wastewater and potable water utility interruption may occur as a result of a power failure. These critical utilities are essential to community continuity and recovery. Their interruption of service may have cascading economic and environmental impacts.

Because of a lack of power, retail and wholesale gas suppliers cannot access gas in underground tanks or have the electricity to pump it into the tanker trucks for delivery. According to the American Automobile Association, on November 2, 2012, about 60% of the gas stations in New Jersey were closed post Superstorm Sandy due to both power failure and lack of fuel supply (United States Energy Information Administration



2012). Currently, all 22 gas stations located on the Garden State Parkway, the New Jersey Turnpike, and the Atlantic City Expressway are equipped with back-up power in the case of an outage.

Power failure can have vast secondary impacts on the health of the community. During periods of extreme heat or extreme cold, vulnerable populations such as the elderly and medically frail can be affected and are susceptible to hypothermia or heat stroke. Additionally, power failure can lead to food spoilage, which has negative impacts on public health.

Individuals powering their homes with generators are subjected to carbon monoxide poisoning if proper ventilation procedures are not followed. Improperly connected portable generators are capable of 'back feeding' power lines which may cause injury or death to utility workers attempting to restore power, and may damage house wiring and/or generators (New Jersey Department of Community Affairs 2012).

Power failure may also lead to an increase in traffic accidents. Traffic accidents may increase because of the lack of traffic control devices such as stoplights and railroad crossing advisory signals. Power outages lasting a long duration will force law enforcement officials to man traffic control points to prevent accidents.

Climate Change Impacts

Several implications for climate change are related to the power failure hazard. Providing projections of future climate change for a specific region is challenging. Shorter term projections are more closely tied to existing trends making longer term projections even more challenging. The further out a prediction reaches the more subject to changing dynamics it becomes.

The New Jersey Climate Adaptation Alliance is a network of policymakers, public and private-sector practitioners, academics, non-governmental organizations (NGO), and business leaders aligned to build climate change preparedness in the state of New Jersey. The Alliance is facilitated by Rutgers University, which provides science and technical support, facilitates the Alliance's operations and advances its recommendations. A document titled *Change in New Jersey: Trends and Projections* was developed to identify recommendations for State and local public policy that will be designed to enhance climate change preparedness and resilience in New Jersey (Rutgers 2013).

Temperatures in the Northeast United States have increased 1.5 degrees Fahrenheit (°F) on average since 1900. Most of this warming has occurred since 1970. The State of New Jersey, for example, has observed an increase in average annual temperatures of 1.2°F between the period of 1971-2000 and the most recent decade of 2001-2010 (ONJSC, 2011). Winter temperatures across the Northeast have seen an increase in average temperature of 4 °F since 1970 (Northeast Climate Impacts Assessment [NECIA] 2007). By the 2020s, the average annual temperature in New Jersey is projected to increase by 1.5°F to 3°F above the statewide baseline (1971 to 2000), which was 52.7°F. By 2050, the temperature is projected to increase 3°F to 5°F (Sustainable Jersey Climate Change Adaptation Task Force 2013).

Both northern and southern New Jersey have become wetter over the past century. Northern New Jersey's 1971-2000 precipitation average was over five inches (12%) greater than the average from 1895-1970. Southern New Jersey became two inches (5%) wetter late in the 20th century (Office of New Jersey State Climatologist). Average annual precipitation is projected to increase in the region by 5% by the 2020s and up to 10% by the 2050s. Most of the additional precipitation is expected to come during the winter months (New York City Panel on Climate Change [NYCPCC] 2009). In addition, heavy precipitation events have increased in the past 20 years.

Climatologists predict an increase in the number and intensity of severe weather events. More storms with higher winds will increase the chance that the power infrastructure will be impacted. Extreme temperatures



are predicted to increase as well. During the hot summer months, the potential for power overload will increase as demand for power increases. Additionally, climatologists predict an increase in precipitation, which may lead to more winter weather thus causing additional power failures.



5.22.2 Vulnerability Assessment

The following sections discuss New Jersey's vulnerability, in a qualitative nature, to the power failure hazard. A consequence analysis for this hazard was also conducted and presented in Section 9. Impacts on the public, responders, continuity of operations, delivery of services; property, facilities, and infrastructure; and the environment, economic condition of the State, and the public confidence in the State's governance are discussed in Section 9 (Consequence Analysis) in accordance with Emergency Management Accreditation Program (EMAP) standards. This section addresses assessing vulnerability and estimating potential losses by jurisdiction and to State facilities.

Assessing Vulnerability by Jurisdiction

Overall, the entire State is vulnerable to the power failure hazard. Loss of power can have serious impacts on the health and welfare of residents, continuity of business, and the ability of public safety agencies to respond to emergencies.

