

The background of the slide features a large, faint watermark of the Rutgers University seal. The seal is circular and contains the text "RUTGERS UNIVERSITY" around the perimeter and "EST. 1823" at the bottom. The seal is centered and occupies most of the slide's background.

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Edward J. Bloustein School
of Planning and Public Policy

Weather related Power Outages in New Jersey

Feb 27, 2014

Center for Energy, Economic and Environmental Policy (CEEPP)

Agenda

1. Approach for Analysis

A. Literature Search on Past Research

2. Storm Events Database Compilation

A. Main Sources used for Database Creation

B. Limiting Factors

C. Definitions

3. Data & Findings

1. Approach for Analysis

A. Literature Search on Past Research

- Richard J. Campbell. Weather-Related Power Outages and Electric System Resiliency. Congressional Research Service, August 2012.
<http://www.fas.org/sgp/crs/misc/R42696.pdf>
- P. Hines and S. Talukdar, Trends in the History of Large Blackouts in the United States. Energy Policy v. 37, pp. 5249-5259, 2009.
http://www.uvm.edu/~phines/publications/2008/Hines_2008_blackouts.pdf

2. Storm Events Database Compilation

A. Main sources used by CEEEP for database creation (1/3)

- **NOAA Storm Events Database**
 - Used as starting point for fields of data to be collected (date, event details, storm “type” wind speed, precipitation, and number of outages)
- **Bayshore Regional Watershed Council: *New Jersey’s Most Notable Storms* Website**
 - Listed mainly hurricanes and tropical storms to effect NJ; used as a guideline for investigating information on larger storms
- **National Oceanic and Atmospheric Administration Miami Regional Library: Monthly Weather Review**
 - Database with PDF monthly details of storms; provided extraneous details for most noteworthy storms

2. Storm Events Database Compilation

A. Main sources used by CEEEP for database creation (2/3)

- Data from NOAA's "Storm Events Database" was mainly used because of its attention to detail and ability to sort events by year, month, and day for the state of New Jersey; as well as by storm "type", and a county- or zone-based (regional) filter
 - The range of dates for this data set is 1/1/1996 – 5/25/2013
- Resources to complement this data set include: Bayshore Regional Watershed Council web resource of notable NJ storms (Volunteer advocacy organization dedicated to the restoration and conservation of Raritan & Sandy Hook Bays), and the NOAA Miami Regional Library Monthly Weather Review (American Meteorological Society)
 - Both online sources provided basic information and dates that could be researched further through the NOAA Storm Events Database and DOE online resources

2. Storm Events Database Compilation

A. Main sources used by CEEP for database creation (3/3)

- Search parameters could be narrowed to New Jersey, begin/end date, event type, and county. Event types could be specified or a dichotomous choice was provided: Zone Based Events or County Based Events (as seen in the chart below).



Storm Events Database

Enter Search Parameters for NEW JERSEY

Data available from: 01/1996 to 06/2013

Begin Date: 08 / 01 / 2005 (mm/dd/yyyy)

End Date: 09 / 05 / 2005 (mm/dd/yyyy)

Event Type: Select Event Type... [More Information...](#)

County: ALL (or equivalent)

- ATLANTIC
- BERGEN
- BURLINGTON
- CAMDEN
- CAPE MAY
- CUMBERLAND

(an unlisted county means that no records are present)

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Zone Based Events (Z)	County Based Events (C)
Blizzard	Dust Devil
Coastal Flood	Flash Flood
Cold Wind/Chill	Flood
Excessive Heat	Funnel Cloud
Extreme Cold/Wind Chill	Hail
Heat	Heavy Rain
Heavy Snow	Lightning
High Surf	Thunderstorm Wind
High Wind	Tornado
Hurricane (Typhoon)	
Ice Storm	
Rip Current	
Sleet	
Storm Surge/Tide	
Strong Wind	
Tropical Depression	
Tropical Storm	
Winter Storm	
Winter Weather	

2. Storm Events Database Compilation

B. Limiting Factors

- Use of available electronic resources
 - Events in the database were found through: NOAA, Bayshore Regional Storm events and subsequent outage reporting were found through online databases and archives – thus our own knowledge and findings are limited to the capacity in which these events were recorded.
- Timeline of recorded events
 - We found power outages were reported in more detail since 1980; prior decades have significantly less reports available online or at all.
 - The NOAA Storm Events Database, which provided data for a great number of the events included is limited to the years 1996-2013, and thus skews the data set to show more events in this time period . Thus, we cannot comment on any frequency of events over the entire time period included.

