Bridging climate science and utility systems: Resiliency planning in NYC

NYSERDA EMEP Conference
November 7, 2013

The City of New York
Mayor Michael R. Bloomberg

Sandy impacted the people, services, infrastructure and economy across the entire city

Infrastructure and Services

People and public safety
- **43** people died in storm-related incidents
- **200+** homes and businesses were destroyed by fire

Buildings
- Nearly **20,000** buildings remained damaged 2 weeks after the storm (red or yellow tagged by DOB, experiencing power outage)
- Nearly **7,000** people occupied city shelters at peak occupancy

Energy
- **800,000+** customers lost power overall because of Sandy, ~**650,000+** customers without power at the peak of the storm

Transportation
- **11 million** travelers across all modes of transportation per day were impacted by closures

Telecom
- **95%** of copper infrastructure destroyed
- **4** months after storm, services have not fully returned to NYC

Waterfront and coastal protection
- **$400 million+** to repair beaches, boardwalks, waterfront structures
- Over **2 million** cubic yards of sand lost from New York beaches, including 1.5 million cubic yards on the Rockaway peninsula alone

Public services
- **>1,100** patients were evacuated from local hospitals
- **1.1 million** children were affected when all schools closed for a week

Business and economic impact
- Direct and indirect losses amounted to **$19 billion** in damages
- **94,000** businesses were inundated, lost power, or both
- **890,000** employees worked at impacted businesses

Preparing New York City for future climate risks
A Stronger, More Resilient New York

On June 11, 2013, the City launched *A Stronger, More Resilient New York*.

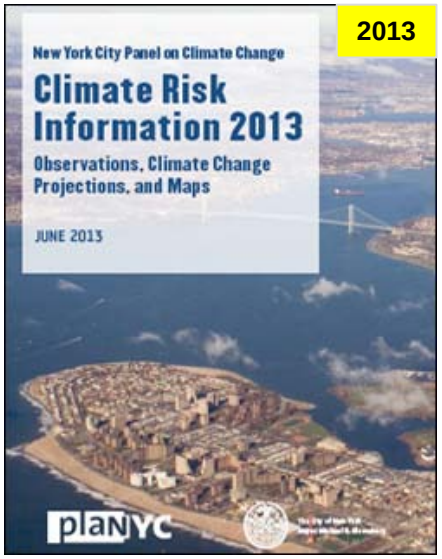
- Analysis and recommendations built on best available science
- Comprehensive assessment of all critical infrastructure and services
- 257 initiatives, including 59 milestones to be met in 2013

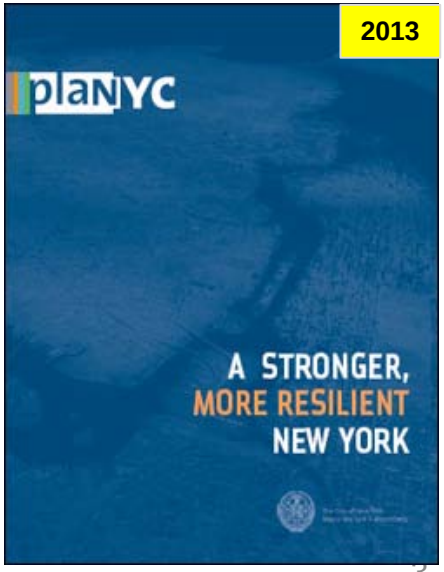
Understanding climate risks for infrastructure planning

1. **Map impacts on infrastructure to impacts on services/people**
   - Infrastructure network structure
   - Geographic information
   - Critical services focus

