Building the climate resilience of electric utilities:

The role of Canadian municipalities

Alliance of Resilient Cities Workshop

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About Acclimatise

Acclimatise is the market **leader in climate risk management** consultancy and intelligence services. We help businesses and governments assess and manage the risks and opportunities of inevitable climate change by:

- **Bridging the gap** between the scientific community and the corporate world, reviewing the latest climate change science, providing clear guidance on the potential business and financial impacts.
- Working with our clients to understand the **direct and indirect climate change implications** for their strategies and business models.
- Assessing the implications for **financial performance**, as well as for issues including brand, reputation and litigation risk.
- Advising on the **climate change positions** being taken by our clients' key stakeholders, including governments, regulatory agencies, investors, banks, insurers, analysts and NGOs.
- Advising on **robust strategies** to manage risks and uncertainties and realise business opportunities.

Building climate resilience

acclimatise
managing your climate risks





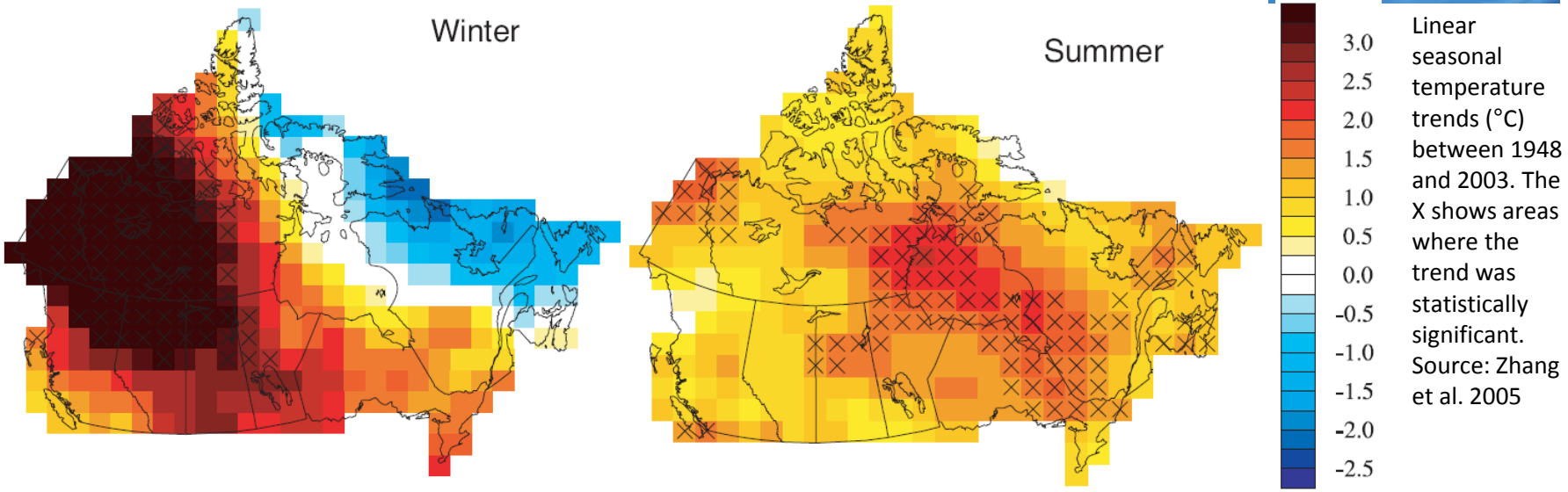
Isle of Man Government


Netherlands Government


Overview

- Key climate change risks to the electricity sector in Canada (generation, transmission and distribution)
- Key adaptation responses to climate change for Canadian municipalities

Two climate change challenges: mitigation and adaptation



Linear seasonal temperature trends (°C) between 1948 and 2003. The X shows areas where the trend was statistically significant. Source: Zhang et al. 2005

- Climate change is underway.
  - Whatever steps we take to limit GHG concentrations we are now faced with decades of increasing temperatures and possibly centuries of sea-level rise.
  - Limiting global average temperature rise to 2°C is looking increasingly challenging. If we fail, the adaptation challenge becomes even greater.
- "The impacts of climate change are already evident in every region of Canada." (Lemmen et al. 2008)
- Organisations face two climate challenges: Reduce emissions to avoid the unmanageable & adapt to the climatic changes already underway to manage the unavoidable.

