5.22 POWER FAILURE

SECTION 5.22 POWER FAILURE

5.22.1 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.

Figure 5.22-1 Electric Service Delivery Companies in New Jersey

Source: New Jersey Clean Energy Program, 2013

5.22.2 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.

Power systems across the State are supported by a vast network of delivery systems, which bridge the gap between supplier and customer. Table 5.1-12 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.

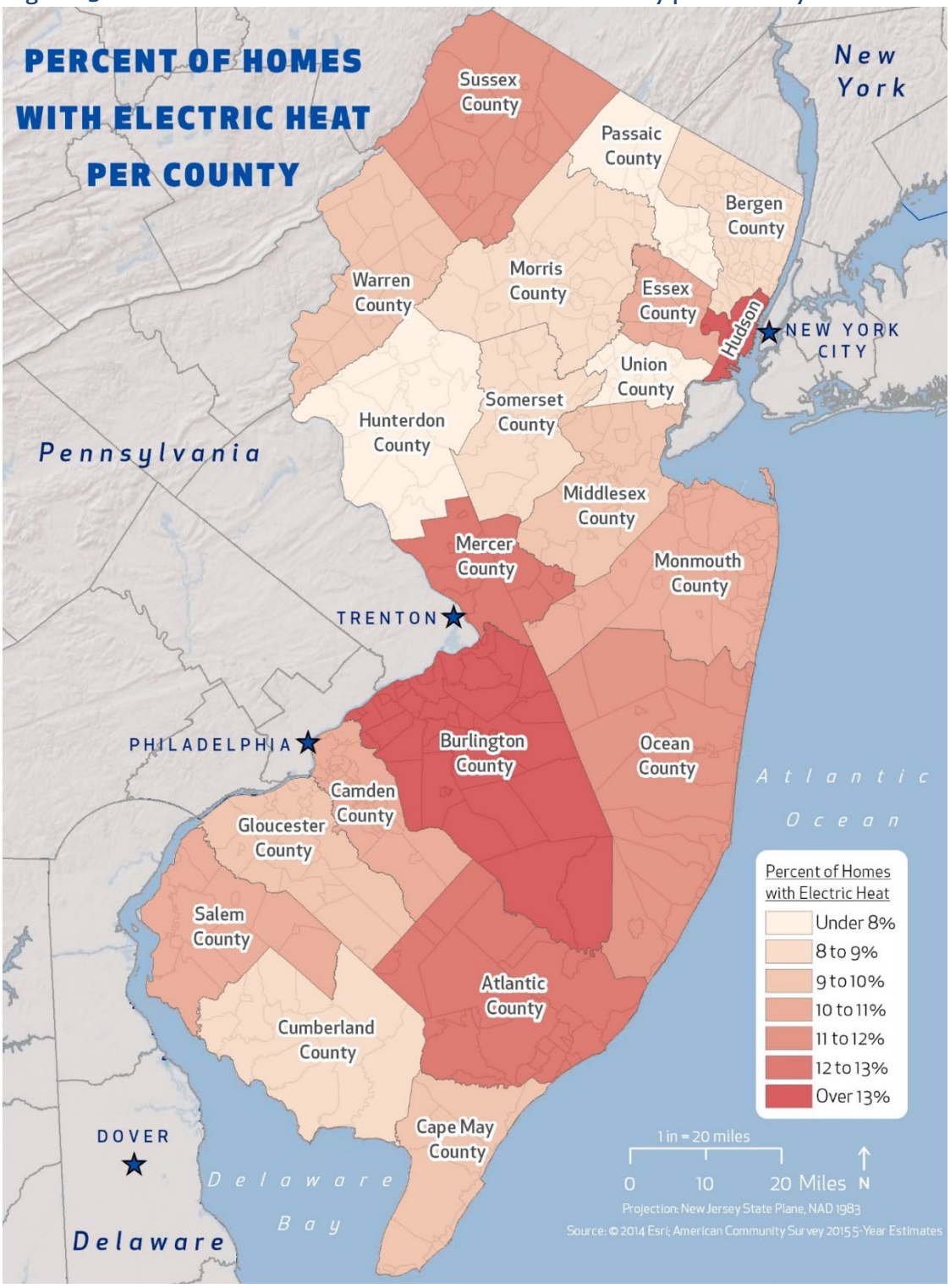
Table 5.22-1 Number of Homes Heated with Electric-Powered Heat