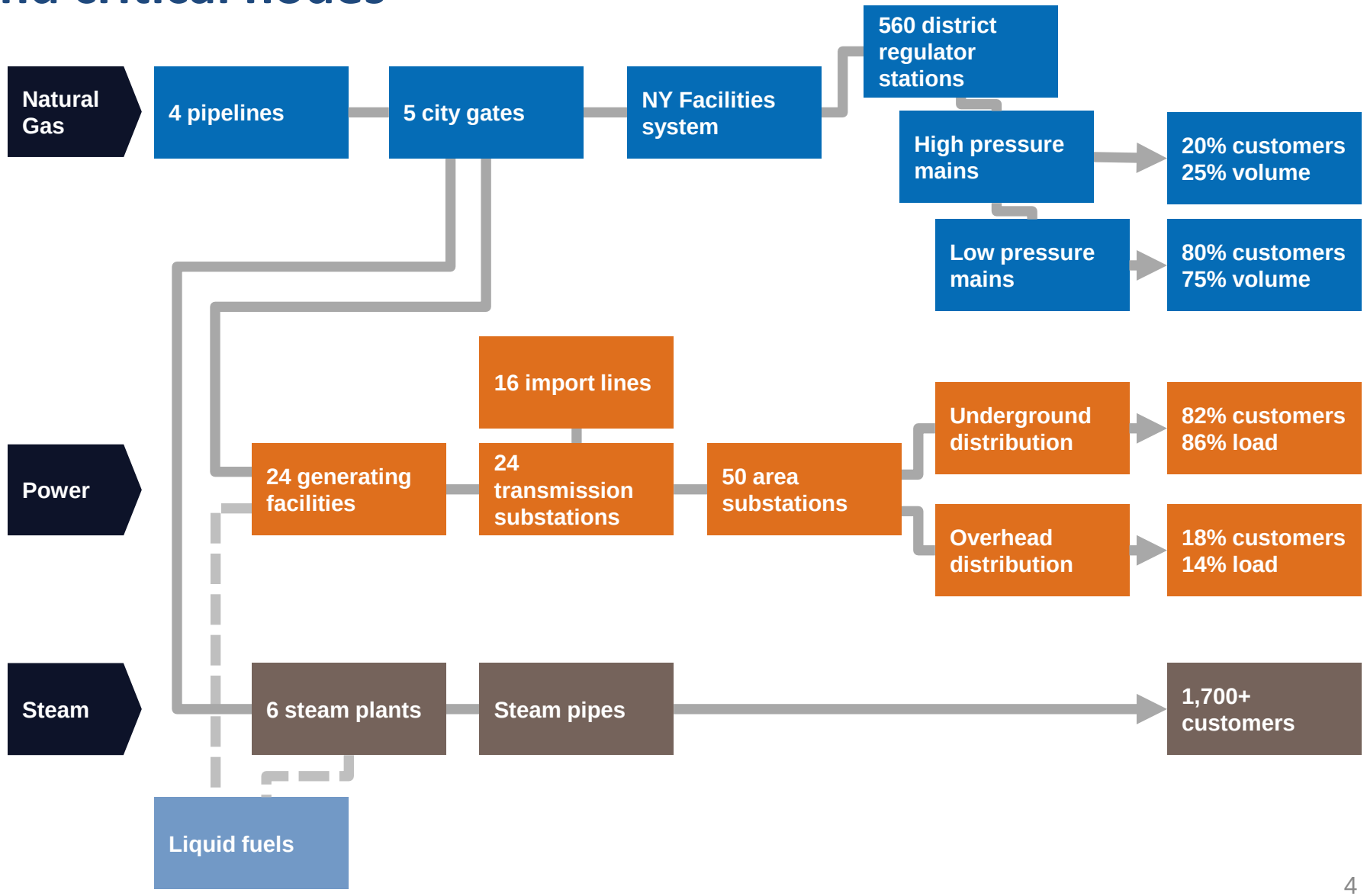
2. **Apply quantitative climate information to understand changing conditions**
   - Ranges of potential outcomes

3. **Quantify risks and impacts**
   - Probabilistic, forward-looking
   - Basis for planning decisions, cost/benefit analyses