KEY CLIMATE RISKS TO ELECTRICITY GENERATION, TRANSMISSION AND DISTRIBUTION IN CANADA:

WHAT ARE THE IMPLICATIONS FOR CANADIAN MUNICIPALITIES?

Changing climate hazards

- Increasing average temperatures
- Increasing temperature extremes
- Increasing glacier, ice, snow and permafrost melting
- Changes in average seasonal and intense precipitation
- Increasing mean sea level
- Possible increases in storminess and storm surge heights

Compound variables & indirect environmental effects

Changes in:

- Availability of water resources
- Water quality
- Sea surface and river water temperature
- Floods
- Droughts
- Cloud cover
- Humidity
- Evaporation and evapotranspiration
- Soil moisture deficit
- Soil movements (e.g. landslips)
- Soil and coastal erosion
- Fire
- Growing season length

The combination of these hazards will have impacts on electricity companies through:

- Natural resources and raw materials, including water
- Supply chains, transport and logistics
- New asset design and construction
- Existing asset operation, performance and maintenance
- Markets and customers
- Workforces
- Social and environmental performance
- Reputation
- Laws, regulations and finance

The chain of cause-consequences of climate change in the context of electricity

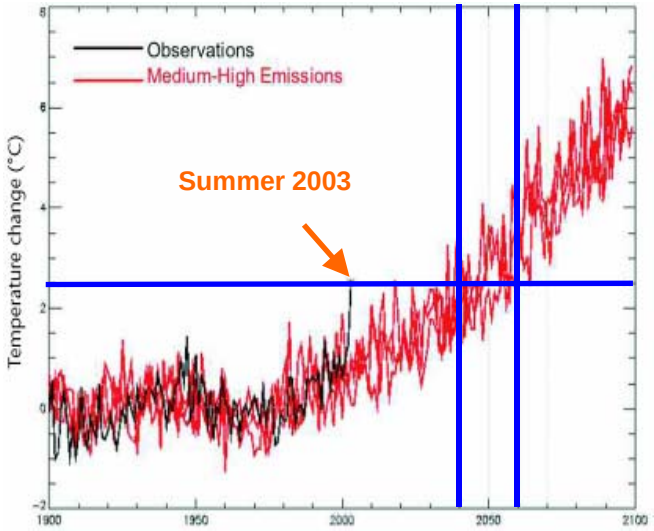
Top risks identified and assessed by global electric companies (Source: CDP, 2009)

Top risks identified by respondents	Top risks where there is evidence of risk assessments
1. Distribution grids negatively affected by extreme events	1. Distribution grids negatively affected by extreme events
2. Changing levels of precipitation leading to variable river levels for hydropower	2. Assets compromised by extreme weather events
3. Assets compromised by extreme weather events	3. Changing levels of precipitation leading to variable river levels for hydro
4. Increased energy demand for air conditioning and refrigeration in summer	4. Disruptions to off-site utilities (e.g. communications, water, waste treatment, etc.)
5. Reduced river flows and efficiency of cooling processes	5.Rising temperatures will increase energy demand for air conditioning and refrigeration in summer
6. Wholesale and retail energy prices will remain volatile	6. Wholesale and retail energy prices will remain volatile
7. Milder winters will result in less demand	7. Customer expectations of secure energy provision will place increasing pressure on companies
8. Disruptions to off-site utilities (e.g. communications, water, waste treatment, etc.)	8a. Increased interruptions to transport systems 8b. Restrictions on water abstraction and efficiency of cooling
9. Changes in sea level and flooding will compromise assets	9a. Changes in sea level and flooding compromising assets 9b. Increase of wholesale and retail energy prices because of restrictions in supply 9c. Litigation becomes more significant
10. Changes in wind pattern that could affect the wind energy production	

