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ECONOMIC, FINANCIAL and STRATEGY CONSULTANTS

Climate Change Preparedness in New Jersey: Utilities – Leading Practices and Trends Nationally

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May 21, 2013

My remarks – overview

Why focus on electric system climate preparedness

Interesting case studies of addressing climate impacts on the grid

- Maryland
- Gulf Coast/Southern Company
- Norwich, CT
- Toronto

The Electric System

WHY A FOCUS FOR CLIMATE PREPAREDNESS?

Electricity: why a focus for climate preparedness

- **Electricity is an essential element of all energy supply and distribution systems and critical infrastructure (e.g., hospitals, banks, airports, transit systems).**
- **All segments of the energy supply and distribution infrastructure require electricity to operate.**
- **This interdependence underscores the need for available grid-supplied electricity before, during, and after an extreme event.**

DOE, Office of Electricity Delivery and Energy Restoration, "Hardening and Resiliency: U.S. Energy Industry Response to Recent Hurricane Seasons," August 2010

Pittsburgh study of critical services & electricity

Pervasiveness of electricity to serve critical social needs

- **Emergency services** (911 and dispatch, police, fire, emergency medical)
- **Medical services** (hospitals, nursing homes, clinics, pharmacies)
- **Communications and cyber** (radio and TV broadcast, wireless, computers)
- **Water and sewer systems**
- **Food** (retail groceries, wholesale networks, food production facilities)
- **Financial** (cash machines, credit card systems, banks)
- **Fuel** (bulk fuel delivery, storage infrastructure, retail gasoline)
- **Transportation** (traffic lights, tunnels, rail, air traffic control,)
- **Dense populations** (prisons, schools, universities, assisted living)
- **Lighting and building operations** (street lights, security lights, building evacuation, elevators, HVAC)

Carnegie Mellon Electricity Industry Center study for Commonwealth of PA (2005), cited in NAS, “Terrorism and the Grid”, 2013.

Definitions

Hardening:

- **Physically changing the infrastructure to make it less susceptible to damage from extreme wind, flooding, or flying debris.**
- **Hardening improves the durability and stability of energy infrastructure, making it better able to withstand the impacts of hurricanes and weather events without sustaining major damage.**

Resiliency:

- **The ability of an energy facility (or system) to recover quickly from damage to any of its components or to any of the external systems on which it depends. "The capacity to absorb shock and rebound quickly"**
- **Resiliency measures do not prevent damage; rather they enable energy systems to continue operating despite damage and/or promote a rapid return to normal operations when damages/outages do occur.**
- **Resilience places a premium on anticipating and planning for post-shock activities and outcomes.**

DOE, Office of Elec. Delivery and Energy Restoration, "Hardening and Resiliency: U.S. Energy Industry Response to Recent Hurricane Seasons," August 2010

What to expert – the draft NCA Energy Chapter's key findings

1. **Extreme weather events are affecting energy production and delivery facilities.**

2. **Higher summer temperatures will increase electricity use.**

3. **Both episodic and long-lasting changes in water availability will constrain different forms of energy.**

4. **In the longer term, sea level rise will affect coastal facilities and infrastructure on which many energy systems, markets, and consumers depend.**

5. **As new investments in energy technologies occur, future energy systems will differ from today's in uncertain ways. Depending on the character of changes in the energy mix, climate change will introduce new risks as well as opportunities.**

Draft National Climate Assessment, Energy Supply and Use Chapter (Chapter 4), 2013

A very uncertain energy future

- **Many uncertainties – financial, economic, regulatory, technological, etc. – will affect private and public consumption and investment decisions on energy fuels, infrastructure, and systems.**
- **One certainty about energy systems in the future is that they will be different than today's, but in ways not yet known.**
- **An evolving energy system is also an opportunity to develop an energy system that is less vulnerable to climate change.**

Draft National Climate Assessment, Energy Supply and Use Chapter (Chapter 4), 2013

