ONTARIO CLIMATE CONSORTIUM

Assessing Climate Change Vulnerability in Ontario's Electrical Transmission Sector

Summary presentation prepared with the Support of Natural Resources Canada

September 17th, 2015

NODELCORP

RSI RISK SCIENCES INTERNATIONAL

ieso Independent Electricity System Operator

Toronto and Region Conservation for The Living City

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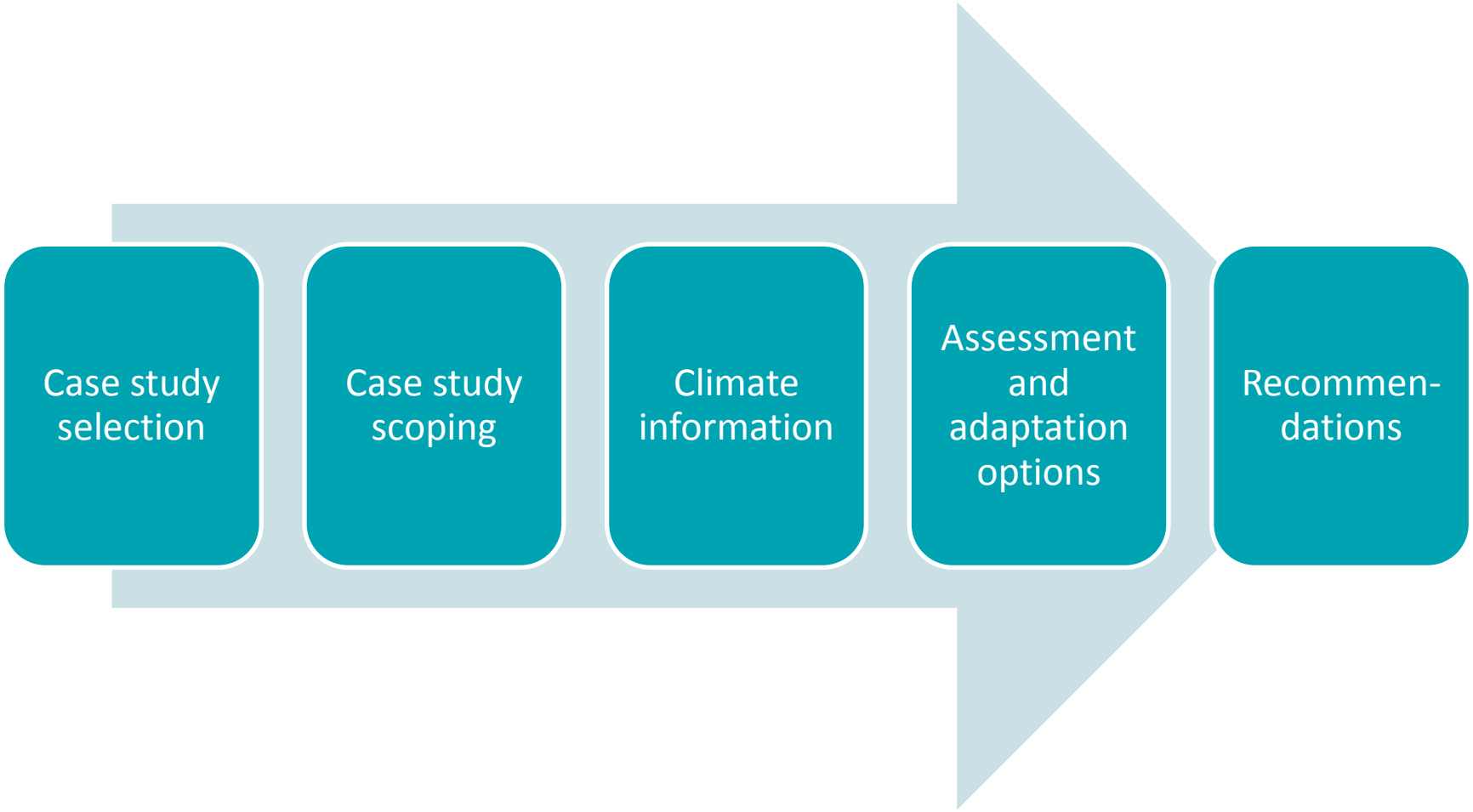
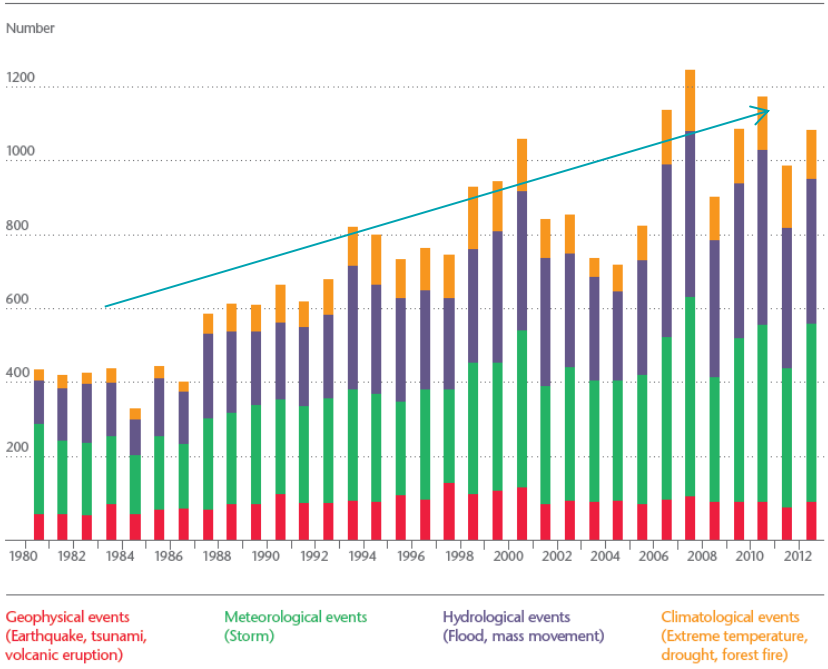
Project Overview



