



# Hurricane Preparedness and Experiences

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*Building Resilience by Reducing Infrastructure Vulnerability*

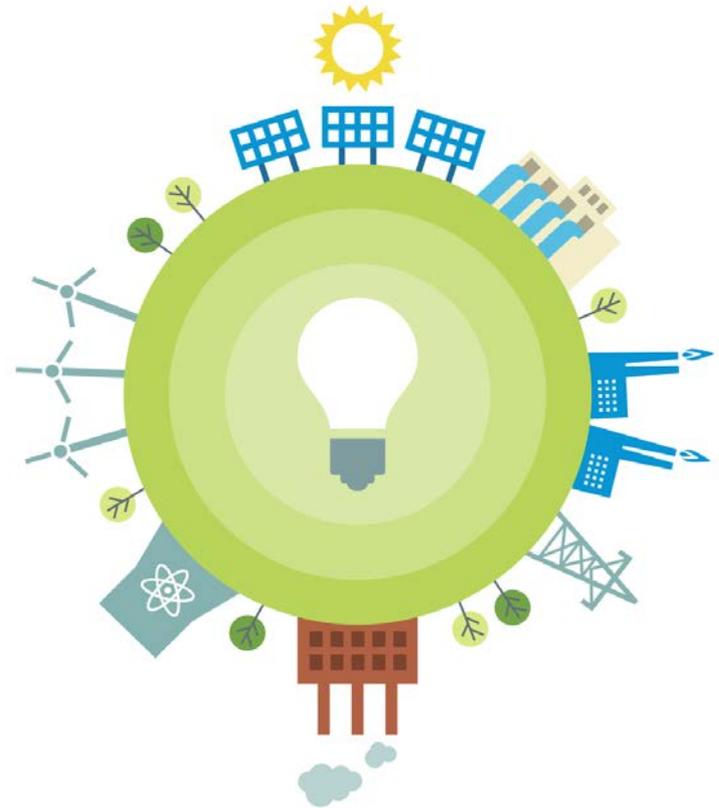
John Norden

DIRECTOR OPERATIONS



# Overview of Presentation

- About ISO New England
- Major Responsibilities
- Electric Grid At-a-Glance
- System Operations Responsibilities
- Hurricane Experiences
- Operating Procedures



# ISO New England (ISO) Has Two Decades of Experience Overseeing the Region's Restructured Electric Power System

- **Regulated by** the Federal Energy Regulatory Commission
- **Reliability coordinator** for New England under the North American Electric Reliability Corporation
- **Independent** of companies in the marketplace and neutral on technology



# Reliability Is the Core of ISO New England's Mission

*Fulfilled by three interconnected and interdependent responsibilities*

Managing  
comprehensive  
regional **power**  
system **planning**

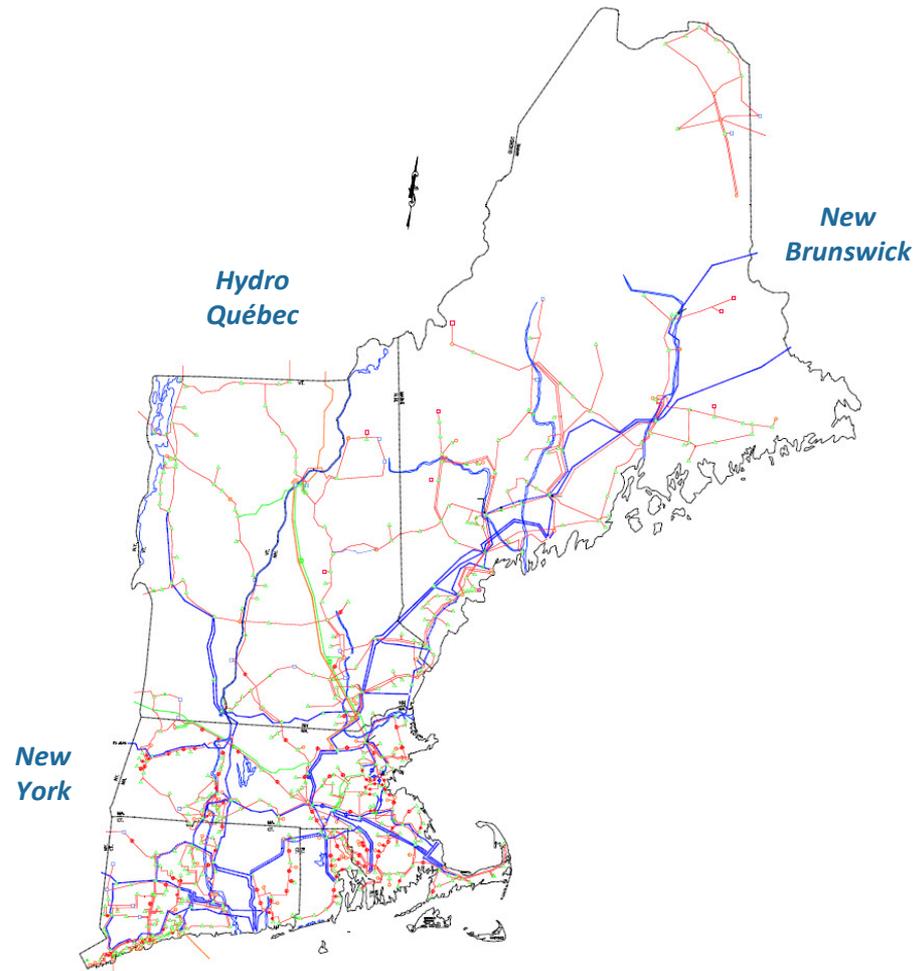


Overseeing the day-to-day  
**operation** of New England's  
electric power generation and  
transmission system