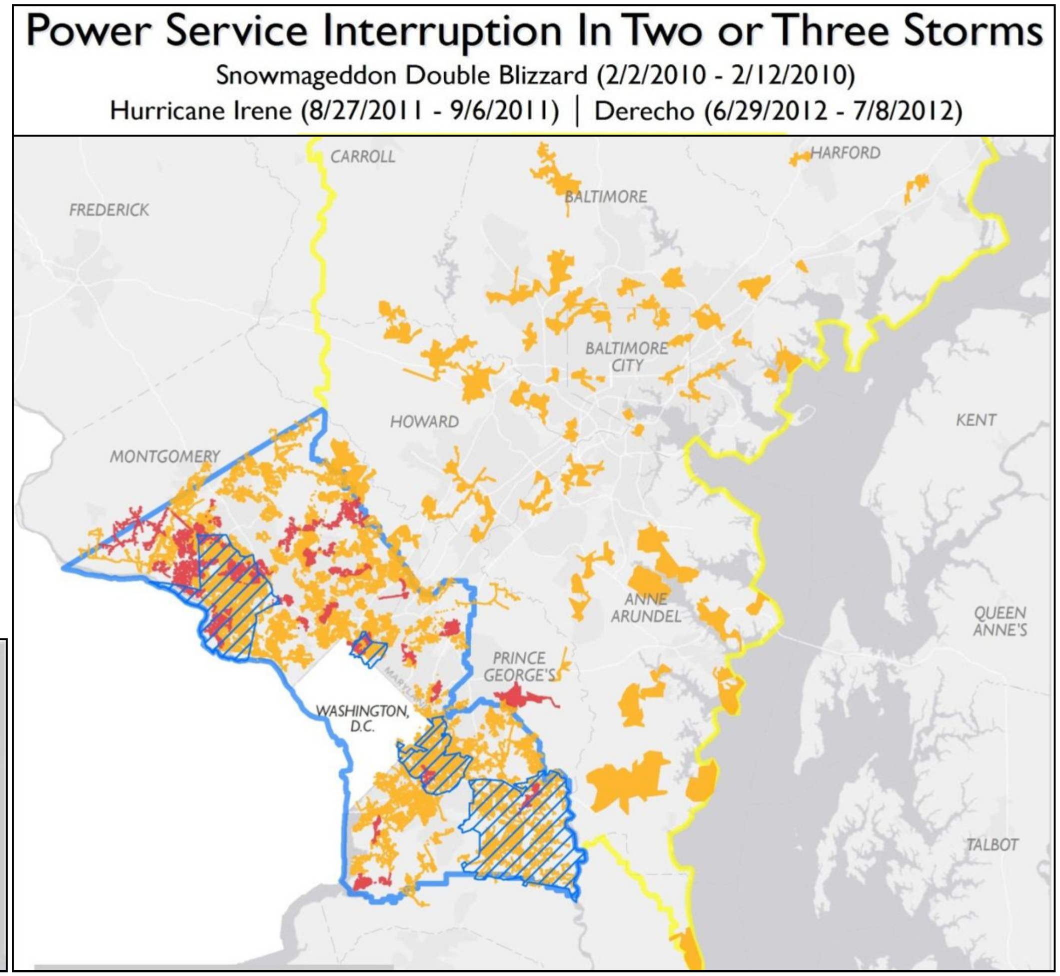
Climate Preparedness & the Grid

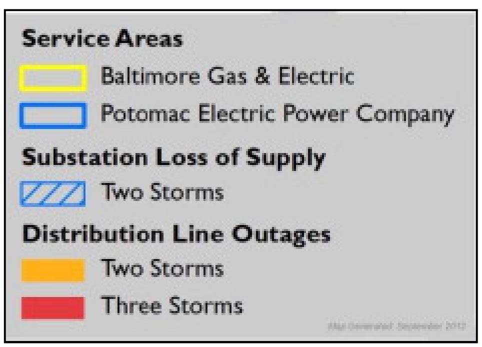
EXAMPLES

Maryland: "Weathering the Storm" (Sept. 2012)

Three big recent weather related electric system outages:

- **Snowmaggedon (2010)**
- **Hurricane Irene (2011)**
- **Derecho and heat waves (2012)**





Report of the Grid Resiliency Task Force, "Weathering the Storm," Office of Governor O'Malley, September 24, 2013

Maryland: "Weathering the Storm" (Sept. 2012)

Premises for the Study

- **Current level of reliability and resiliency during major storms is not acceptable.**
- **Increased reliability and resiliency during major storms is the goal.**
- **Severe weather events resulting from climate change are likely to continue to occur. Utilities, government and citizens must be prepared for severe weather events.**
- **If done strategically and appropriately, increased expenditures by the utilities to improve resiliency and harden the gird – to literally ensure that the electric distribution system can weather the storm – will lead to fewer outages during storms and shorter outages when interruptions happen.**

Report of the Grid Resiliency Task Force, "Weathering the Storm," Office of Governor O'Malley, September 24, 2013

Maryland: Valuing electric reliability to consumers

LBNL survey of 28 studies (conducted by 10 utilities, 1989 and 2005), with Indicators of electric customers' willingness to pay to avoid outages.

Customer type	Cost/Hour for outage on summer weekday	
	1-hour outage	8-hour outage
Residential	$4	$11
Small C&I	$856	$4,991
Medium/ Large C&I	$21,312	$98,278

- **Residential costs are higher on weekends, C&I higher on weekdays**
- **Residential and Medium/large C&I customers: higher cost s during summer outages; Small C&I customers: higher costs during winter interruptions**

Report of the Grid Resiliency Task Force, "Weathering the Storm," Office of Governor O'Malley, September 24, 2013