2. Storm Events Database Compilation

C. Definitions (1/2)

- Storms classified into one of 6 categories: Wind/Rain, Winter Weather/Nor'easter, Tornado, Ice Storm, Lightning, Tropical Storms/Hurricanes*.
 - *Storms were either classified by NOAA or details provided through other electronic sources gave a narrative perspective of each storm that generally included indicators such as wind speeds, precipitation type, as well as other factors. Timeline of recorded events
- From the data sorted by storm type, the total number of events for were tallied, along with the total number of customers that were reported to have lost power for that event type.

2. Storm Events Database Compilation

C. Definitions (2/2)

- All of the outages reported are sustained¹ outages.
- Events collected were 1000 or more outages per a weather event.
- “Major” events are defined as 100,000 or more outages per a weather event.

¹*Sustained outages are characterized by Richard Campbell as “sustained duration outages lasting longer than five minutes (and extending to hours or days) ” (Campbell 3).*

Agenda

1. Approach for Analysis

A. Literature Search on Past Research

2. Storm Events Database Compilation

A. Main Sources used for Database Creation

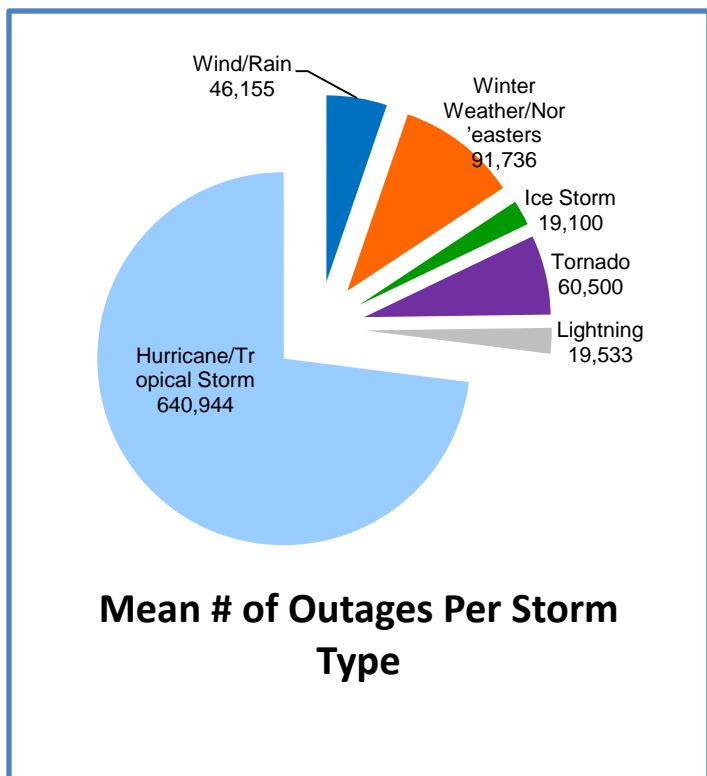
B. Limiting Factors

C. Definitions

3. Data & Findings

3. Data and Findings

A. Breakdown of Storm Event “Types” and their respective Mean Outages (1985 – 2013)



	# of Total Events	# of Cumulative Affected Customers	% of reported events	Mean size of customer outages
Wind/Rain	96	4,430,900	67.1	46,155
Winter Weather/Nor'easters	22	2,018,200	15.4	91,736
Ice Storm	5	95,500	3.5	19,100
Tornado	2	121,000	1.4	60,500
Lightning	9	175,800	6.3	19,533
Hurricane/Tropical Storm	9	5,768,500	6.3	640,944
Totals	143	12,609,900		

Table 1: Database storm event totals and proportion of storm types/mean outages; from CEEEP Storm Events Database)