Developing and  
administering the region's  
competitive **wholesale**  
**electricity markets**

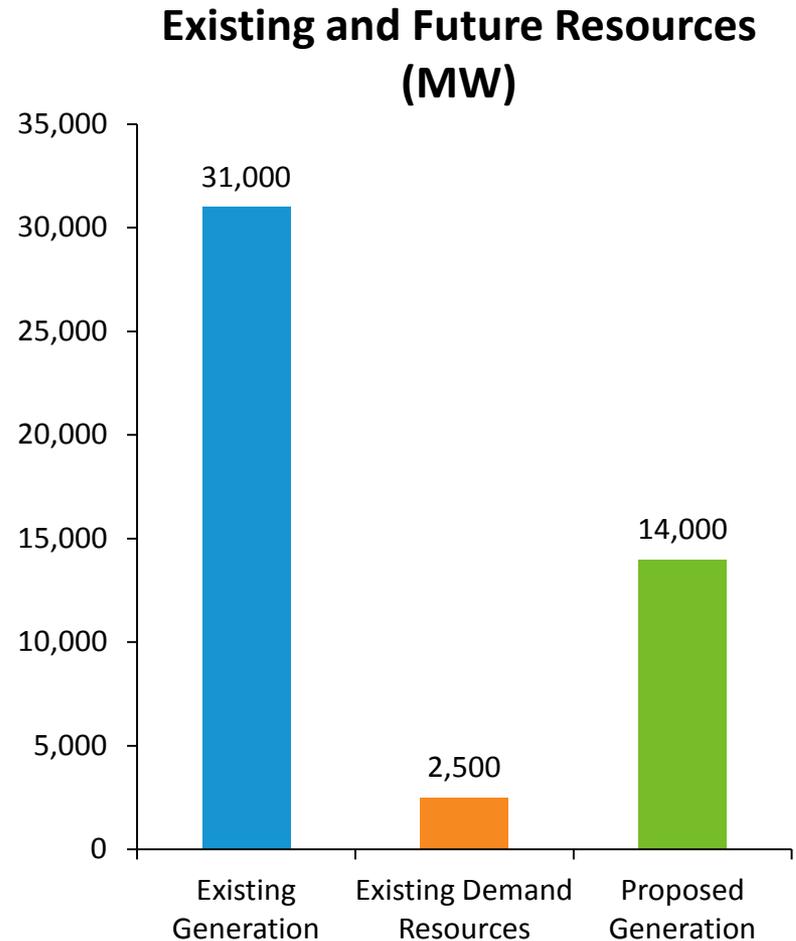
# New England's Transmission Grid Is the Interstate Highway System for Electricity

- **8,600 miles** of high-voltage transmission lines (115 kV and above)
- **13 transmission interconnections** to power systems in New York and Eastern Canada
- **16%** of region's energy needs met by imports in 2015
- **\$7.4 billion** invested to strengthen transmission system reliability since 2002; **\$4.6 billion** planned
- Developers have proposed multiple transmission projects to access non-carbon-emitting resources



# A Range of Generation and Demand Resources Are Used to Meet New England's Energy Needs

- **350** generators in the region
- **31,000 MW** of generating capacity
- **14,000 MW** of proposed generation in the ISO Queue
  - Mostly natural gas and wind
- **4,200 MW** of generation has retired or will retire in the next five years
- **600 MW** of active demand response and **1,900 MW** of energy efficiency with capacity supply obligations



# Summary of Responsibilities of System Operations

Protecting the Grid from Failure

Balancing Supply and Demand

Maintaining Transmission System Reliability



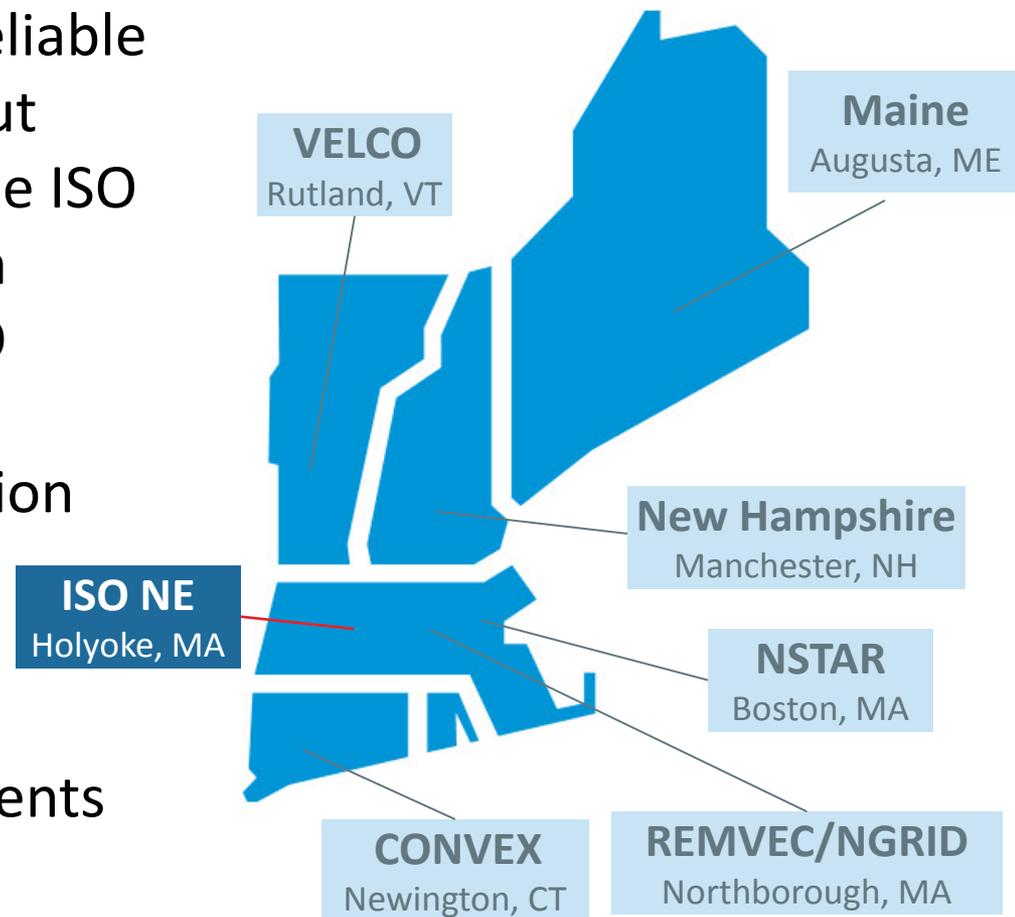
# ISO Control Room (Master Control Center)