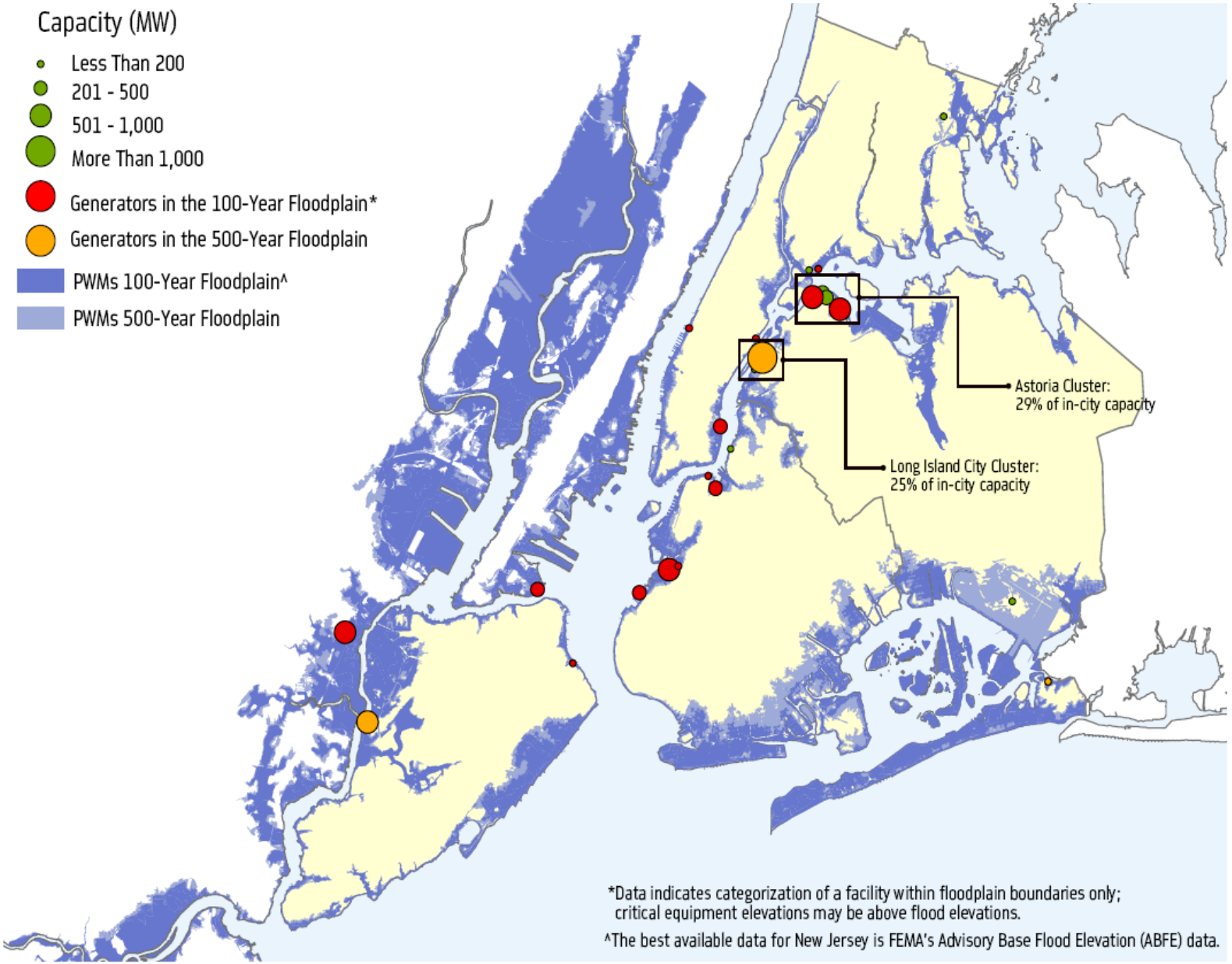




Utility networks: Interconnecting paths to the customer and critical nodes



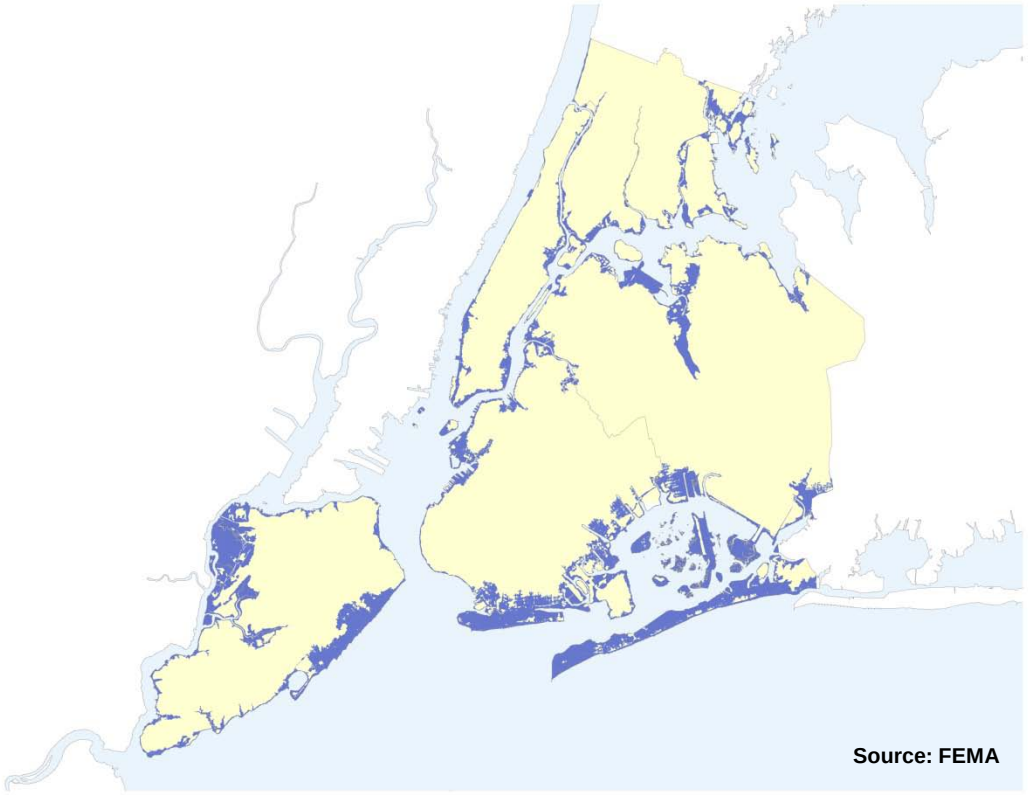
Power assets in the floodplain



Floodplain mapping

FEMA has recently released new maps in a process that began before Sandy.

FEMA June 2013 Preliminary Work Maps (PWMs)



100-Year Floodplain: A Zone (FEMA 2013 PWMs)