Outages refer to outage for a meter and not for a consumer

3. Data and Findings

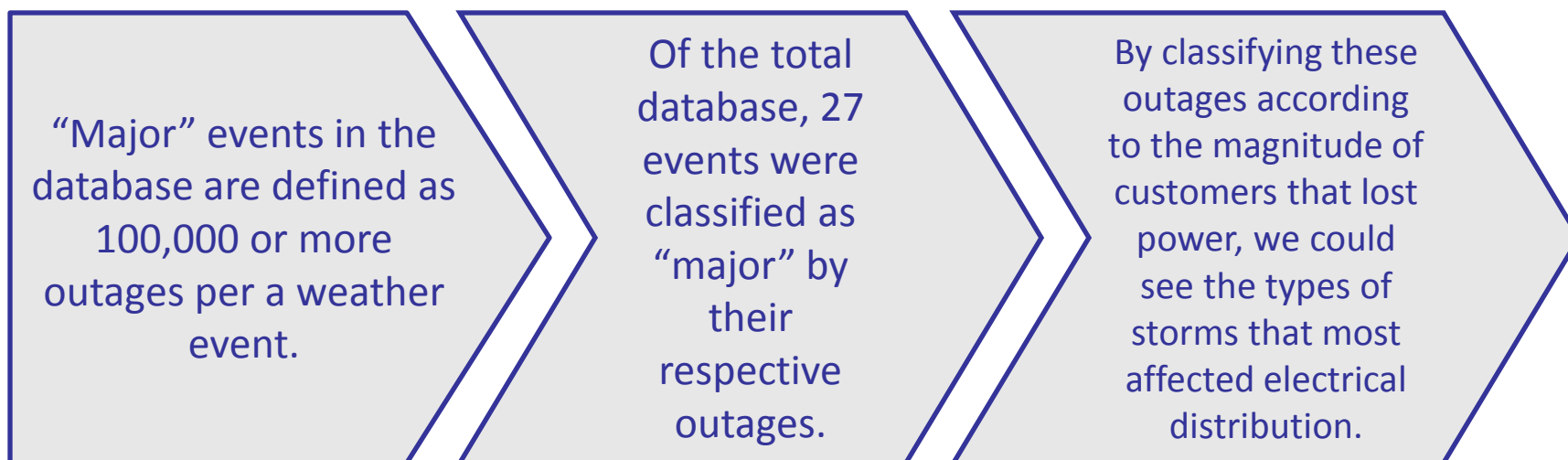
B. Breakdown of Storm Event “Types” and their respective Mean Outages (1985 – 2013)

<i>All Storms – Outages: 1985 - 1995</i>			<i>All Storms – Outages: 1996 - 2013</i>		
Storm Type	Total # of Storms	Total # Outages	Storm Type	Total # of Storms	Total # Outages
Hurricane/ Tropical Storm	2	277,000	Hurricane/ Tropical Storm	7	5,491,500
Winter Weather/ Nor'easter	2	140,000	Winter Weather/ Nor'easter	20	1,878,200
Wind/Rain	Not Reported	Not Reported	Wind/Rain	96	4,430,900
Ice Storm	Not Reported	Not Reported	Ice Storm	5	95,500
Tornado	Not Reported	Not Reported	Tornado	2	121,000
Lightning	Not Reported	Not Reported	Lightning	9	175,800
Total	6	417,000	Total	139	12,192,900

No consistent data available over long period in the way that storms have been reported. The reporting of outages for more types of storms is apparent in these two year brackets.