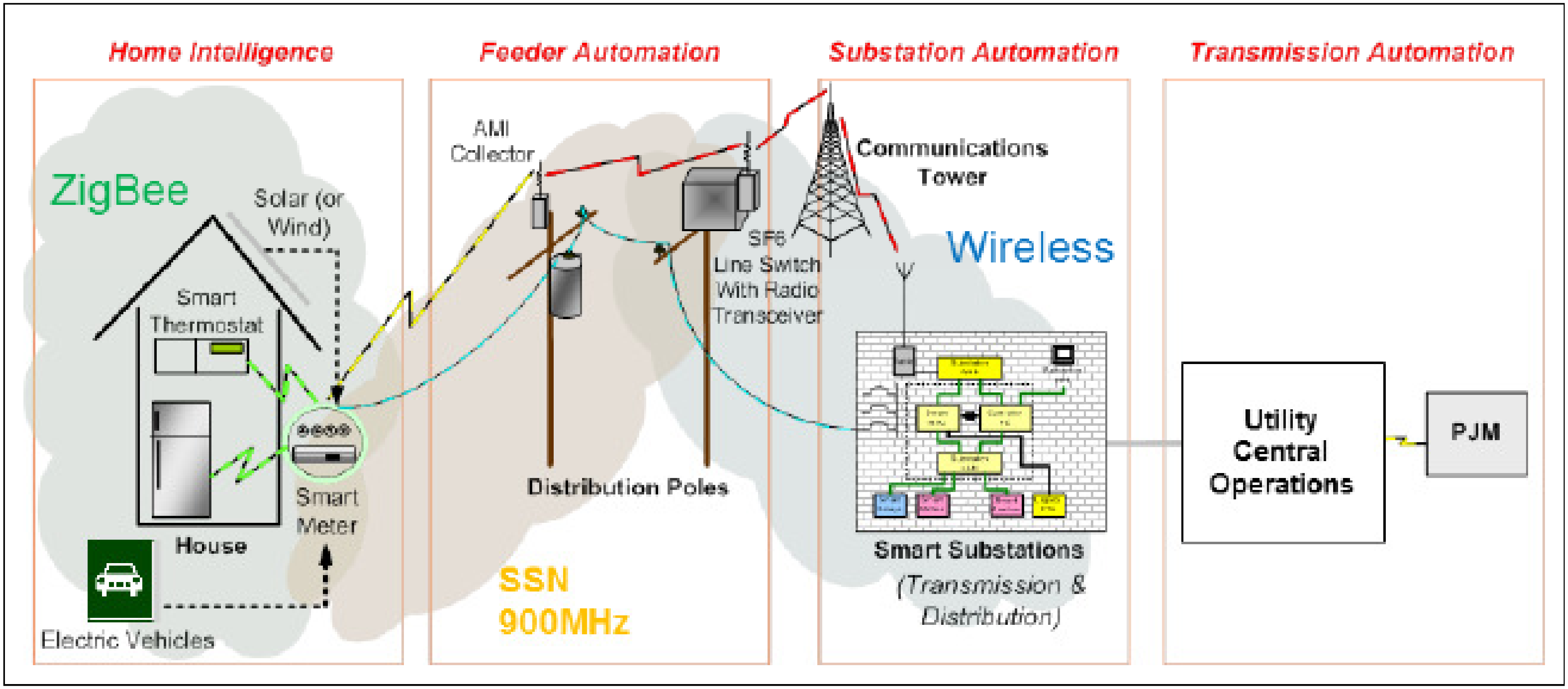
Potential Cost of Storm Outages for Residential Customers

Storm	BGE	Choptank	DPL	PE	Pepco	SMECO	All Utilities
Snowmaggedon							
Peak Interruptions	45,158	16,867	16,830	14,192	90,858	11,824	292,799
Total Hours	1,145,347	223,146	581,785	110,002	3,591,156	286,540	5,937,976
Cost	**$12,827,886**	**$2,499,235**	**$6,515,992**	**$1,232,022**	**$40,220,947**	**$3,209,248**	**$66,505,331**
Hurricane Irene							
Peak Interruptions	476,664	11,990	63,597	8,554	194,516	104,328	1,139,380
Total Hours	27,697,518	184,483	1,954,386	88,325	4,989,481	4,638,825	39,553,018
Cost	**$310,212,202**	**$2,066,210**	**$21,889,123**	**$989,240**	**$55,882,187**	**$51,954,840**	**$442,993,802**
Derecho							
Peak Interruptions	429,841	7,371	28,059	60,209	410,679	56,424	992,583
Total Interruptions	762,781	13,112	50,476	72,718	786,766	83,250	1,769,103
Total Hours	28,643,177	97,116	436,823	2,149,880	20,465,930	1,203,860	52,996,786
Average Duration	37.6	7.4	8.7	29.6	26.0	14.5	30.0
Cost	**$320,803,582**	**$1,087,694**	**$4,892,418**	**$24,078,656**	**$229,218,416**	**$13,483,232**	**$593,563,998**
Total for Three Storms							
Total Hours	57,486,042	504,745	2,972,994	2,348,207	29,046,567	6,129,225	98,487,780
Total Customers	1,240,173	52,138	194,945	251,236	534,601	151,800	2,424,893
Cumulative Outage Hours Per Customer	46.4	9.7	15.3	9.3	54.3	40.4	40.6
Cumulative Cost Per Customer	$519	$108	$171	$105	$609	$452	$455
Total Cost	**$643,843,670**	**$5,653,139**	**$33,297,533**	**$26,299,918**	**$325,321,550**	**$68,647,320**	**$1,103,063,131**

Report of the Grid Resiliency Task Force, "Weathering the Storm," Office of Governor O'Malley, September 24, 2013