Context

Figure 1
Worldwide Natural Catastrophes 1980-2012



Source: Münchener Rückversicherungs-Gelleschaft (2013).

The Expert Panel on Climate Change Adaptation

Report to The Minister of The Environment

November 2009

Recommendation 9

The Ministry of Energy and Infrastructure should request the Independent Electricity System Operator, in accordance with its responsibility for maintaining the reliability of the electricity grid in the province, to complete a climate change risk assessment of the Province's electricity grid and to propose adaptive actions. This should be carried out in partnership with other energy agencies in Ontario such as the Ontario Power Authority, Hydro One and local distribution companies, and should be completed by the end of 2012.

Case Study Selection & Scoping

Major transmission station in GTA + Connected Circuits
Infrastructure components included in study

Above ground circuits

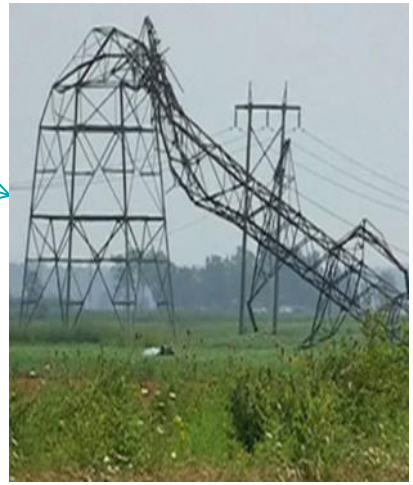
Above ground station components

Below ground station components

Case study scoping

Climate parameters considered in study

Tornadoes and other high wind events



Extreme rainfall

Ice storms

Extreme heat

Summary of Climate Parameters

Climate Element	Threshold	Probability – Historical	Probability – Future
Ice Storms	24 mm	20%	>30%
	29 mm	<7%	~10%
	50 mm	~1%	~1%
Tornadoes	(E)F-2+	~0.3%	~0.3%
Other high impact wind	120 km/h +	est. ~40%	est. ~40%
"Large Scale" wind storms	110 km/hr	20%	>30%
	120 km/hr	<7%	10%
Extreme Temperatures	35°C	100%	100%
	40°C	25%	100%

NB: These are figures developed for this particular study. Extreme caution is indicated for use or application in other cases

Assessment Results

General Observations

- Built-in redundancy through design and O&M procedures means that acute climate events studied are not likely to significantly affect delivery of services from case study location
  - 4 high risks identified; 87 “special cases”
  - Projecting incidence of small-scale extreme events is a challenge

Climate Parameter	Results
Ice accretion	• System-wide vulnerability, particularly on 230 kV segments
High impact wind	• Convective winds in excess of 120 km/hr • Debris impacts • Localized extreme wind events (i.e. microbursts)
Extreme heat	• Potential high risk associated with line sag over transportation corridors