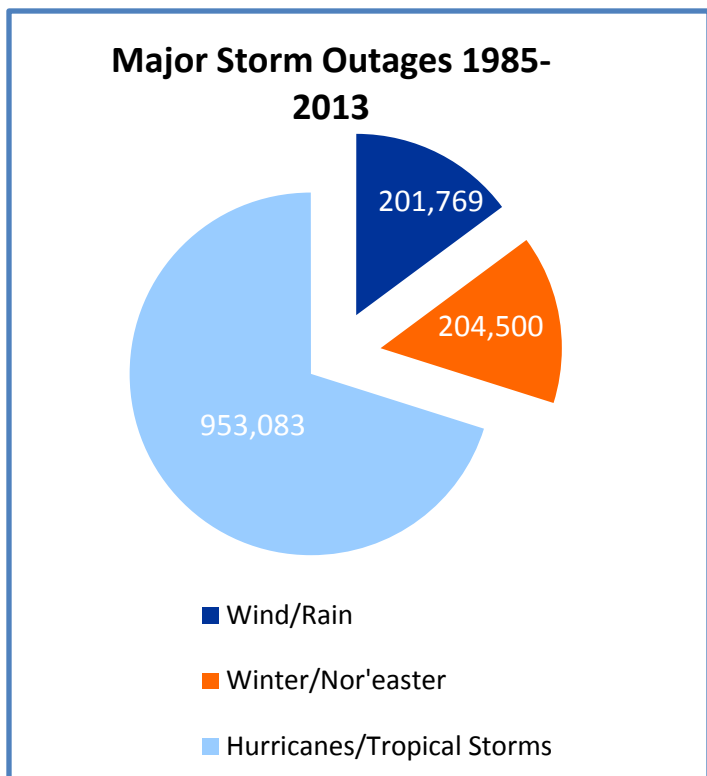
3. Data and Findings

C. “Major Storms” 1985 – 2013: 100,000 + outages reported/ event



3. Data and Findings

D. “Major Storms” 1985 – 2013: 100,000 + outages reported/ event



	# of Major Storms	# of Cumulative Affected Customers	% of Major events	Mean size of customer outages
Wind/Rain	13	2,623,000	48.2	201,769
Winter Weather/Nor'easters	8	1,636,000	29.6	204,500
Hurricane/Tropical Storm	6	5,718,500	22.2	953,083
Totals	27	9,977,500		

Table 2: “Major” Storms and their outages (by totals, proportion, and mean outages); from CEEEP Storm Events Database)

3. Data and Findings

E. What is a Hurricane/ Tropical Storm?

A hurricane is a type of tropical cyclone – an organized rotating weather system that develops in the tropics. Hurricanes rotate counterclockwise in the Northern Hemisphere.

Tropical cyclones are classified as follows:

- Tropical Depression—An organized system of persistent clouds and thunderstorms with a closed low-level circulation and maximum sustained winds of 38 mph (33 knots) or less.
- Tropical Storm—An organized system of strong thunderstorms with a well defined circulation and maximum sustained winds of 39 to 73 mph (34-63 knots).
- Hurricane—An intense tropical weather system with a well defined circulation and sustained winds of 74 mph (64 knots) or higher. In the western North Pacific, hurricanes are called typhoons, and similar storms in the Indian Ocean are called cyclones.

Courtesy of U.S Department of Commerce, A Preparedness Guide "Hurricanes: Unleashing Nature's Fury. August 2001

3. Data and Findings

F. Defining Storm Impact Terminology

➤ Direct Hit

- A close approach of a tropical cyclone to a particular location. For locations on the left-hand side of a tropical cyclone's track (looking in the direction of motion), a direct hit occurs when the cyclone passes to within a distance equal to the cyclone's radius of maximum wind. For locations on the right-hand side of the track, a direct hit occurs when the cyclone passes to within a distance equal to twice the radius of maximum wind.

➤ Indirect Hit

- Generally refers to locations that do not experience a direct hit from a tropical cyclone, but do experience hurricane force winds (sustained or gusts) or tides of at least 4 feet above normal.

➤ Landfall

- The intersection of the surface center of a tropical cyclone with a coastline. Because the strongest winds in a tropical cyclone are not located precisely at the center, it is possible for a cyclone's strongest winds to be experienced over land even if landfall does not occur. Similarly, it is possible for a tropical cyclone to make landfall and have its strongest winds remain over the water.

Courtesy of National Weather Service, National Hurricane Center: Glossary of NHC Terms. <http://www.nhc.noaa.gov/aboutgloss.shtml>

3. Data and Findings

G. Saffir-Simpson Hurricane Wind Scale

Saffir-Simpson Hurricane Wind Scale		
Category	Sustained Winds	Types of Damage Due to Hurricane Winds
1	74-95 mph	Very dangerous winds will produce some damage: Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110 mph	Extremely dangerous winds will cause extensive damage: Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3	111-129 mph	Devastating damage will occur: Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4	130-156 mph	Catastrophic damage will occur: Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5	157 mph or higher	Catastrophic damage will occur: Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Courtesy of National Weather Service, National Hurricane Center: Saffir-Simpson Hurricane Wind Scale.
<http://www.nhc.noaa.gov/aboutsshws.php>

3. Data and Findings

H. Hurricanes/ Tropical Storms in NJ

- Despite accounting for only a relatively small percentage of the types of weather-related events that have caused power outages in the state since 1985, hurricanes and tropical storms show a considerable number of mean customer outages (as seen in the previous charts).
- Using data retrieved from the Bayshore Regional Watershed Council online resource entitled “List of New Jersey’s Most Notable Storms” and additional online sources*, we have cited **36 hurricanes and tropical storms** that have affected New Jersey in various capacities – as remnants of the storm to high levels of precipitation and winds - **since 1985 to present day**, an average of 1.3 hurricanes or tropical storms per year over that span of time.