Maryland: "Weathering the Storm" (Sept. 2012)

Methods to improve resiliency: Smart grid



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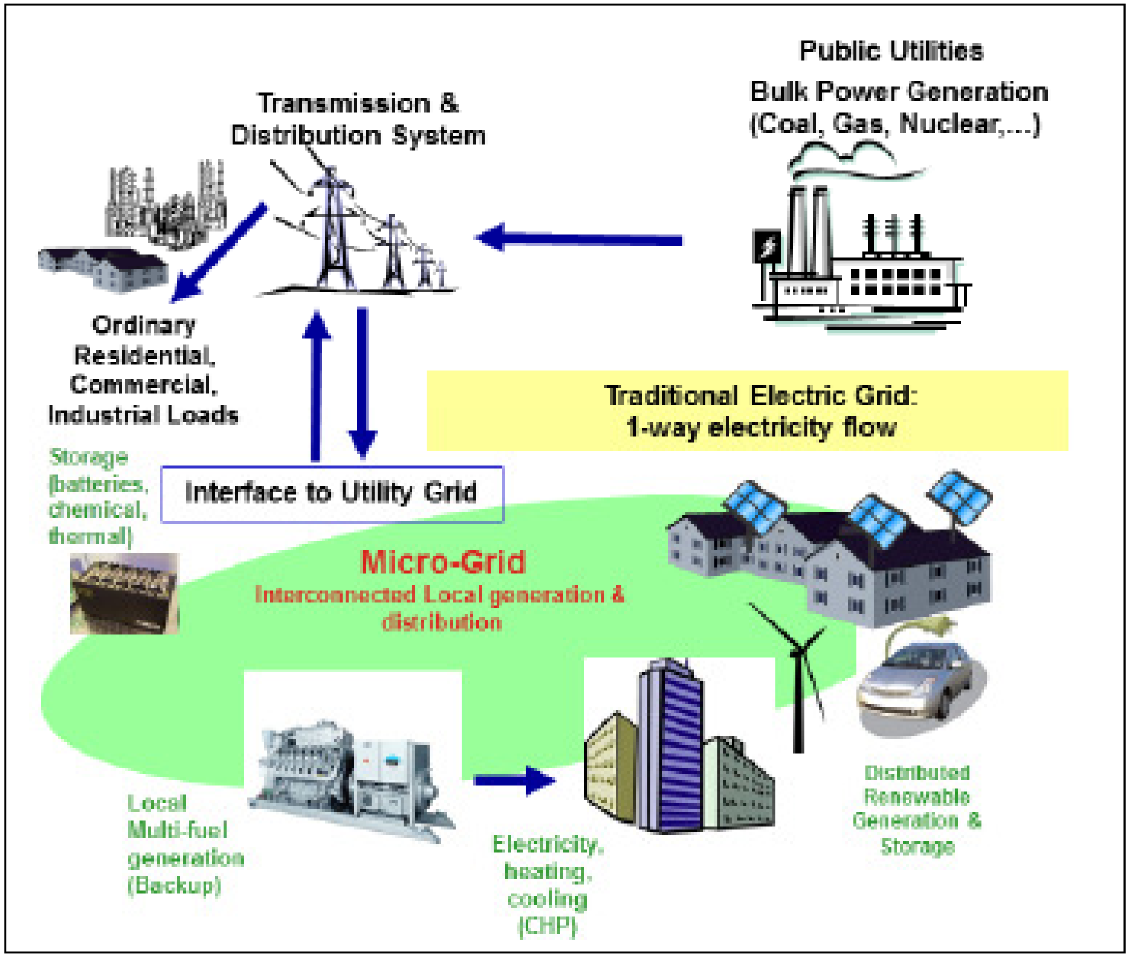
Maryland: "Weathering the Storm" (Sept. 2012)

Methods to improve resiliency:

Microgrids



Report of the Grid Resiliency Task Force, "Weathering the Storm," Office of Governor O'Malley, September 24, 2013

Maryland: "Weathering the Storm" (Sept. 2012)

Methods to improve resiliency: Regulatory, Administrative, Planning

- Vigilant utility inspection and maintenance (e.g.,)
  - **Poorest performing feeders**
  - **vegetation management (with penalties)**
- Ratemaking (e.g.,)
  - **trackers for investment recovery**
  - **Reliability standards for distribution service – with incentives, penalties**
- Identifying critical services (e.g.,) – utility and government
  - **Lists of special needs feeders**