Triple Bottom Line Module - Potential Adaptation Options

Alternative	Description
1	Northern community supplied by single circuit 115 kV line; Twinning, Redundant Design
2	Northern community supplied by single circuit 115 kV line; Enhanced Design, Asset Hardening.
3	Northern community supplied by single circuit 115 kV line; Low Voltage Redirection
4	500 kV transmission corridor carrying supply from major nuclear facility; Asset Hardening
5	Northern communities supplied by 115 kV transmission; Twinning, Redundant Design
6	Northern communities supplied by 115 kV transmission; Local Generation

Triple Bottom Line Results

Alternative 4 the priority when economic factors weighted highest

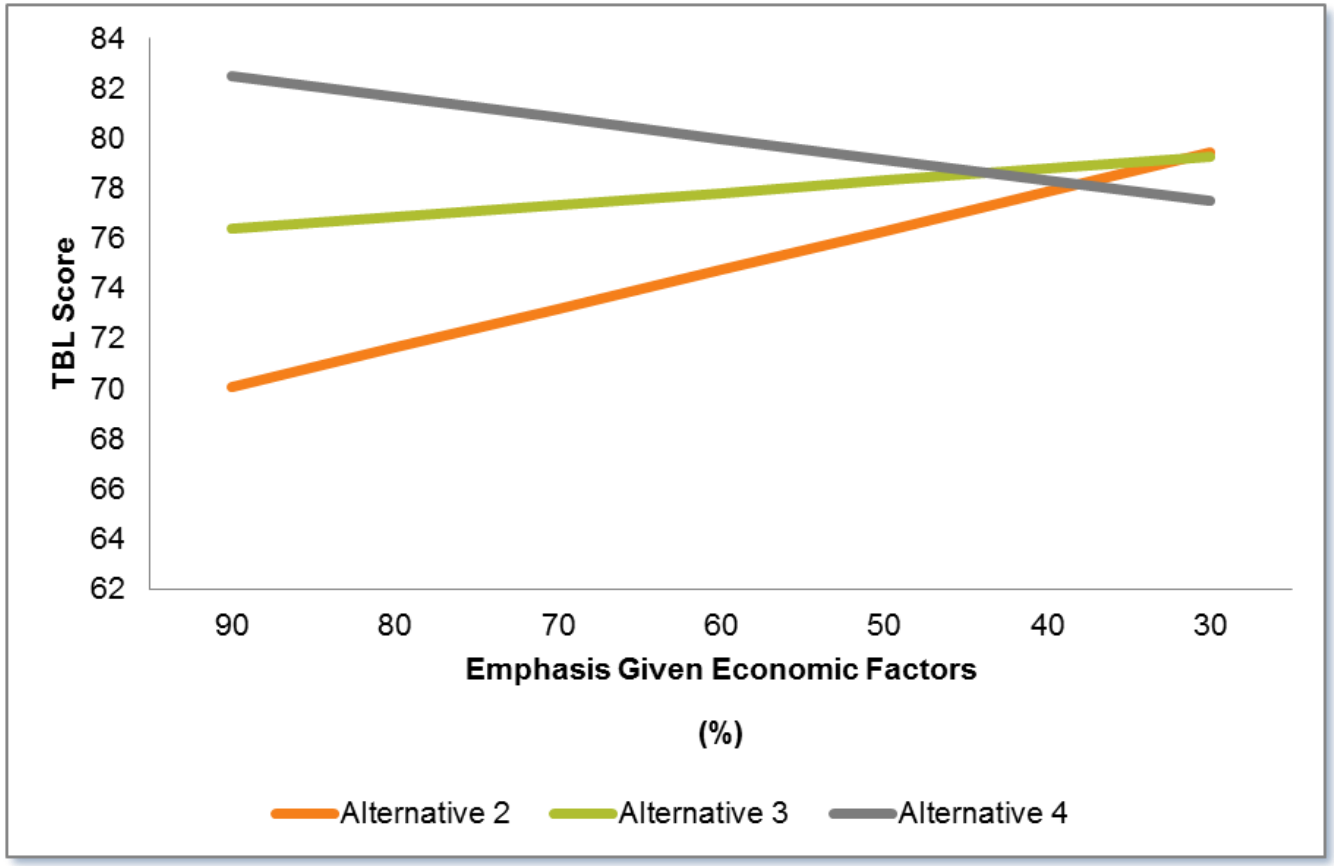


Figure 2 - TBL Sensitivity Analysis. Adjusting Economic Emphasis for most promising alternatives

Recommendations

- Monitor frequency and impact of ice and wind storm events
- Survey transmission system-transportation system crossings
- Additional forensic analysis of four-wire bundles
- Increase availability of long-term historical climate data
- Improve early warning systems
- Conduct a more in-depth triple bottom line assessment

Questions?

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