- All system data must be processed for evaluation
- Staffed 24 hours per day
- Secure facilities
- In case of failure, the ISO has a back up control center



# ISO New England is the Region's Reliability Coordinator

- Local Control Centers (LCC) work with the ISO to maintain reliable grid operation and carry out directives received from the ISO
- Serve as backup for certain critical functions of the ISO
- Staffed 24 hours per day
- Evaluate detailed information about local conditions
- Identify the most limiting Local contingency
- Take transmission components out of service



# Storm Preparedness Prep List

- **Communications:**

- Daily conference calls and briefs with local control centers, NPCC, gas pipelines, nuclear plants, NOAA
- Communicate and coordinate action plans with appropriate stakeholders

- **Additional Staffing:**

- Additional Operators and Shift Supervisors stationed at Main Control Center
- Additional Operations Engineering, IT and Analytical Staff also on site throughout the storm
- Additional staff stationed at the Backup Control Center



# Storm Preparedness Prep List (continued)

- **Generation Readiness**

- All generator outages that can be cancelled and/or postponed are cancelled or postponed as necessary
- All stations requested to have fuel on hand for storm
- ISO's Principal Nuclear Coordinator contacts nuclear fleet to ensure readiness and preparations are in place
- Local Control Centers requested to confirm that black start facilities are notified to have fuel supplies available for extended runs



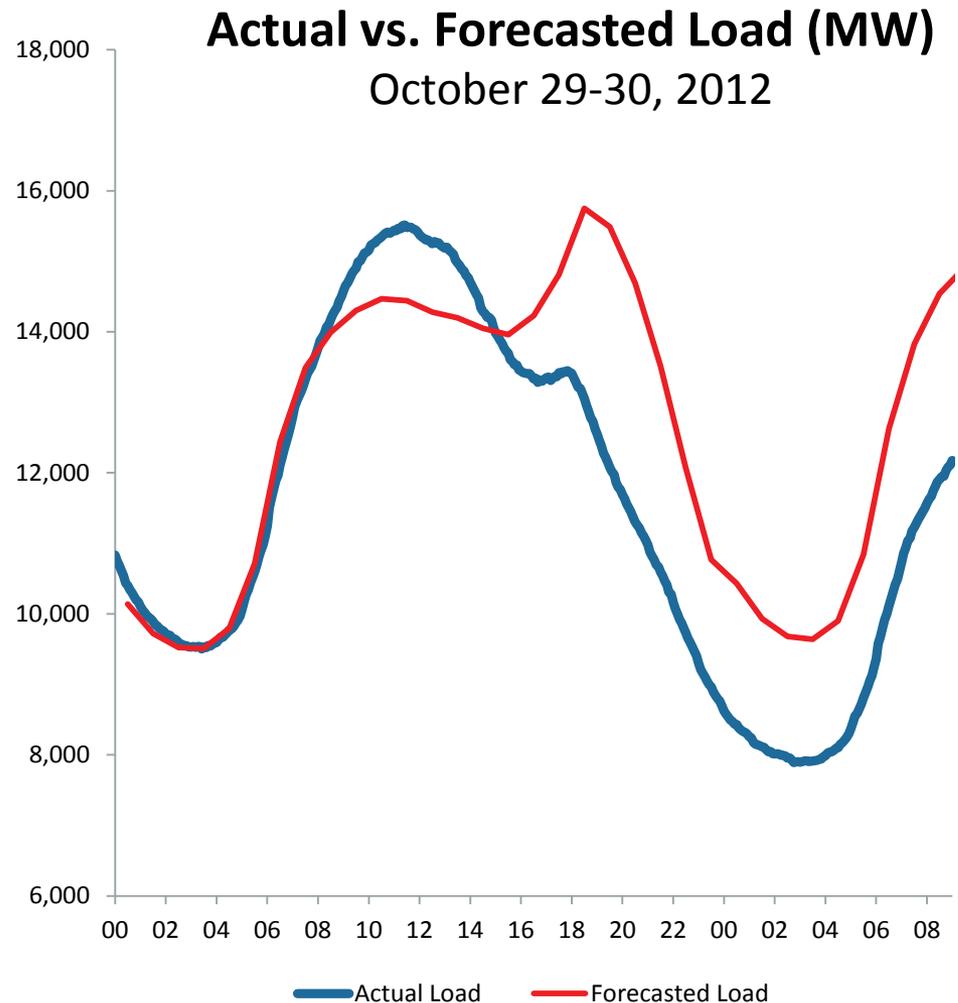
# Storm Preparedness Prep List (continued)