Differences in the climate vulnerability of electricity generation assets

Thermal and nuclear

- Rising water temperature reduces efficiency of water cooling systems and forces output reductions or plant shutdowns due to environmental regulations



Example:

- During the European heat wave of 2003, 3 generating stations reduced outputs and 14 were shut down in France.
- Shut-down and output reductions were enforced through environmental regulations to protect water resources and water quality.
- In France EDF used the open market to secure electricity from other countries to meet its generating shortfall.
- The cost of electricity rose substantially. EDF was not allowed to pass on the increases to consumers ($300 million). The supply restrictions in France had a knock-on effect in the UK and elsewhere, creating significant wholesale and retail price fluctuations.

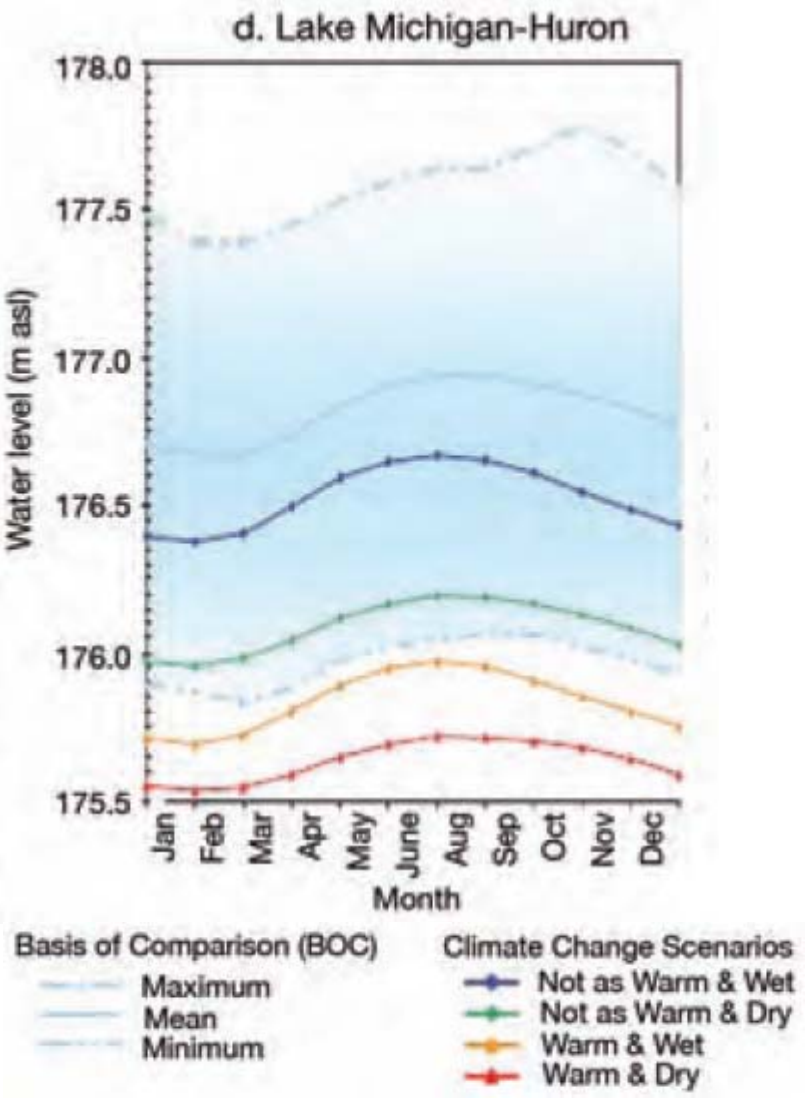
Differences in the climate vulnerability of electricity generation assets (cont.)

Hydropower

- Water levels on the Great Lakes characterised by interannual variability (in the past 15 years a range of ~180cm between the min and max water levels).
- Climate change models project lower water levels on the Great Lakes (below the lower bounds of observed variability in the last 50 years): down by 0.7-1.2m by the 2050s compared to 1900-1989 in lake Michigan-Huron
- Potential loss of estimated hydropower capacity of the Great Lakes up to 1,100MW per year (higher climate change scenario and higher water year); corresponds to half of Ontario's capacity.