COUNTY	Number of Homes	Home Heated with Electricity	Percentage of Homes Heated with Electricity
Atlantic	127,435	15,359	12.1%
Bergen	353,978	31,386	8.9%
Burlington	177,058	26,247	14.8%
Camden	205,768	22,138	10.8%
Cape May	98,747	9,154	9.3%
Cumberland	56,216	4,683	8.3%
Essex	313,824	34,341	10.9%
Gloucester	111,445	10,273	9.2%
Hudson	274,423	45,615	16.6%
Hunterdon	49,816	3,770	7.6%
Mercer	143,833	17,849	12.4%
Middlesex	297,940	29,541	9.9%
Monmouth	259,823	27,972	10.8%
Morris	190,765	16,356	8.6%
Ocean	279,989	32,226	11.5%
Passaic	176,433	12,792	7.3%
Salem	27,619	2,886	10.4%
Somerset	124,672	10,761	8.6%
Sussex	62,184	7,372	11.9%
Union	200,708	14,582	7.3%
Warren	45,266	4,311	9.5%

Source: American Community Survey 5-Year Estimates, 2015

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.

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



Source: American Community Survey 5-Year Estimates, 2015

5.22.3 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.

5.22.4 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.

Figure 5.22-3 Northeast Before 2003 Blackout

Figure 5.22-4 Northeast During 2003 Blackout

Source: NOAA, 2003

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.

2011 Hurricane Irene

According to the New Jersey Board of Public Utilities (NJBPU), 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

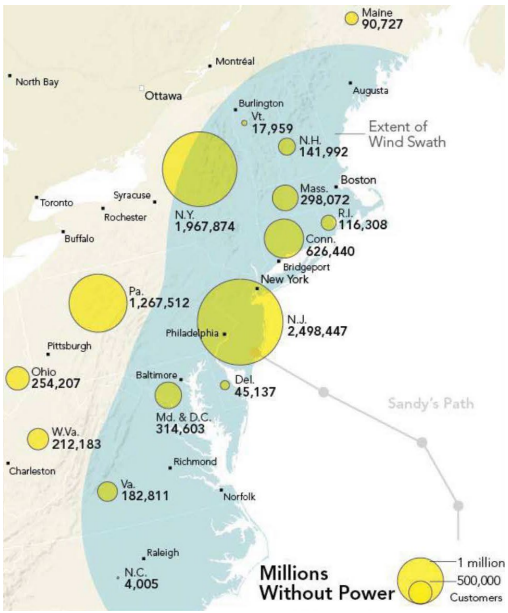
Table 5.22-2 New Jersey Customer Outages from Superstorm Sandy

Date	Customer Outages
10/30/2012	2,498,447
10/31/2013	2,040,195
11/1/2013	1,733,202
11/2/2013	1,587,584
11/3/2013	1,284,381
11/4/2013	968,613
11/5/2013	756,774
11/6/2013	537,089
11/7/2013	383,143

Source: United States Department of Energy, 2012

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, 2012). 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 were able to receive electricity had power restored due to Superstorm Sandy and the subsequent Nor'easter.

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



Source: Huffington Post, 2012

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.

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
11/9/1965	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.
7/14/1977	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	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.
8/14/2003	Northeast	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.

Date(s) of Event	Event Type	Counties Impacted	Description
3/14/2010	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.
11/7/2012	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.
1/31/2013	High Wind	Camden, Monmouth, Ocean, Middlesex, Mercer	Strong to high winds occurred across New Jersey from the middle of the evening on the 30th into the early afternoon of the 31st in New Jersey. Peak wind gusts reached between 45 mph and 65 mph and downed weak trees, tree limbs and power lines and caused power outages. Approximately 20,000 homes and businesses lost power. The wind damage was exacerbated by isolated severe thunderstorms that moved through the central part of the state during the early morning on the 31st. PSE&G reported about 11,000 outages across New Jersey, 3,400 of them in Burlington County. Power was expected to be fully restored later in the day on the 31st
February 8-9, 2013	Winter Weather	Northern New Jersey	scattered power outages were reported, mainly in the northern portion of the state, with service restored by Saturday afternoon.
6/24/2013	Thunderstorm Wind	Burlington	A severe thunderstorm knocked down a couple of trees in Southampton Township. The combination of lightning strikes and damaging winds caused some power outages.
7/7/2013	Thunderstorm Wind	Morris	Thunderstorms that tracked across Morris County dropped hail and produced damaging winds, resulting in downed trees and power lines. Approximately 5,500 customers in Mine Hill Township, Roxbury Township, and nearby areas lost power as a result of the thunderstorms during the evening of the 7th. With power outages continuing, Mine Hill and Roxbury Townships opened air-conditioned community centers and town halls for residents who needed to cool down from the ongoing heat and humidity or recharge electronic devices. There were still about 2,500 homes and businesses without power on the afternoon of the 8th.
7/28/2013	Thunderstorm Wind	Hunterdon	An approaching cold front triggered thunderstorms that caused isolated wind damage as well as power outages in New Jersey on the 28th. About 3,000 Atlantic City Electric customers lost power.