- **Transmission Readiness**
  - All transmission outages that can be postponed and/or cancelled are
  - ISO is in constant communication with neighboring system operators and the Northeast Power Coordinating Council via formal conference calls throughout event

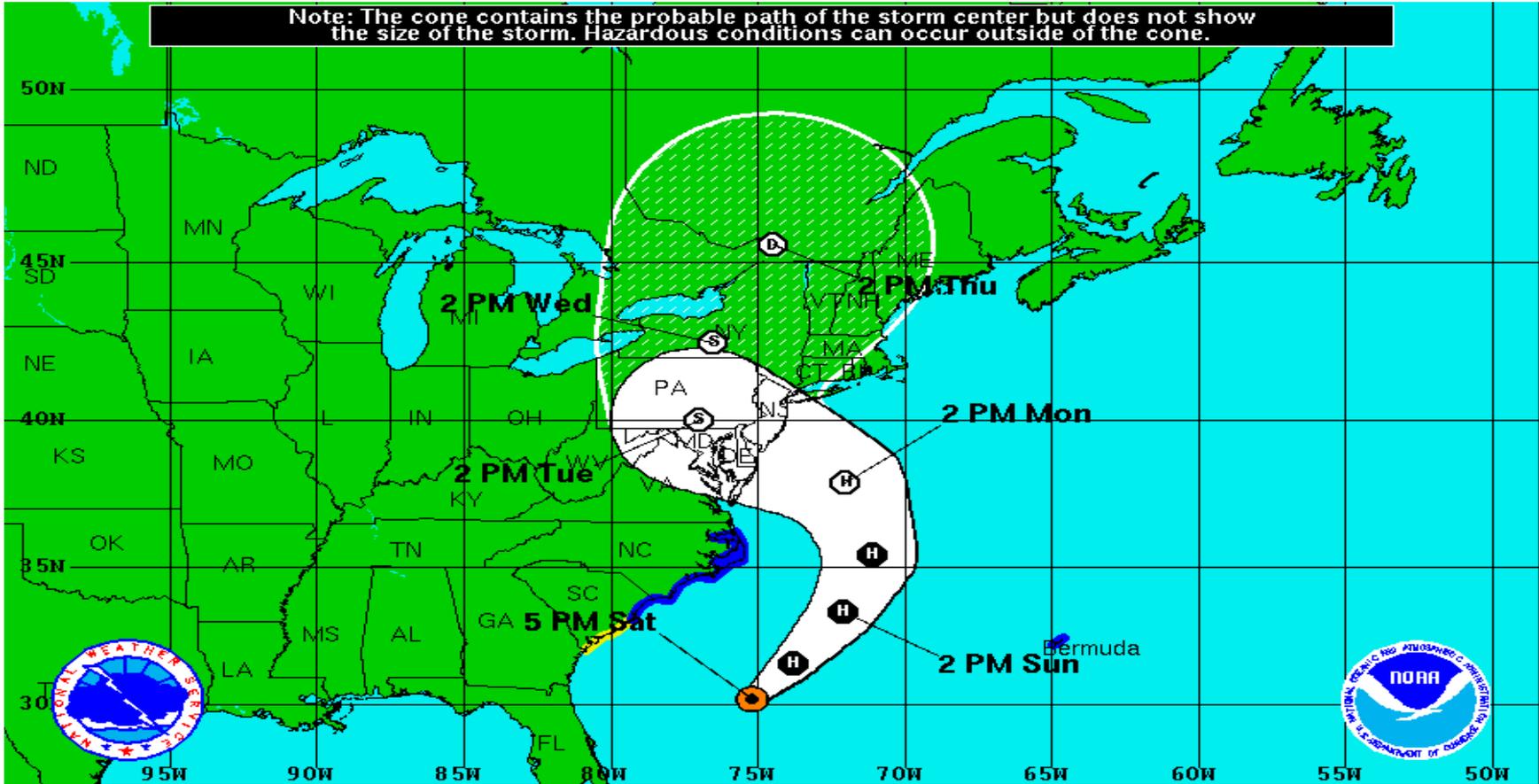
# Hurricane Sandy – October 29, 2012

- 1.4 million customers lost power at peak of the storm
- About 25% of region's load was lost during the storm
- 3,000 MW of generator outages – half remained for multiple days
- 70 transmission equipment outages, 36 of which were sustained outages
- **Bulk power system was operated reliably by local and regional operators and generators**



# Forecasted Weather Conditions, Sunday 10/29/12

Note: The cone contains the probable path of the storm center but does not show the size of the storm. Hazardous conditions can occur outside of the cone.