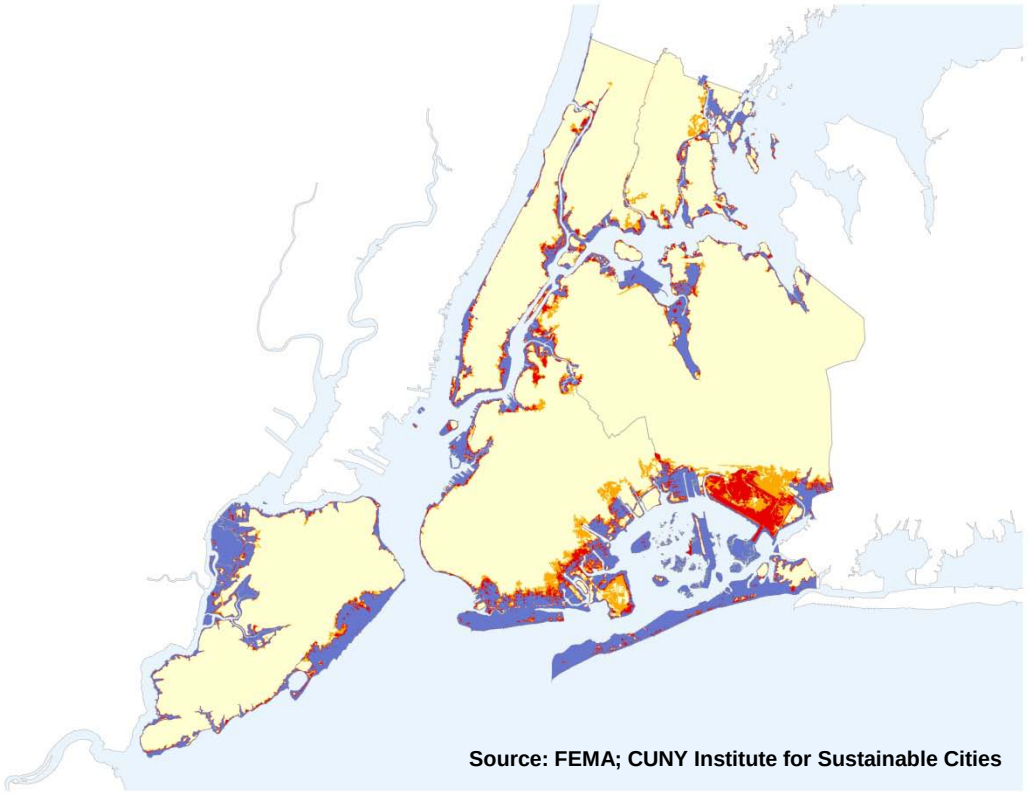
Surge inundation **probabilities** and **floodplain extents** generated from modeling of probable storms

90th percentile SLR

Floodplain mapping

Using the NPCC projections, the City, with the CUNY Institute for Sustainable Cities, developed maps showing how these floodplains will expand by the 2050s.

FEMA PWMs, with 2020s and 2050s Floodplain Growth



Source: FEMA; CUNY Institute for Sustainable Cities

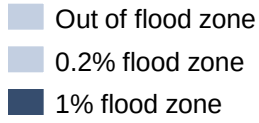
100-Year Floodplain (FEMA 2013 PWMs)
100-Year Floodplain (Projected 2020s)
100-Year Floodplain (Projected 2050s)

100-YEAR FLOODPLAIN*			
	2013 PWMs	2050s Projected	Change (%)
Residents	398,000	801,000	101%
Jobs	271,000	430,000	59%
Buildings	68,000	114,000	68%
Floor Area (SF)	534M	855M	60%

* 90th percentile SLR projection

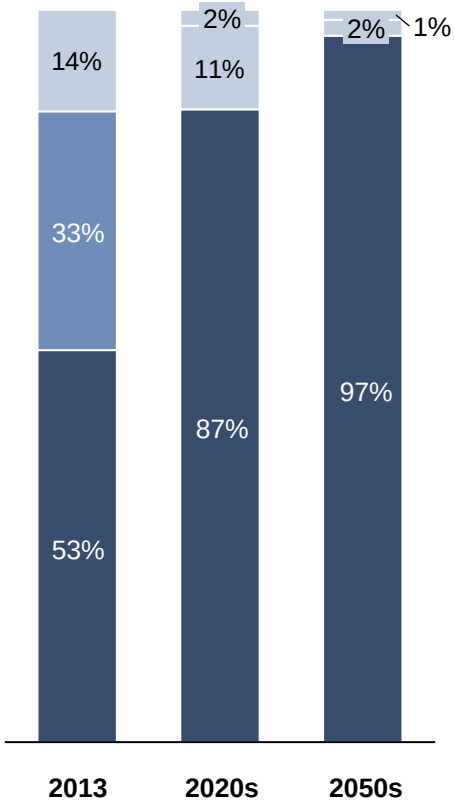
Vulnerability increases with projected sea level rise

90th percentile SLR

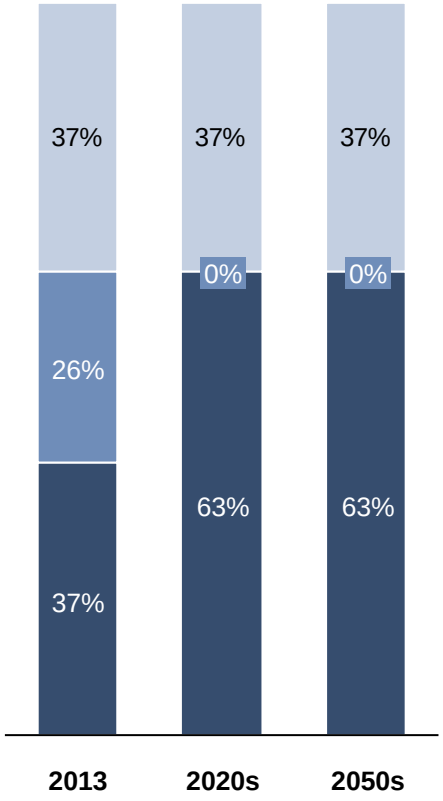


Electric assets by current and future flood zone status

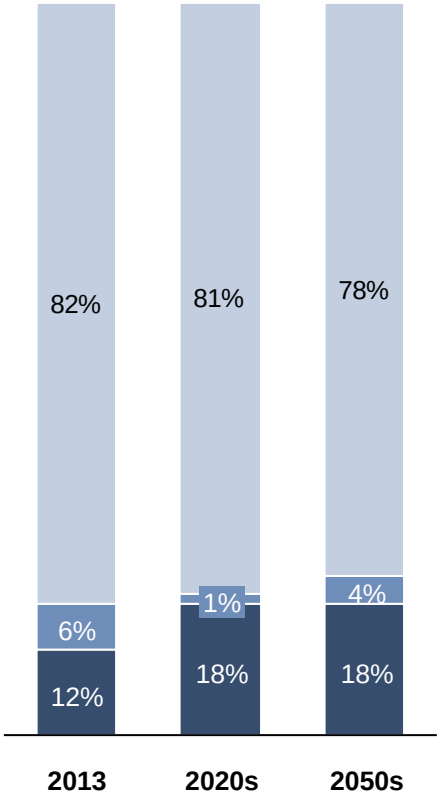
In-city generation by capacity, MW (27 assets)