Date(s) of Event	Event Type	Counties Impacted	Description
12/14/2013	Winter Weather	Camden, Gloucester, Burlington	A series of low pressure systems combined with a high-pressure system passing across nearby Canada to bring a winter storm of snow, sleet and freezing rain from the morning into the overnight on the 14th. Snowfall averaged 4 to 7 inches in northwest New Jersey, 3 to 6 inches in the Raritan Basin and Monmouth County and around an inch in southwest New Jersey. Ice accumulations averaged one-quarter of an inch in northwest and west central New Jersey and around one-tenth of an inch in southwest New Jersey. The combination caused extremely difficult traveling conditions as well as isolated power outages.
2/3/2014	Winter Weather	Camden, Ocean, Burlington	The heavy, wet snow tore down weak tree limbs and power lines and caused power outages as about 6,500 homes and businesses lost power.
2/5/2014	Winter Weather	Statewide	A major winter storm brought heavy snow and sleet to northwest New Jersey and a wintry mix which included a significant accumulation of ice to the central third of New Jersey. Snowfall reached one foot in Sussex County and ice accumulations were as high as half an inch. The snow that was still on the trees from the just concluded winter storm was a major contributing factor to the power outages. The weight of the snow, then sleet and freezing rain on limbs all collaborated to cause more tree damage then would have occurred if trees were bare at the start of the event. It was the worst ice related outages in the Public Service Electric and Gas's service area since 1999. Public Service Electric and Gas reported about 110,000 of its customers lost power with Mercer, Burlington and Middlesex Counties most affected. Power was fully restored late in the day on the 7th. Jersey Central Power and Light reported about 44,000 of its customers lost power with Middlesex and Monmouth Counties most affected. Power was fully restored on the afternoon of the 6th. One of the hardest hit municipalities with outages was Lambertville as 40 percent of the city lost power. Atlantic City Electric reported about 2,000 of its customers lost power.
4/15/2014	Strong Wind	Atlantic, Cape May, Ocean, Gloucester, Burlington, Sussex	Strong winds affected New Jersey on the 15th. Peak wind gusts averaged around 40 mph, with some locally higher gusts mainly in the southeast and northwest parts of the state. In southeastern New Jersey the highest wind gusts occurred during the middle of the day in the southwest flow preceding a cold front. In the rest of the state the highest wind gusts occurred following a cold frontal passage during the second half of the afternoon into the early evening on the 15th. The strong winds coupled with the rain knocked down some weak tree limbs and wires and caused isolated power outages
July 8-10, 2014	Thunderstorm Wind	Statewide	A hot and humid air mass and a lee side trough helped trigger a squall line of strong to severe thunderstorms that moved through New Jersey during the evening of the 8th. The worst wind damage occurred across the central third of the state. About 80,000 homes and businesses lost power in the state. Hardest hit counties were Burlington, Gloucester and Monmouth. About 15,200 homes and businesses were without power on the morning of the 9th and 5,500 overnight on the 9th. Power was fully restored on the 10th.
11/26/2014	Winter Weather	Hunterdon, Mercer, Middlesex, Somerset	A winter storm on the 26th, the day before Thanksgiving Day, dropped heavy snow over parts of northwest New Jersey and caused power outages as well as additional traveling difficulties.