**Number based on data/observations by Bayshore Regional Watershed Council up to 2007, along with United States National Oceanic and Atmospheric Administration’s National Weather Service, National Climatic Data Center, and the National Weather Service Weather Prediction Center.*

3. Data and Findings

I. Hurricanes/ Tropical Storms in NJ

- While some of these 36 hurricanes/tropical storms reported minor electricity distribution impact - including little to no major power loss to customers - our database compilation included **9 total with reported power outages at 1000 or more**, and classified **6 as “major” with over 100,000 outages** (many of the 6 exceeding this number).
- Thus major hurricanes/tropical storms average at .21 per year over the 28 year span of 1985-2013.
- These **6 major storms** accounted for an estimated total of **5,717,800** reported outages over the course of 1985-2013, **averaging to 952,966 per storm**.

3. Data and Findings

J. Major 6 Hurricanes/ Tropical Storms (1/2)

Name	Date	Description	Max # of Outages	Estimated Outage Duration
Hurricane Gloria	9/27/1985	Hurricane Gloria paralleled the New Jersey coastline just offshore as a Category 2 hurricane. Its arrival forced 95,000 citizens to evacuate, while eleven casinos in Atlantic City closed, resulting in a loss of \$7 million (1985 USD). Dubbed by some as the storm of the century, the hurricane was expected to become the first hurricane to hit the New Jersey coastline since the hurricane in 1903, though a last minute turn spared the state. Strong winds downed trees and power lines, leaving 237,000 without power after the storm.	237,000	Up to 5 days
Hurricane Floyd	9/17/1999	Hurricane Floyd crossed the entire state as a tropical storm, unleashing torrential rainfall amounting to a maximum of 13.34 inches in Somerville. The combination of the heavy rain that loosened the ground and the persistence of the strong winds uprooted hundreds of trees. Strong wind gusts left over 650,000 citizens without power during the storm's passage. - 616,400 homes and businesses lost power up to 5 days.	650,000	Up to 5 days
Hurricane Isabel	9/19/2003	The winds from Isabel downed hundreds of trees and power lines across New Jersey, leaving hundreds of thousands without power. Tropical Storm Isabel produced strong power outage producing winds, moderate tidal flooding along the Delaware Bay and the Delaware River and erosion and rough surf along the shore. Winds gusted up to 62 mph in New Jersey and downed countless numbers of trees, tree limbs and power lines. It was one of the worst power outages on record for area utilities. Jersey Central Power and Light reported that 220,000 of its customers lost power while Conectiv Energy reported about 162,000 of its customers lost power.	382,000	3-5 days