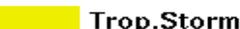


**Hurricane Sandy**  
 Saturday October 27, 2012  
 5 PM EDT Advisory 22  
 NWS National Hurricane Center

**Current Information:**   
 Center Location 30.2 N 75.2 W  
 Max Sustained Wind 75 mph  
 Movement NE at 13 mph

**Forecast Positions:**  
 Tropical Cyclone  Post-Tropical  
 Sustained Winds: D < 39 mph  
 S 39-73 mph H 74-110 mph M > 110mph

**Potential Track Area:**  
 Day 1-3  Day 4-5

**Watches:**  
 Hurricane  Trop.Storm

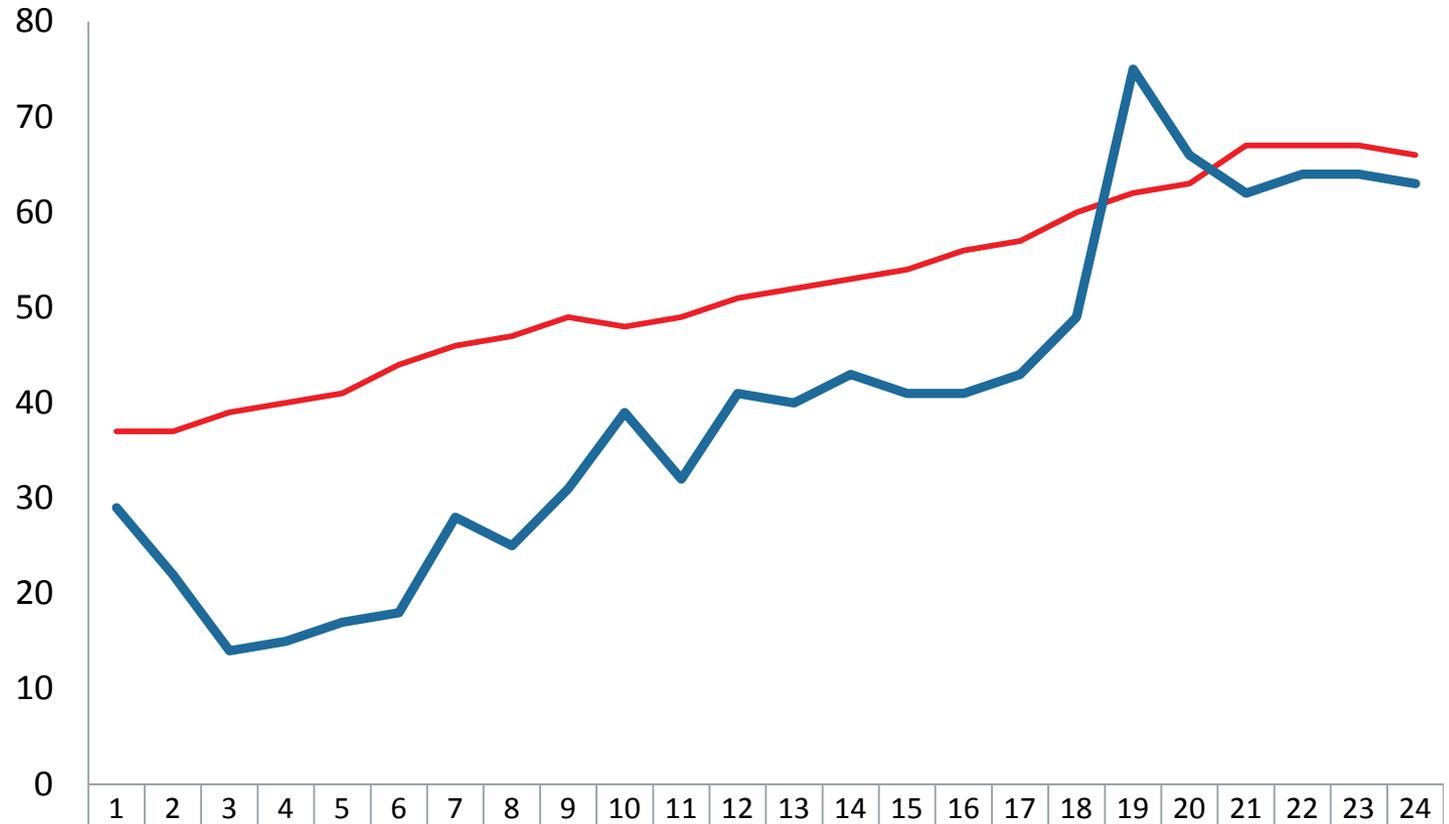
**Warnings:**  
 Hurricane  Trop.Storm

# Weather Conditions Actual, Sunday 10/29/12



# Wind Gusts Reached 75 MPH on the Connecticut Coast

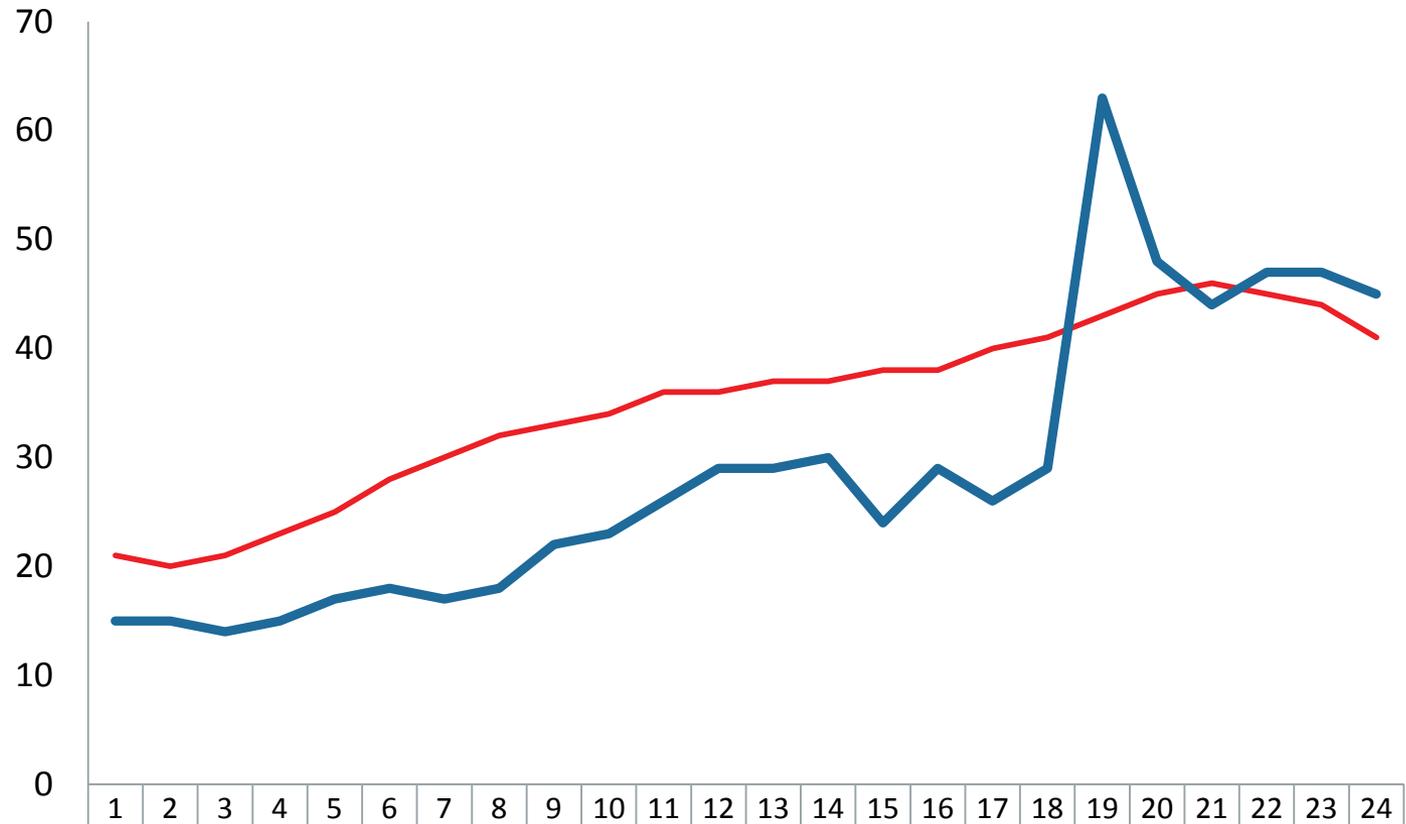
## 10/29/12 Wind Gust Speed: New Haven Forecast vs. Observed (MPH)



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
— New Haven Wind Gusts Forecast	37	37	39	40	41	44	46	47	49	48	49	51	52	53	54	56	57	60	62	63	67	67	67	66
— Wind Gusts Observed	29	22	14	15	17	18	28	25	31	39	32	41	40	43	41	41	43	49	75	66	62	64	64	63