Transmission substations by load served,[1] MW (24 assets)



Major area substations by load served, MW (50 assets)

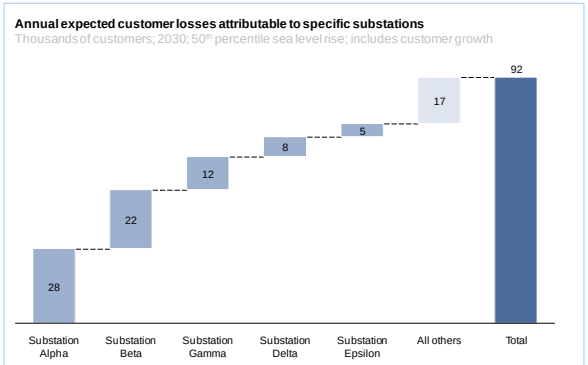


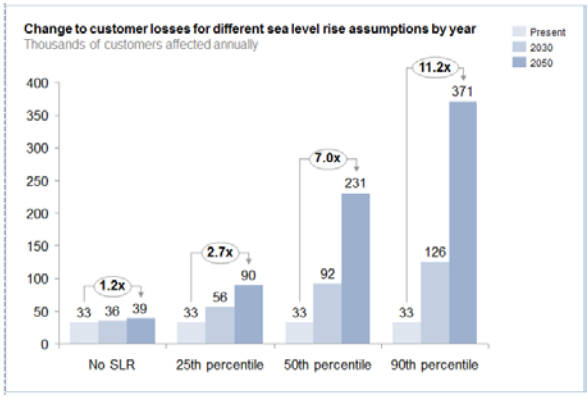
Source: OLTPS analysis

Modeling electric system risks from storm surge

Risk model helps answer several questions

1. What are the **probabilities** of occurrences and the **consequences** of failure?
2. Which assets drive the greatest share of **customer losses**?
3. How much do **risks grow in the future** as the climate changes?





Model brings together three components

1 Stochastic surge model

- Uses historical storm patterns (FEMA storm set) as basis
- Generates hundreds of "synthetic" storms using ~10 parameters
- Physics model produces estimates of surge height for different storms with an attached probability

2 Network architecture

- Maps each electric network to individual substations
- Includes critical equipment elevations for each substation

3 Customer data

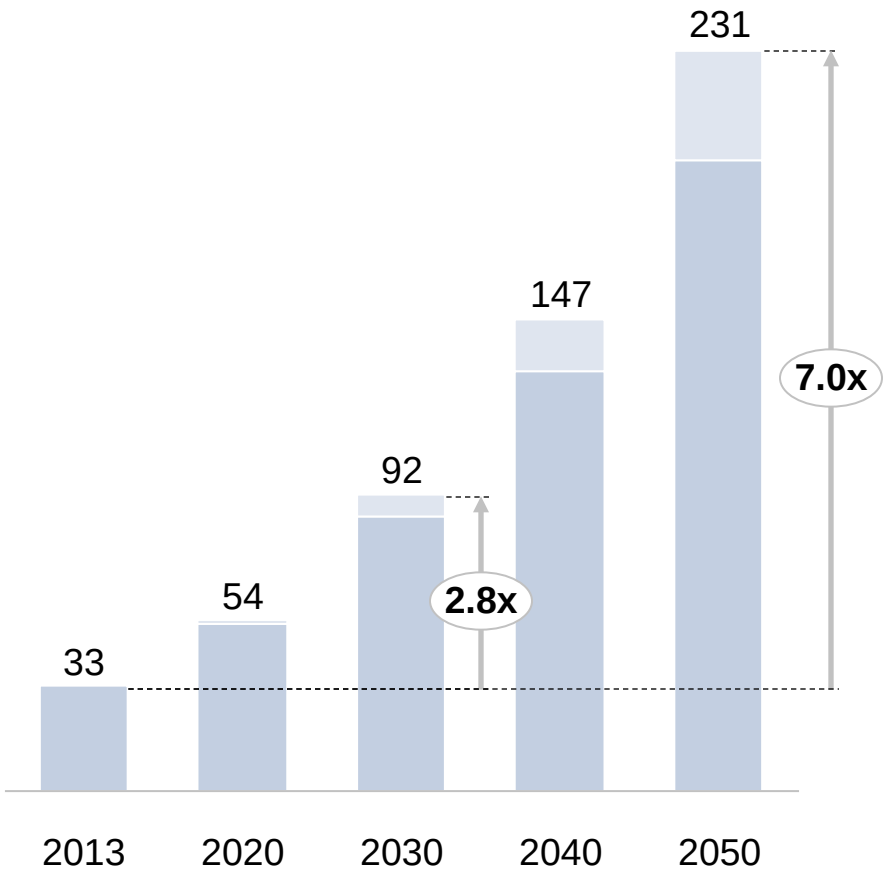
- Using NYC databases, maps customers, critical users, and economic activity to each electric network