Individuals with medical needs are vulnerable to power failures, because medical equipment such as oxygen concentrators requires electricity to operate. The elderly are also vulnerable to the effects of power failure, as power failure has the potential to expose them to extreme heat or extreme cold. According to the United States Census, there were 340,644 households or approximately 10% of homes in New Jersey that rely on electricity to heat their homes. Individuals living in these households will be exposed to significantly colder indoor temperatures during a power failure. The following counties have at least 10% or greater of their homes heated with electricity: Cape May (22.4%); Hudson (16.1%); Ocean (14.9%); Atlantic (14.7%); Burlington (14.2%); Sussex (14%); Mercer (12.3%); Salem (11.7%); Camden (11.3%); and Monmouth (10%). Table 5.22-1 above lists the number of homes per county with electric-powered heating units.

During power failure events, water purification systems may not be functioning. Further, populations on private wells will not have access to potable water. Many power outage events are caused by storm events that can lead to flooding. Without electricity, residents would be unable to pump water from their basements potentially causing structural and content damage to their homes. Section 5.6 (Flood) includes a more detailed discussion on the State's vulnerability to the flood hazard.

Assessing Vulnerability to State Facilities

All State buildings, critical facilities, and infrastructure without backup power systems or islanding capabilities with distributed generation are exposed to power failure events. It is imperative that facilities that provide vital State services; protect life and property; and support emergency response, government, sheltering functions, and recovery efforts remain operational during times of need.

State buildings and critical facilities rely on power to conduct daily activities that support New Jersey residents. Of particular concern are those facilities that rely on power to conduct life-saving operations, such as fire, police, and emergency medical services, which may be unable to respond to calls if their stations are not operational. Also important are 9-1-1 communications systems that rely on power to transmit emergency calls to first responders. Without a consistent power source, responders may be unable to charge equipment or operate critical systems, such as computer networks or communications devices. Response efforts could be hampered by the traffic delays caused by inoperable signals. Although many of these facilities typically have backup power, a prolonged power failure would pose challenges related to refueling backup systems. Also, backup power systems may malfunction if they are not regularly maintained, forcing the closure of the facility.



In the event of a power outage, transformers and substations can be damaged. A power failure in one area can cause a cascading effect, damaging components in other parts of the electrical grid. Other utilities may also be impacted as a result of a power failure including potable water and wastewater plants.

Estimating Potential Losses by Jurisdiction

As discussed, power interruptions can cause economic impacts stemming from lost income, spoiled food and other goods, costs to the owners/operators of the utility facilities, and costs to government and community service groups. FEMA's benefit-cost analysis methodology measures the loss of electrical service on a per-person-per-day-of-lost-service basis for the service area affected. For the electrical utility, the standard value is \$131 per person per day (BCA module version 4.8).

Deaths caused by carbon monoxide poisoning are a concern during extended power outages. According to the New Jersey Department of Health website, there were five deaths in New Jersey caused by carbon monoxide poisoning from the improper use of generators after Superstorm Sandy. In the 2 weeks following Superstorm Sandy, 398 people were treated for carbon monoxide exposure in hospital emergency rooms. In addition, power outages can also create an increased risk of fire because of the use of alternative light and fuel sources such as candles, wood, and kerosene.

A prolonged power failure in New Jersey would impact the State's economy. New Jersey hosts the busiest commuter rail network in the country, which operates primarily on electricity. Disruption in the rail network would mean that thousands of workers would not be able to travel to their jobs. For example, the 2003 Northeast Blackout cost states in the northeast an estimated \$4 to \$10 billion in losses collectively. A widespread power failure in New Jersey could have a similar effect on the State. Aside from direct losses within the State, indirect losses would also occur in neighboring states, given the importance of New Jersey in the New York City and Philadelphia metropolitan areas. Other factors include New Jersey's chemical industry and pharmaceutical industry, which rely heavily on power for manufacturing purposes.

Estimating Potential Losses to State Facilities

All State buildings, critical facilities and infrastructure are exposed and vulnerable to a power failure event. The State may potentially experience losses because of an interruption of critical services. Further increased costs such as providing shelters, and costs related to cooling and heating centers may be incurred. Extended power outages will require officials to shelter victims who require heat and power for activities of daily living. This hazard is difficult to quantify in terms of loss of state services.

Environmental Impacts

Power failures are particularly critical at locations where the environment and public safety are at risk. Facilities such as hospitals, sewage treatment plants, mines, etc. typically have backup power; however, even backup power can fail due to equipment malfunction or lack of fuel supply. Distributed generation and cogeneration plants are additional backup power options with the capability to 'island' and generate energy off the power grid. There are environmental benefits to distributed generation such as reduction in greenhouse gas emissions and reduced carbon footprint. Typically, power failure events are not generally threats to environment, unless there are major secondary incidents such as a hazardous substance release. Refer to Section 5.19 (Hazardous Substances) for additional information.