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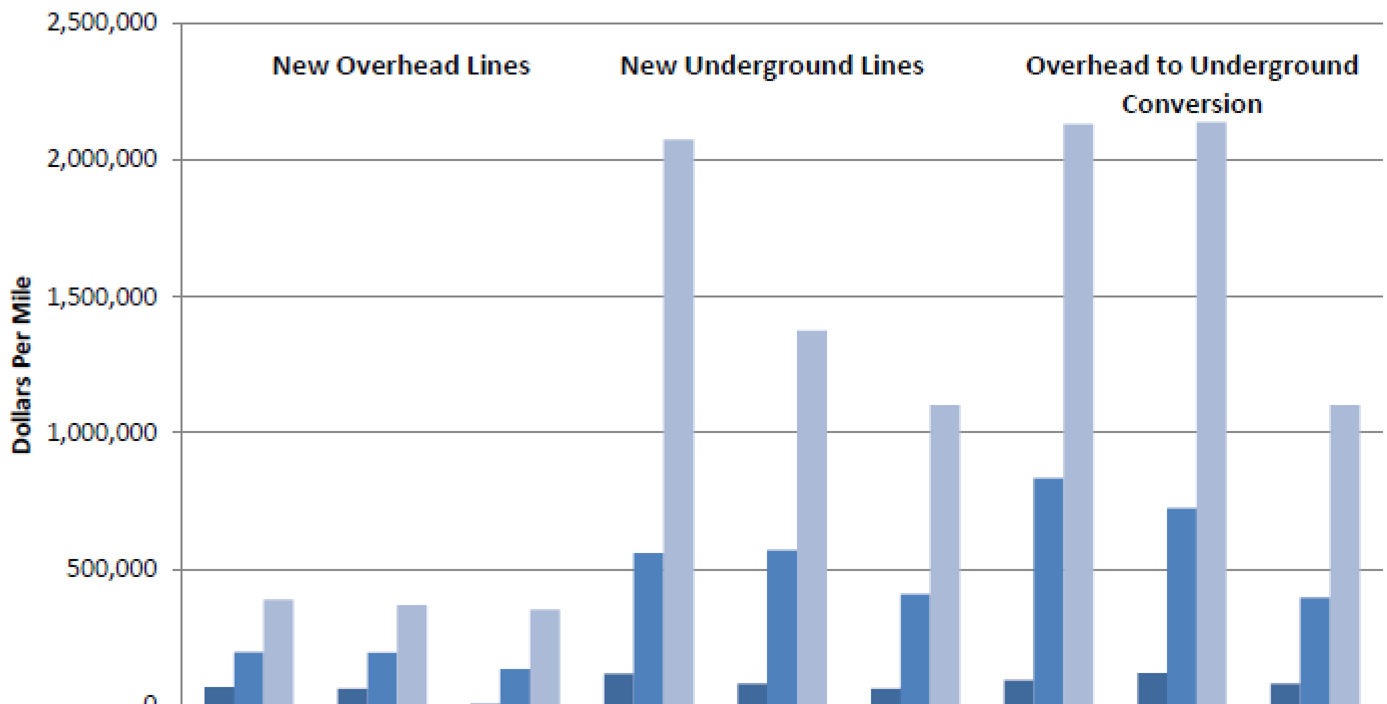
Maryland: "Weathering the Storm" (Sept. 2012)

Methods to improve resiliency: Hardening (undergrounding)



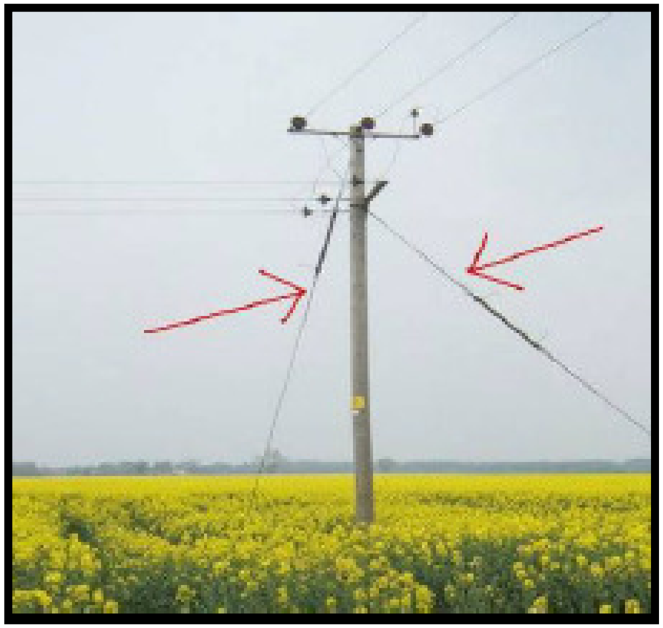
	Urban	Suburban	Rural	Urban	Suburban	Rural	Urban	Suburban	Rural
Minimum	67,892	63,000	5,300	117,000	80,000	63,000	93,202	120,000	80,000
Average	196,628	193,850	135,307	559,293	571,400	408,532	832,383	723,692	395,874
Maximum	388,600	367,000	351,000	2,074,000	1,375,000	1,100,000	2,130,000	2,138,400	1,100,000

Report of the Grid Resiliency Task Force, "Weathering the Storm," Office of Governor O'Malley, September 24, 2013

Lessons from the Gulf Coast: Hardening of the grid

Wind Protection

- Upgrading damaged poles and structures
- Strengthening poles with guy wires
- Burying power lines underground



Flood Protection

- Elevating substations/control rooms
- Relocating/constructing new lines and facilities

Modernization

- Installing asset tools and databases
- Deploying sensors and control technology