# Observed Wind Speeds Exceeded Forecast

## 10/29/12 Wind Speed: New Haven Forecast vs. Observed (MPH)



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
— New Haven Wind Speed Forecast	21	20	21	23	25	28	30	32	33	34	36	36	37	37	38	38	40	41	43	45	46	45	44	41
— Wind Speed Observed	15	15	14	15	17	18	17	18	22	23	26	29	29	30	24	29	26	29	63	48	44	47	47	45

# Extensive Communication Plan Implemented Prior to, During, and Following Event

- Calls and meetings held before, during and in some case throughout restoration process, with:

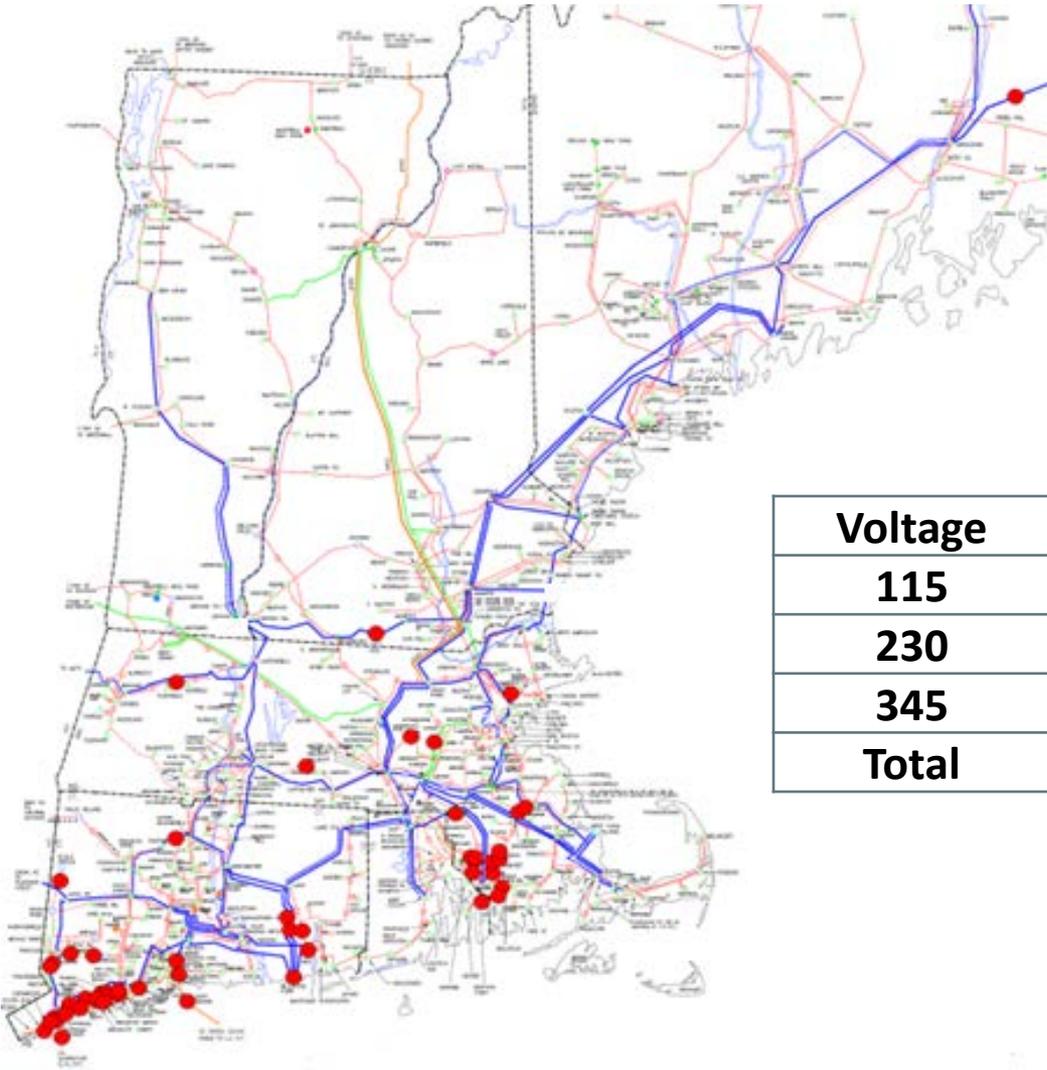
<b>Master Local Control Center (M/LCC) Heads*</b>
<b>Northeast Power Coordinating Council</b>
<b>North American Electric Reliability Corporation</b>
<b>Natural gas pipelines</b>
<b>Nuclear power plants</b>
<b>National Oceanic Atmospheric Administration</b>
<b>State and federal regulatory contacts</b>
<b>NEPOOL Reliability Committee</b>
<b>Transmission Owners</b>
<b>Generators</b>