Allows for a probabilistic, customer-centric understanding of substation flood protection priorities

Baseline
Growth
50th pct

Annual expected outages due to storm surge will increase dramatically by 2050

Annual expected customer outages due to surge
Thousands; 50th pct SLR; baseline no-action[1]



- **50th percentile SLR**
  - 2020s: 6 inches
  - 2050s: 17-18 inches

[1] Population growth figures based on projections from Department of City Planning through 2030; past that assume 0.4% growth rate per year based on 2012-2030 avg
[2] Economic growth based on long-term historical average of 2.2% a year

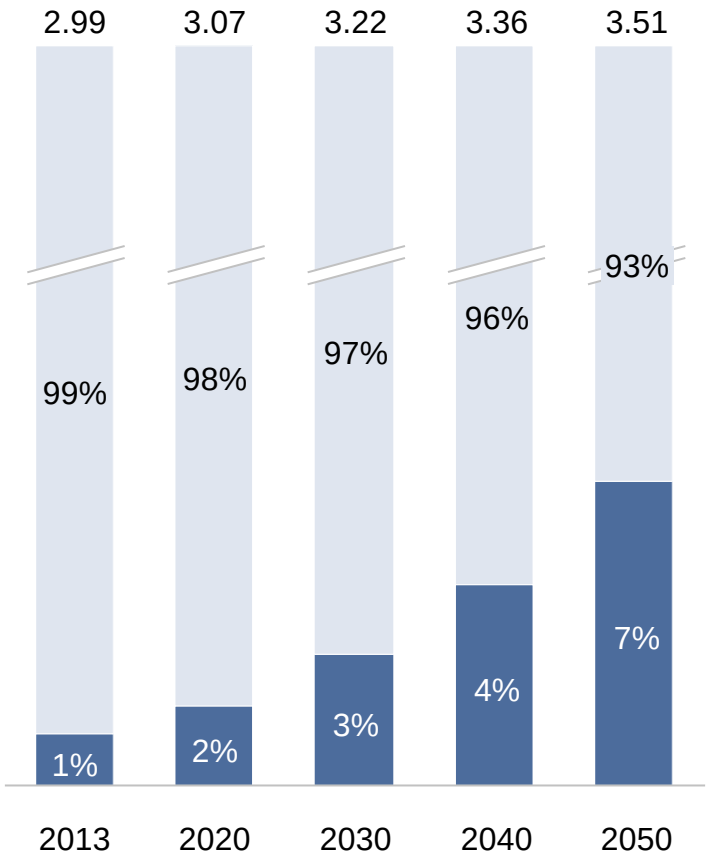
SOURCE: Mayor's Office of Long-Term Planning and Sustainability

Baseline
Growth
50th pct

Annual share of affected customers increases to 7 percent by 2050

Customers by annual status

% of total; millions of customers; 50th percentile SLR



- **50th percentile SLR**
  - 2020s: 6 inches
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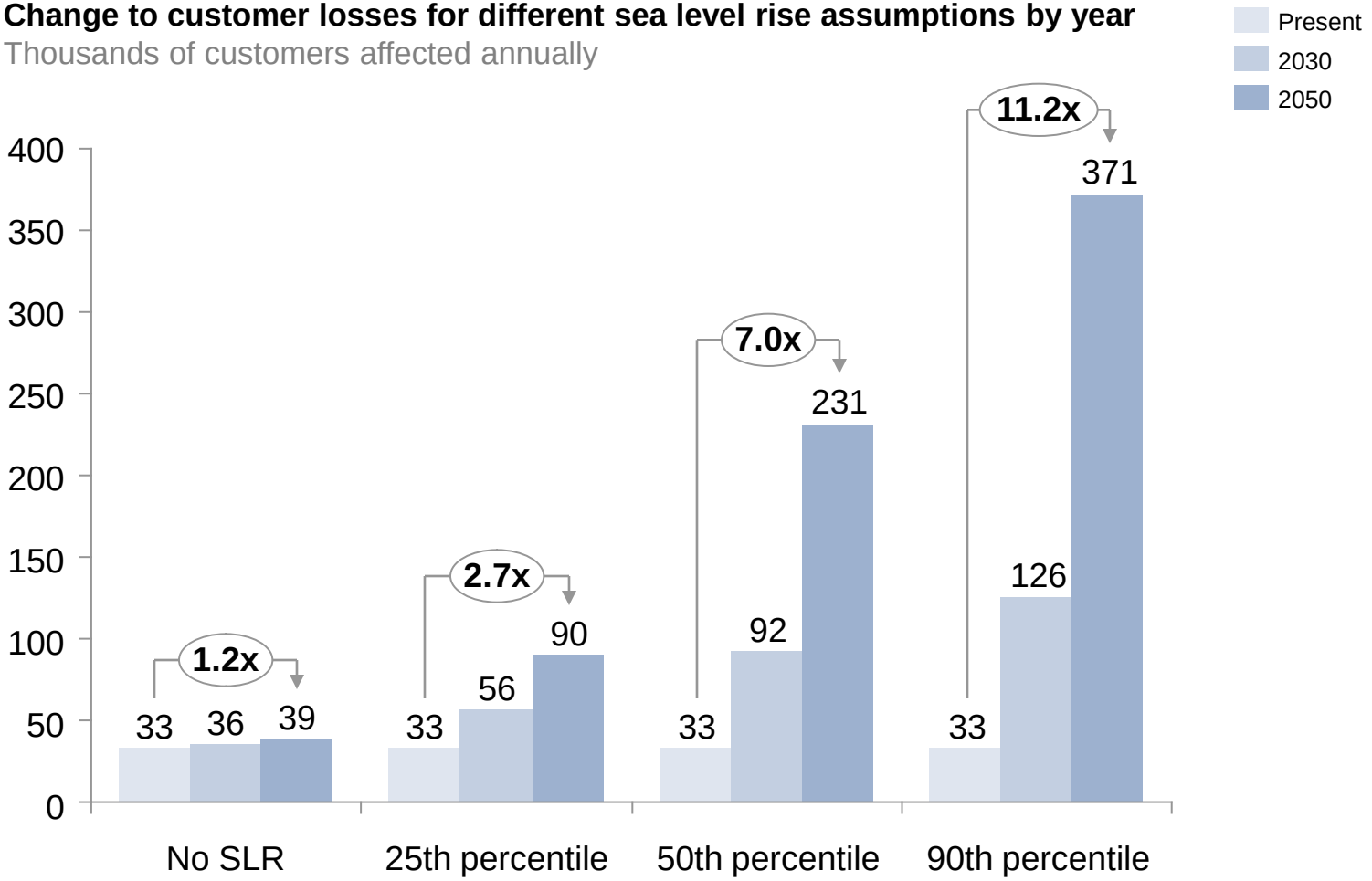
SOURCE: Mayor's Office of Long-Term Planning and Sustainability