DOE, Office of Elec. Delivery and Energy Restoration, "Hardening and Resiliency: U.S. Energy Industry Response to Recent Hurricane Seasons," August 2010

Lessons from the Gulf Coast: Resiliency

General -specific readiness

- Conducting storm preparedness planning, training
- Complying with inspection protocols
- Managing vegetation
- Participating in mutual assistance groups
- Purchasing or leasing mobile transformers and substations
- Procuring spare T&D equipment

Storm-specific readiness

- Facilitating employee evacuation and reentry
- Securing emergency fuel contracts for vehicles and generators
- Supplying logistics to staging areas

Southern Company:

Installed ~4.4 million smart meters in 2012 (100% coverage of its service territory)

Important justification: Better system management as a result of enhanced outage notification and restoration information, as well as other operational data including voltage at metering points on the distribution line.

DOE, Office of Elec. Delivery and Energy Restoration, "Hardening and Resiliency: U.S. Energy Industry Response to Recent Hurricane Seasons," August 2010

Norwich CT Public Utilities

Preparedness for extreme storms:

- Vegetation management – supported by infrared inspections and pole integrity analyses
- GIS mapping of system
- Integration of communications (supported by fiber optic cable) of city first responders
- Smart grid metering
- Work with state's muni coop association to invest in / inventory small 2.5 MW power gen sets (e.g., for water and wastewater treatment)

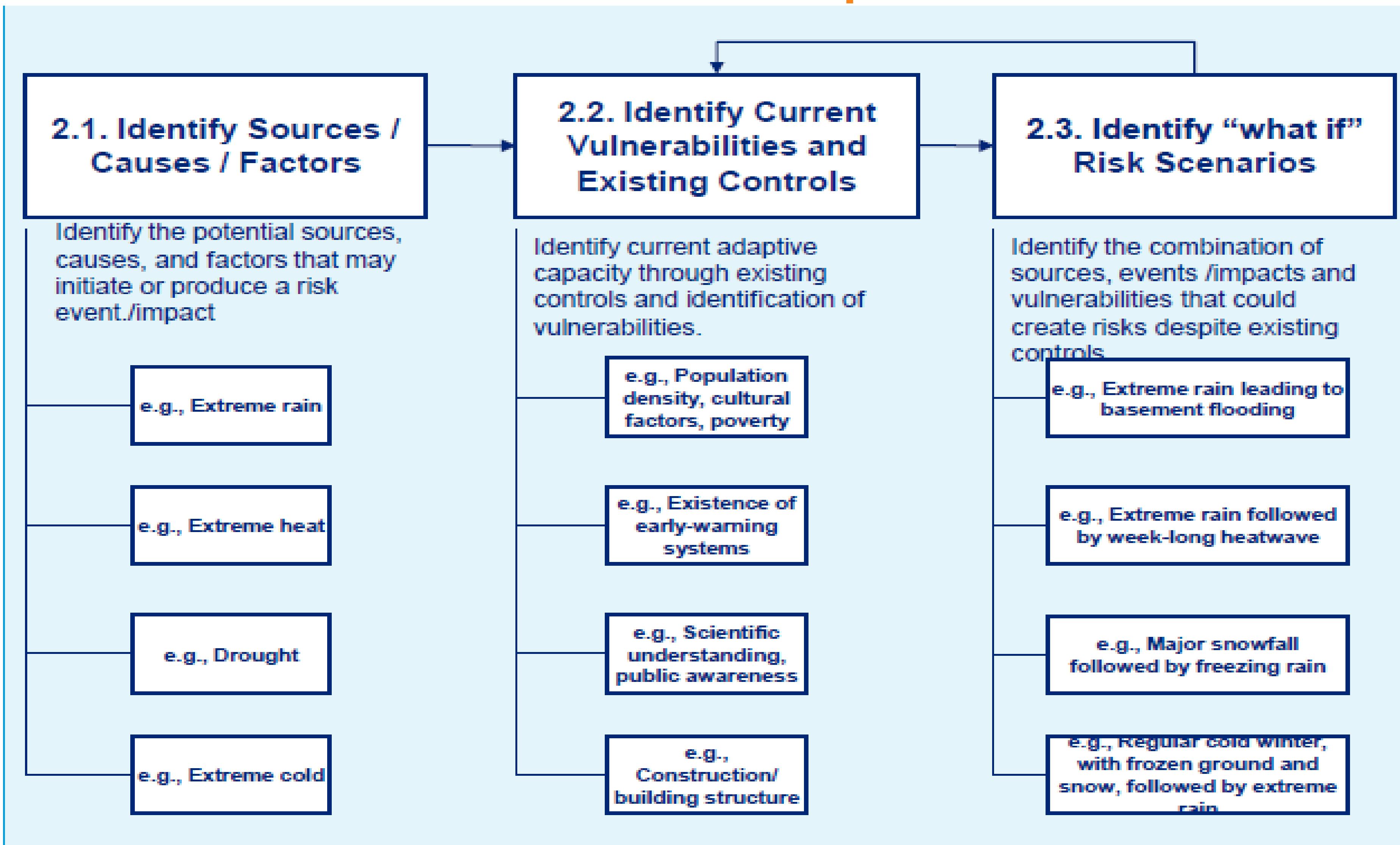
Toronto WeatherWise Partnership

Terms of Reference: Objectives

- Identify & understand extreme weather events in planned timeframes (short, medium and long).
- Identify the risk tolerance of major stakeholders to power disruption considering location & season.
- Quantify potential impacts on a sample of key components of electrical system and associated critical support infrastructure serving the Toronto region.
- Identify a general prioritized set of potential short, medium and long-term adaptation measures for the electrical system and/or customers.