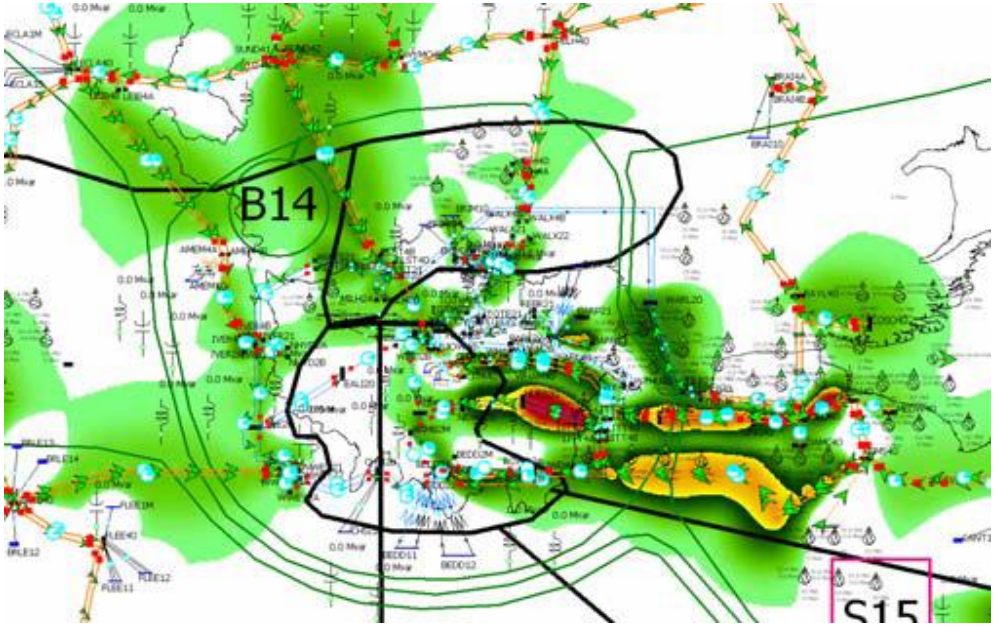
Wind

- In situ observational datasets in the US show decreasing trends between 1973 and 2005 in the 50th and 90th percentiles (other data sources show different trends); up to a 10% decrease in average wind speed in some regions (Pryor et al., 2009)
- Decreased average wind speed and peak winds will translate into reduced electricity output



Transmission failures due to increased peak demand in extreme weather

- Higher temperatures and increased climate variability could increase peak demand and electricity loads on transmission and distribution systems.
- Northeast blackout of August 2003: A chain of causes with a relation to climate
  - Transmission loads in Northern Ohio moderately high to serve AC demand; 'Peak load conditions on a less than peak load day'
  - Loss of a production unit led to higher transmission loadings



- Lack of appropriate monitoring, contingency planning and support from the organisations insuring the reliability of the interconnected grid
- Transmission line sag due to high loading and high temperatures led to tree-to-line contacts causing short-circuits

Left: projected overloads on the distribution system due to climate change by the 2020s (between 12pm and 3pm, under a high GHG emission scenario)

Pink= 100% overloading, red=65% overloading, yellow=39% overloading, green= marginal overloading.

Implications for project finance and insurance of electricity assets

- The International Finance Corporation Performance Standards on Social and Environmental Sustainability are under review.