Date(s) of Event	Event Type	Counties Impacted	Description
12/9/2014	Winter Weather	Sussex	A wintry mix of sleet and freezing rain occurred at the onset of precipitation associated with a strong nor'easter during the morning of the 9th.Icy conditions were reported throughout most of Sussex and Warren Counties as well as parts of western Morris County and northern Hunterdon County. Schools in Hackettstown (Warren County) had delayed openings. Isolated power outages were reported in Sussex County
January 4-5, 2015	Strong Wind	Burlington, Atlantic, Cape May, Ocean	A strong cold frontal passage brought strong winds in its wake into New Jersey during the evening and overnight on the 4th. The strongest winds occurred in eastern New Jersey and over the higher terrain of northwest New Jersey. Peak gusts in those locations averaged 50 to 55 mph, while elsewhere most peak gusts were between 40 and 45 mph. The strong winds knocked down weak tree limbs, trees and wires and caused isolated power outages
2/2/2015	Strong Wind	Statewide	Strong, gusty northwest winds occurred in the wake of a departing and intensifying low pressure system during the late afternoon into the middle of the evening on the 2nd in New Jersey. Peak wind gusts average around 50 mph and knocked down weak trees, tree limbs and wires. Scattered power outages occurred.
February 12-13, 2015	Strong Wind	Atlantic, Cape May, Ocean, Sussex	Strong gusty northwest winds occurred behind a secondary cold frontal passage in New Jersey during the evening and overnight on the 12th. Peak wind gusts averaged around 55 mph over the higher terrain of Sussex County, around 50 mph along the immediate coast of central and southern New Jersey and 30 to 40 mph elsewhere. Where the strongest winds occurred, some weak tree limbs and power lines were knocked down and isolated power outages occurred
2/15/2015	Strong Wind	Camden, Gloucester, Salem, Cumberland, Atlantic, Cape May, Ocean, Burlington,	Strong to high winds caused isolated property damage (mainly stripped siding), knocked down or snapped numerous trees and tree limbs. This resulted in downed wires and power outages. About 5,000 homes and businesses lost power, mainly in southeast New Jersey. Nearly all power was restored on the evening of the 15th.
3/1/2015	Winter Weather	Southern New Jersey	Ice accumulations on exposed surfaces reached as high as around one-third of an inch in the southern half of the state and caused scattered power outages
3/17/2015	Strong Wind	Monmouth, Middlesex	Gusty northwest winds following a cold frontal passage affected locations near and along Raritan Bay in New Jersey during the late afternoon and early evening on the 17th. Peak wind gusts averaged 45 to 50 mph and knocked down weak tree limbs and wires and caused isolated power outages.
3/20/2015	Winter Weather	Central New Jersey	The heaviest snow fell in the central third of the state. It was a heavy, wet snow and the snow did knock down some weak trees and tree limbs and caused isolated power outages in central New Jersey, primarily in Burlington County. About 100 homes and businesses were still without power on the morning of the 21st.
October 2-3, 2015	High Wind	Southern and Central New Jersey	In Pennsville (Salem County), a large falling tree limb was the cause of a major power outage that left more than 3,300 Atlantic City Electric customers in the dark for a couple of hours the evening of the 2nd. Other scattered power outages also occurred across portions of southern to central New Jersey during the height of the storm on the 2nd and 3rd.

Date(s) of Event	Event Type	Counties Impacted	Description
2/16/2016	Thunderstorm Wind	Cumberland, Salem	Severe wind gusts associated with a cold front moving through the area knocked down trees and caused power outages.
2/24/2016	Thunderstorm Wind	Burlington	Several trees and wires down with power outages throughout the county.
7/25/2016	Thunderstorm Wind	Middlesex	Trees taken down due to thunderstorm winds leading to power outages.
1/24/2017	Winter Weather	Morris, Warren	Power outages from the storm were estimated at around 20,000.
2/13/2017	High Wind	Sussex, Morris	High winds blew through the area after a cold frontal passage, enough to lead to downed trees and wires during the day of the 13th and from a severe squall line early on the 13th. Several thousand power outages were reported with some lasting 24 hours in Sussex and Morris counties.
3/14/2017	Blizzard	Bergen, Essex, Passaic, Union, Hudson	Heavy snow and sleet along with strong winds occurred across the rest of Northeast New Jersey. Large trees fell onto homes in Bergen county and approximately 4,500 power outages resulted from the strong winds and heavy snow.

Source: NOAA NCDC, 2017

5.22.4.1 FEMA DISASTER DECLARATIONS

Between 1954 and 2017, 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 5.22-4 illustrates the number of FEMA disaster declarations by county.

Table 5.22-4 FEMA Power-Outage-Related Disaster Declarations (1954 to 2017)

Disaster Number	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	Impacted Number of Counties
EM-3188	New Jersey Power Outage	9/23/2003	8/14/2003 to 8/16/2003		X					X		X							X				X		5

Source: FEMA, 2017

Figure 5.22-6 FEMA Power Outage-Related Disaster Declarations by County

5.22.5 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. As shown in Table 5.22-3, it can be anticipated that multiple power outage events caused by natural hazards can happen in a year. It is more difficult to predict the probability of power outages caused by technical error. 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.

5.22.5.1 POTENTIAL EFFECTS OF CLIMATE CHANGE

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).

Several implications for climate change are related to the power failure hazard. The frequency and intensity of severe weather and drought may increase as climate changes. These changes in weather patterns can cause damage or weaken New Jersey's power infrastructure.

5.22.6 IMPACT ANALYSIS

5.22.6.1 SEVERITY AND WARNING TIME

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.

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.

5.22.6.2 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 works 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.

5.22.6.3 ENVIRONMENTAL IMPACTS

Power failures are particularly critical at locations where the environment and public safety are at risk. Facilities such as hospitals, sewage treatment plans, 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.

5.22.7 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.

5.22.7.1 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. Refer to Table 5.22-1 and Figure 5.22-2 above for details on vulnerability based on location.

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.

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.

5.22.7.2 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 5.2.1).

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.

5.22.7.3 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.

5.22.7.4 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.

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