Baseline
Growth
All pct

Changes in surge risk depend on sea level rise assumptions

Change to customer losses for different sea level rise assumptions by year

Thousands of customers affected annually

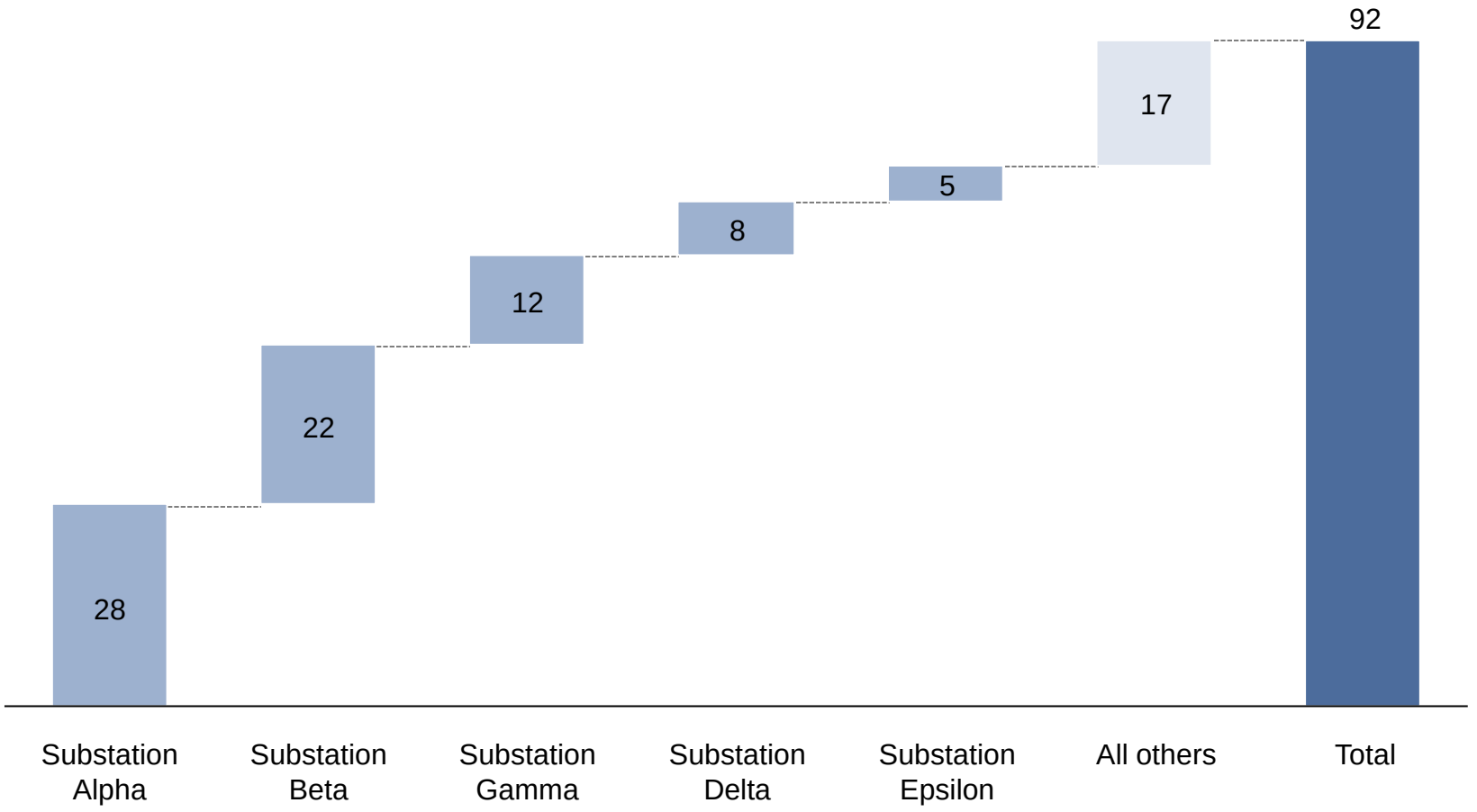


SOURCE: Mayor's Office of Long Term Planning and Sustainability

Five assets drive 80 percent of customer losses

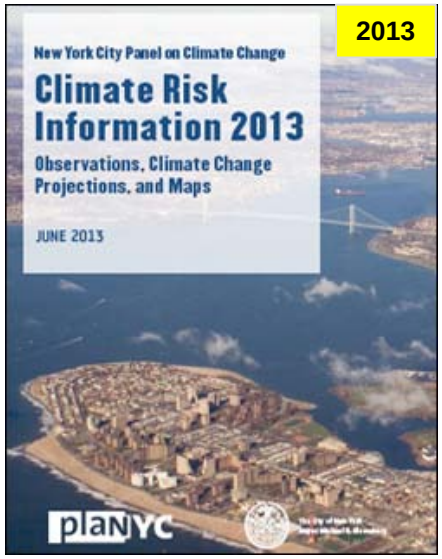
Annual expected customer losses attributable to specific substations

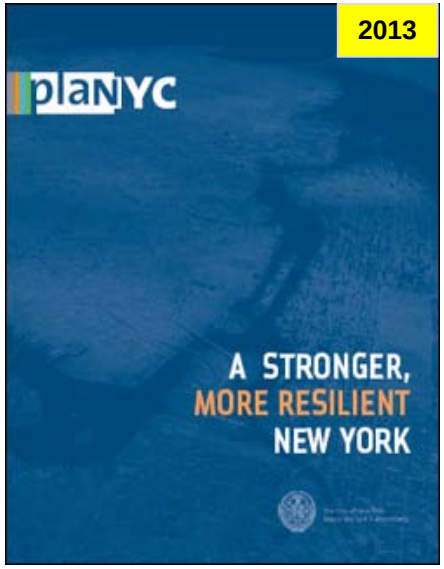
Thousands of customers; 2030; 50th percentile sea level rise; includes customer growth



SOURCE: Mayor's Office of Long-Term Planning and Sustainability

Applying climate science to resiliency planning in NYC





Four practical lessons:

1. **Mayoral task forces jump-start stakeholder cooperation:** Stakeholders and regulators developed shared understanding of climate risks and appropriate decision-making frameworks

2. **Gap between climate science and regulatory policy can be bridged:** City led efforts toward practical application of climate projections to utility systems through modeling

3. **City can bring ratepayer perspective to the discussion:** Quantification of risk took into account impacts on the economy and critical infrastructure

4. **Progress achieved through sustained cooperation:** City continues to work closely with Con Edison engineers to develop understanding of system risks – partnership of regular meetings and feedback

The Risks of Climate Change

At the Administration's request, the NYC Panel on Climate Change (NPCC)updated its 2009 analysis of how climate change might impact New York, including the risk for chronic hazards.