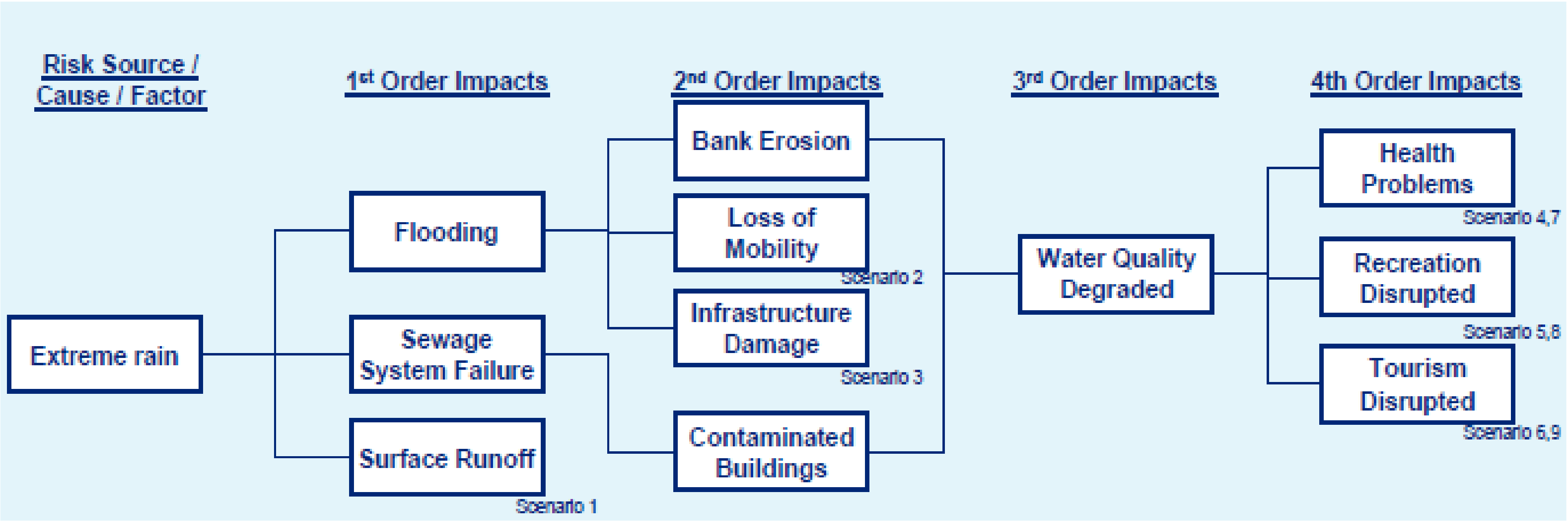
WeatherWise Partnership January 30, 2012, workshop overview, Facilitated by: Greater Toronto CivicAction Alliance , Toronto Environment Office

Toronto WeatherWise Partnership



Climate Change Risk Assessment WeatherWise Partnership meeting, January 30, 2012 City of Toronto Process and Tool

Toronto WeatherWise Partnership



Climate Change Risk Assessment WeatherWise Partnership meeting, January 30, 2012 City of Toronto Process and Tool