*\* Staffing also enhanced at ISO/LCC*

# Actions Taken by ISO New England During Sandy

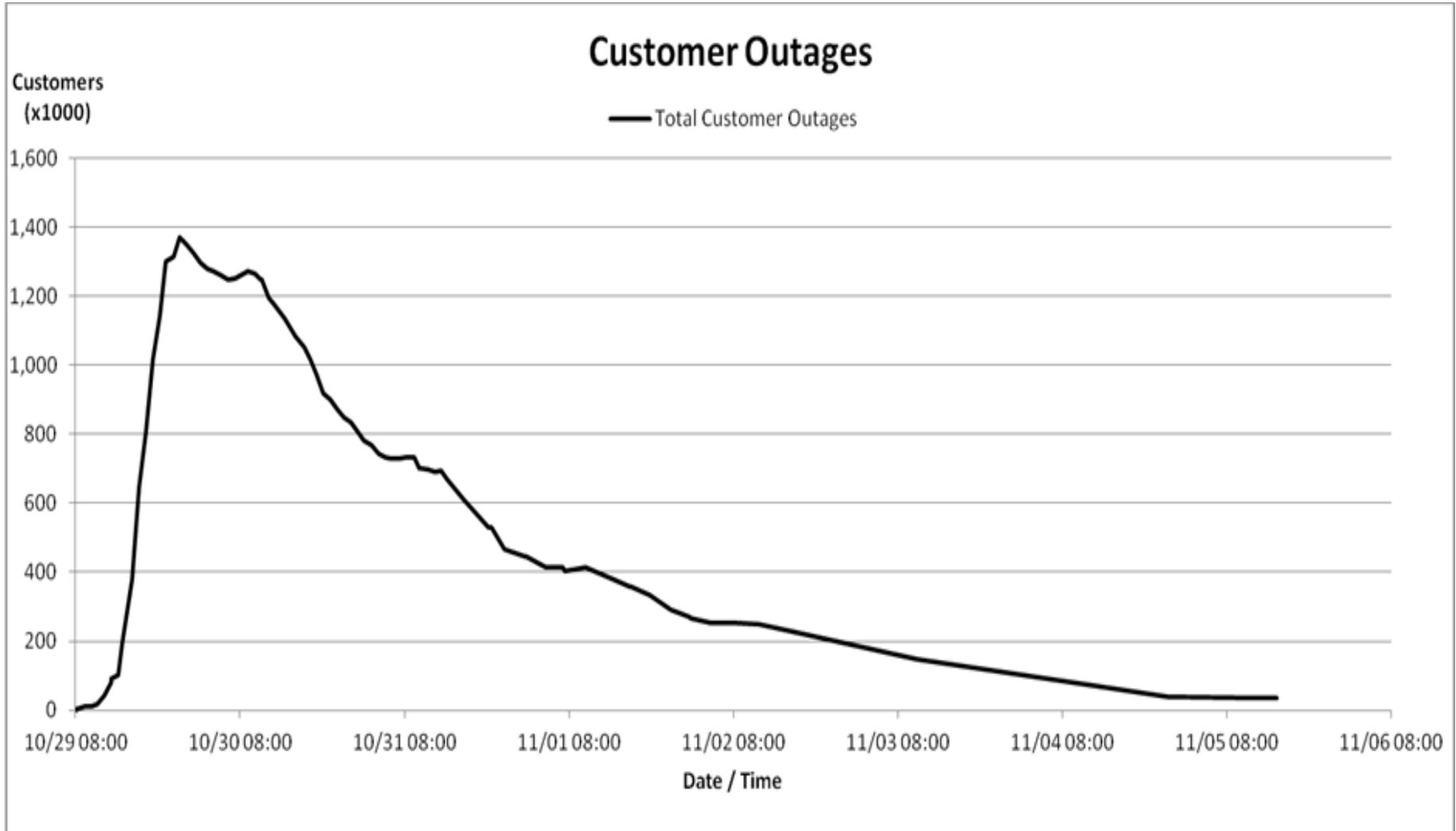
- M/LCC 2 – Abnormal Conditions Alert was declared at 1400, on Sunday 10/28/12 and continued until Friday 11/2/12
  - Outages of generation and transmission recalled, postponed if possible and continued through the week
  - Some outages selectively taken in accordance with M/LCC 2
- Additional generation committed to provide storm support in event of system shutdown or overloads especially along coastal regions
  - Nuclear unit uncertainty if high winds actually occurred
  - Uncertainty about precise track and intensity of the storm
  - Ability of resources to enhance thermal and voltage performance under multiple contingencies
- Minimum Generation Emergency Warning declared
- Minimum Generation Emergency declared