CHRONIC HAZARDS	Baseline (1971-2000)	2020s		2050s	
		Middle Range (25th-75th percentile)	High End (90th percentile)	Middle Range (25th-75th percentile)	High End (90th percentile)
Average Temperature	54ºF	+2.0ºF to 2.8ºF	+3.2ºF	+4.1ºF to 5.7ºF	+6.6ºF
Precipitation	50.1 in.	+1% to 8%	+10%	+4% to 11%	+13%
Sea Level Rise[1]	0	+4 to 8 in.	+11 in.	+11 to 24 in.	+31 in.

Source: NPCC; for more details, see *Climate Risk Information 2013*

[1] Baseline period for sea level rise projections is 2000-2004.

Sea levels are likely to rise 1-2 ft. and could rise more than 2 ½ ft.

These sea level rise projections have been incorporated into NOAA'S coastal flood risk mapping tool and USACE's recently released storm surge calculator.

The Risks of Climate Change

The NPCC also updated its 2009 analysis for extreme events.

EXTREME EVENTS		Baseline (1971-2000)	2050s	
			Middle Range (25th-75th percentile)	High End 90th percentile)
Heat Waves and Cold Events	Days per year ≥ 90ºF	18	39 to 52	57
	Heat waves per year	2	5 to 7	7
Intense Precipitation	Days per year with rainfall > 2 in.	3	4	5
Coastal Floods at the Battery[1]	Future annual frequency of today's 100-year flood	1.0%	1.7% to 3.2%	5.0%
	Flood heights from a 100-year flood (feet above NAVD88)	15.0	15.9 to 17.0	17.6

The number of 90+ degree days could double (or triple), to current level of Birmingham, AL

[1] Baseline period for sea level rise projections is 2000-2004.

Source: NPCC; for more details, see *Climate Risk Information 2013*

Understanding risks to our critical infrastructure