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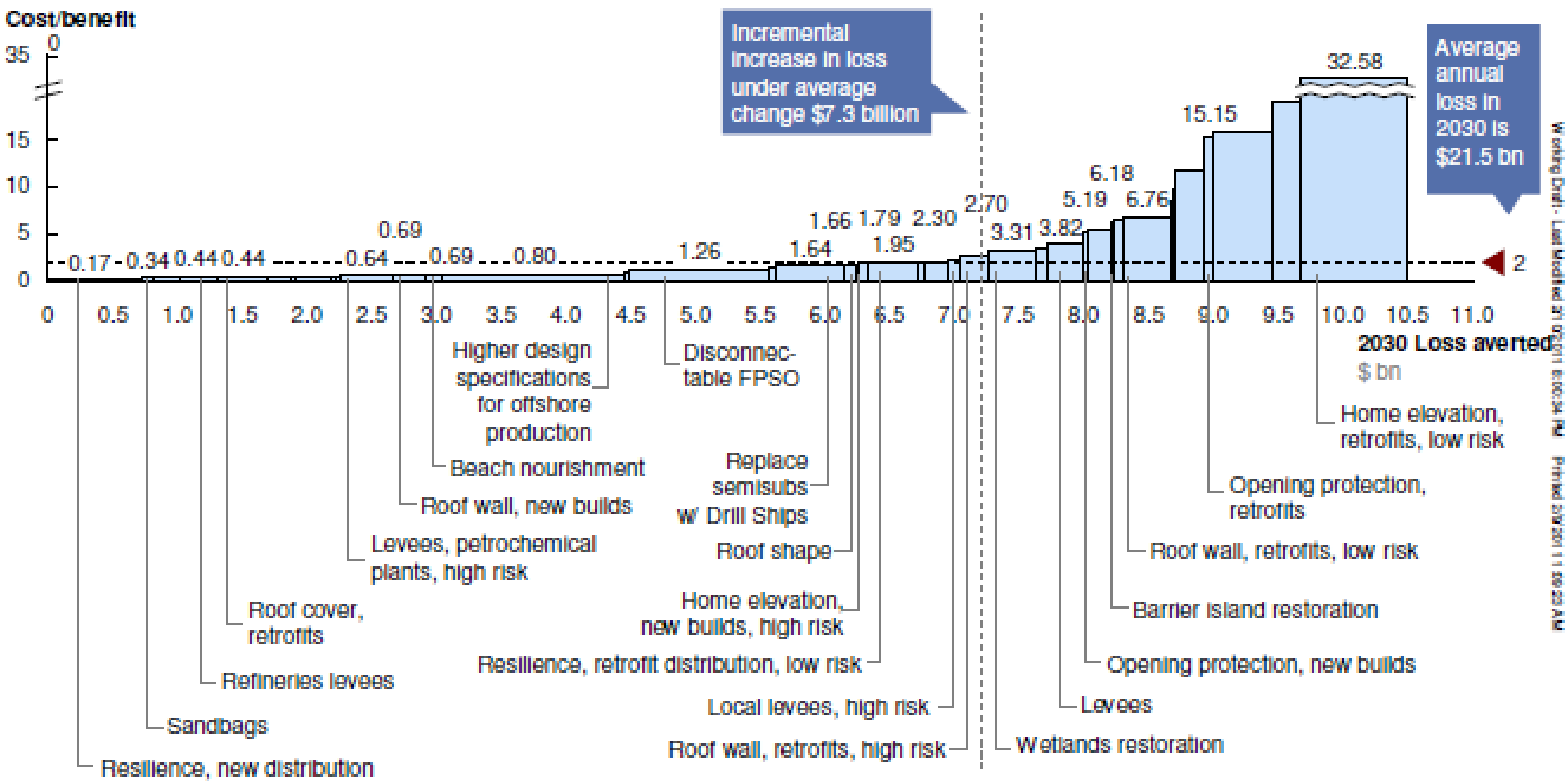
Adaptation – Cost/Benefit Supply curve (illustrative)



Humayun Tai, McKinsey, “Increasing resilience to natural hazards: framework for utility and societal impacts,” presentation to Harvard Electric Policy Group, December 7, 2012

Possible resilience and adaptation actions in energy sector

NCA Energy Chapter: Possible Actions	Extreme Weather	Greater Peak Use	Water Issues	Sea Level
Supply: System and Operational Planning				
Diversifying Supply Chains	X	X	X	X
Strengthening and Coordinating Emergency Response Plans	X	X	X	
Providing remote/protected emergency-response coordination centers	X			
Developing flood-management plans or improving stormwater management	X			X
Developing drought-management plans for reduced cooling flows			X	
Developing hydropower management plans/policies addressing extremes			X	
Supply: Existing Equipment Modifications				
Hardening/building redundancy into facilities	X	X		
Elevating water-sensitive equipment or redesigning elevation of intake structures	X			X
Building coastal barriers, dikes, or levees	X			X
Providing back-up power supply for grid interruptions	X	X	X	
Insulating equipment for temperature extremes	X			
Implementing dry or low-water hybrid (or recirculating) cooling systems for power plants			X	
Adding technologies/systems to pre-cool water discharges			X	
Using non-fresh water supplies: municipal effluent, brackish or seawater			X	
Relocating vulnerable facilities	X		X	X
Supply: New Equipment				
Adding peak generation, power storage capacity, and distributed generation	X	X	X	X
Adding back-up power supply for grid interruptions	X	X	X	
Increasing transmission capacity within and between regions	X	X	X	X
Use: Reduce Energy Demand				
Improving building energy and cooling-system efficiencies, and demand-response capabilities (e.g., smart grid)	X	X		
Setting higher ambient temperatures in buildings	X	X		
Improving irrigation and water distribution/reuse efficiency		X	X	
Allowing flexible work schedules to transfer energy use to off-peak hours		X		

Some references

Congressional Research Service, "Weather-Related Power Outages and Electric System Resiliency," August 2012

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HM Government, "Climate Resilient Infrastructure: Preparing for a Changing Climate," Presented to Parliament by the Secretary of State for Environment, Food and Rural Affairs, May 2011

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Deloitte, "Climate Change Risk Assessment, City of Toronto Process and Tool," WeatherWise Partnership, January 30, 2012

Testimony of John Bilda, General Manager of Norwich Public Utilities, Norwich, Connecticut, Submitted for the Record to the Senate Energy and Natural Resources Committee Hearing on Weather Related Electrical Outages, Thursday, April 26, 2012

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