3. Data and Findings

J. Major 6 Hurricanes/ Tropical Storms (2/2)

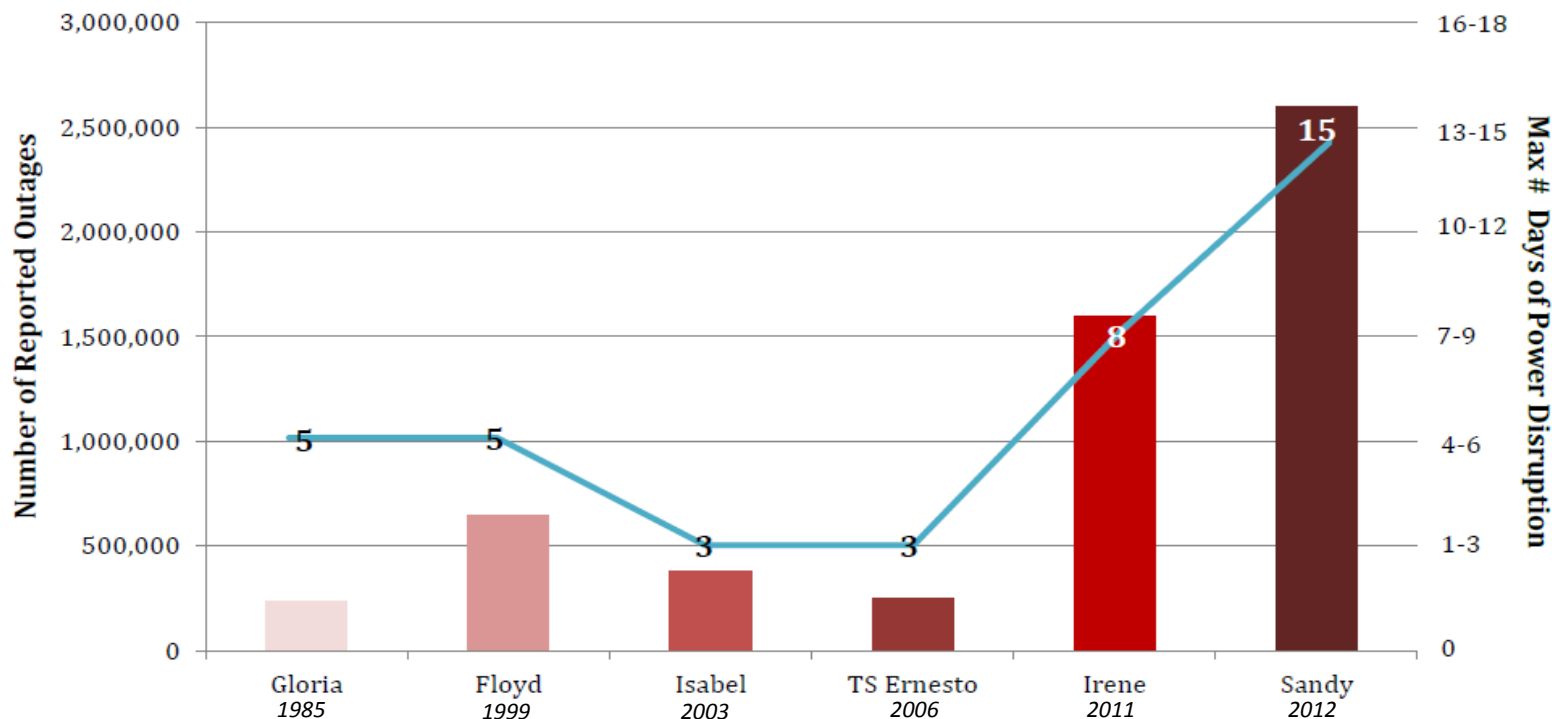
Name	Date	Description	Max # of Outages	Estimated Outage Duration
Tropical Storm Ernesto	9/1/2006	The combination of the remnants of Tropical Storm Ernesto and a large high pressure system over eastern Canada produced heavy rain and flooding, strong and in some cases damaging winds, tidal flooding and beach erosion in New Jersey. Over 200,000 homes and businesses lost power with more than half of the outages in southeastern New Jersey's Atlantic City Electric Service area. All power was restored by the 5th.	249,500	3 days
Hurricane Irene	8/27/2011	Tropical storm force wind gusts overspread New Jersey during the late afternoon and evening of the 27th and persisted through the afternoon of the 28th. In total, approximately 1.6 million customers of JCP&L and PSE&G throughout the state lost power. Two days after the storm, 500,000 PSE&G customers were still without power, down from a peak of about 928,000. By September 3, thousands of JCP&L customers were still without service.	1,600,000	8 days
Hurricane Sandy	10/29/2012	Sandy produced record breaking outages, in the state, 2.7 million utility customers lost power, by far surpassing the record from Tropical Storm Irene in 2011. Public Service Electric and Gas alone had power lost to 1.4 million of its customers in the state, twice the number of its customers impacted by Irene. The utility reported about 48,000 trees had to be removed or trimmed to restore power and over 2,400 poles had to be replaced. Jersey Central Power and Light estimated that nearly 1.0 million of its customers lost power, about ninety percent of its customer base. It was unable to restore power to about 30,000 of its shore and barrier island customers because of massive infrastructure damage to those homes and businesses. Elsewhere in the state, power restoration was hampered by a nor'easter that occurred on November 7th. PSE&G restored all power on November 12th and JCP&L by November 14th.	2,600,000	15 days

3. Data and Findings

K. Comparing Hurricanes/ Tropical Storms Outages and Duration

Major Hurricanes and Tropical Storms in NJ

Storms Outages and Duration of Outages



References

- Bayshore Regional Watershed Council: *New Jersey's Most Notable Storms*
<http://www.bayshorewatershed.org/bw/Insiders%20Guide/List%20of%20New%20Jersey's%20Most%20Notable%20Storms/>
- National Weather Service, National Hurricane Center. <http://www.nhc.noaa.gov/aboutgloss.shtml>
- National Oceanic and Atmospheric Administration Miami Regional Library: *Monthly Weather Review* (American Meteorological Society), 1914-current. <http://www.aoml.noaa.gov/general/lib/>
- National Oceanic and Atmospheric Administration Storm Events Database.
<http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=34%2CNEW+JERSEY>
- National Oceanic and Atmospheric Administration Storm Surge and Coastal Inundation.
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<http://web.archive.org/web/20080226215213/http://www.srh.noaa.gov/fwd/wcm/hurric.pdf>

Thank You

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