# Sustained Transmission Line Outages Resulting from Sandy



<b>Voltage</b>	<b>Outages</b>	<b>Sustained Outage</b>
<b>115</b>	<b>61</b>	<b>30</b>
<b>230</b>	<b>1</b>	<b>1</b>
<b>345</b>	<b>6</b>	<b>3</b>
<b>Total</b>	<b>70</b>	<b>36</b>

# Customer Restoration Estimates



# Operating Procedures (OP) Can Be Implemented in Response to System Conditions



- OP-4 includes 11 actions that system operators use to maintain system reliability during a capacity deficiency
- OP-4 can be implemented New England-wide, by local control center area, by state, or targeted to a specific area
- OP-4 actions can be called in any order
- If necessary, OP-4 can be skipped to move into OP-7 during an emergency
- Link to Operating Procedure No. 4:
  - <http://www.iso-ne.com/participate/rules-procedures/operating-procedures>

# Potential Relief Under OP-4

*Roughly 3,000 MW of potential relief systemwide from 11 action steps*

OP-4 Action	Action Description (Page 1 of 2)	Possible Relief (MW)
1	Implement <b>Power Caution</b> and advise Resources with a CSO to prepare to provide capacity and notify “Settlement-Only” generators with a CSO to monitor reserve pricing to meet those obligations	0 <sup>1</sup>
	Begin to allow depletion of 30-minute reserves	600
2	Dispatch Real-Time Demand Resources in the amount and location required	May = 308 <sup>3</sup> July – September = 372 <sup>3</sup>
3	Voluntary load curtailment of Market Participants’ facilities	40 <sup>2</sup>
4	Implement <b>Power Watch</b> and issue public appeal for voluntary conservation	0
5	Schedule Emergency Energy Transactions and arrange to purchase Control Area to Control Area Emergency Capacity and Energy	1,000
6	Voltage reductions requiring > 10 minutes	135 <sup>4</sup>
	Dispatch Real-Time Emergency Generation	May = 75 <sup>3</sup> July – September = 185 <sup>3</sup>

Source: COO Report, NPC Meeting, May 2016

# Potential Relief Under OP-4, *continued*

*Roughly 3,000 MW of potential relief systemwide from 11 action steps*

OP-4 Action	Action Description (Page 2 of 2)	Possible Relief (MW)
7	Request generation without a CSO to provide energy for reliability purposes	0
8	Voltage reductions requiring 10 minutes or less	269 <sup>4</sup>
9	Transmission customer generation not contractually available to Market Participants during a capacity deficiency	5
	Voluntary load curtailment by large industrial and commercial customers	200 <sup>2</sup>
10	Implement <b>Power Warning</b> and issue urgent public appeal for voluntary conservation	200 <sup>2</sup>
11	Request state governors' support for ISO appeals for conservation	100 <sup>2</sup>
	<b>Total Relief (MW)</b>	May = 2,932 July – September = 3,106

## NOTES:

1. Based on Summer Ratings. Assumes 25% of total MW Settlement-Only units <5 MW will be available and respond.
2. The actual load relief obtained is highly dependent on circumstances surrounding the appeals, including timing and the amount of advanced notice that can be given.
3. The RTDR and RTEG MW values are based on FCM results as of April 18, 2016.
4. The MW values are based on a 26,930 MW system load and the most recent voltage reduction test % achieved.

Source: COO Report, NPC Meeting, May 2016

# Action in an Emergency (OP-7)

- If OP-4 actions are not adequate to manage a capacity deficiency, the ISO will implement OP-7
  - OP-4 can be skipped to move into OP-7 immediately, if necessary
- OP-7 allows system operators to order the disconnection of firm customer load—frequently referred to as manual load shedding, load curtailment, controlled power outages, or rolling blackouts—as a means of maintaining the integrity of the bulk power system
- OP-7, like OP-4, can be called region-wide or locally
- When OP-7 actions are required, transmission and/or distribution companies disconnect customers at the direction of the ISO or the Local Control Center (LCC)
  - ISO system operators do not have the ability to disconnect customers
- Link to Operating Procedure No. 7:
  - <http://www.iso-ne.com/participate/rules-procedures/operating-procedures>

# There are Three Essential Elements that Help Grid Operators Maintain Reliability During Hurricanes

- Essential elements to maintain the bulk electric power system reliability during hurricanes and other weather related challenges include
  1. Early preparation and training
  2. Timely and accurate weather forecast data
  3. Continuous communication with a vast network of affected



# Questions