➢ *"IFC also believes that the private sector needs to implement risk-appropriate climate adaptation measures"*

➢ *"It is now clear that the risks and impacts from climate change: (i) should be appropriately addressed in environmental and social assessments." (IFC Progress report April 2010)*

- Knock-on effects for the Equator Principles for project finance
- "These impacts may be valid considerations in credit risk analysis for lending banks."
- Increased insurance premiums in risky locations

Putting climate risks to electric utilities into perspective for municipalities

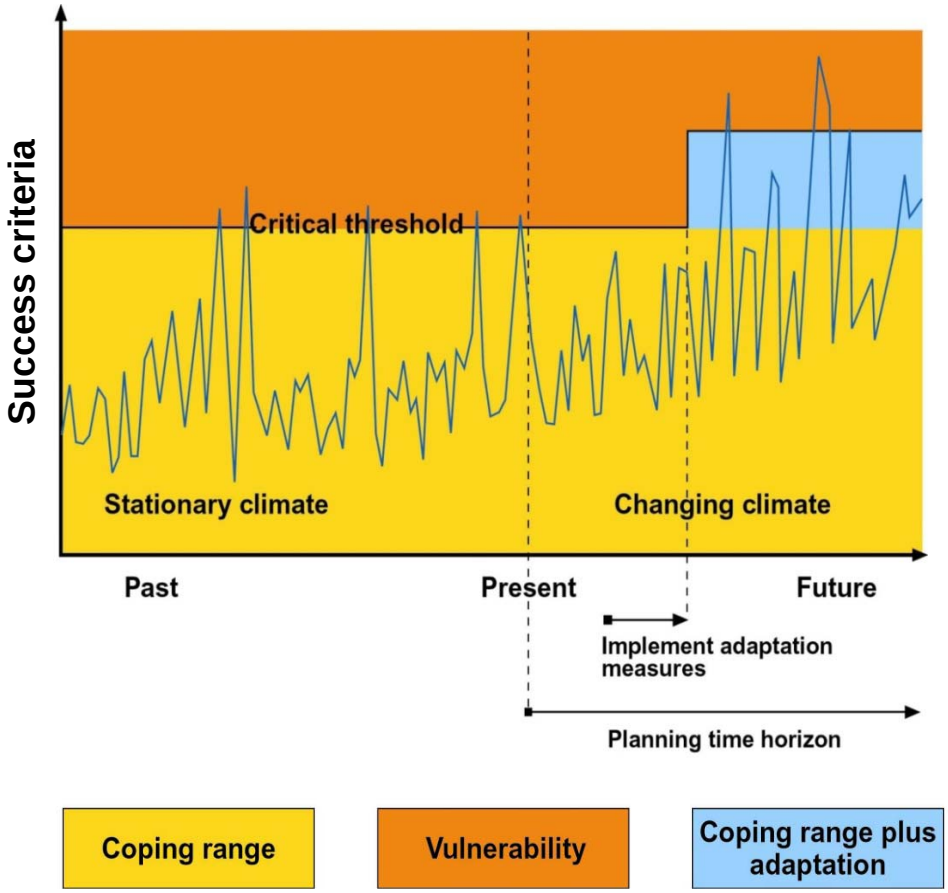
Municipalities as owners	Municipalities as customers
Decreased output of electricity generation assets	Decreased electricity reliability
Increased summer demand and decreased winter demand and possible increased peak demand	Increased electricity costs
Increased costs to comply with laws and regulations	
Increased capital costs to maintain, repair and replace assets	
Increased operational costs to manage reduced efficiencies	
Increased requirements to access project finance and increased insurance costs	
Increased risk of litigation	

KEY ADAPTATION MEASURES FOR ELECTRIC UTILITIES:

WHAT IS THE ROLE OF CANADIAN MUNICIPALITIES?

A risk-based approach to manage climate risks for electric utilities in an integrated manner

- Important to evaluate impacts driven by both:
  - Extreme (acute) events AND
  - Incremental (chronic) changes
- Ask how these changes could affect performance, critical thresholds, etc.
- Ask how the impacts can be managed by business continuity measures, or by changes to assets and business systems
- Ask what can be the process, operational or capital investment response



[Source: Willows & Connell, 2003]

A checklist of actions to build adaptive capacity

Types of actions	Example and role for municipalities (as owners in black and as customers in red)
Research and analysis No-regret	• Climate risk assessments and cost-benefit analyses incorporated into planning (asset design and refurbishment) • *Funding or collaboration with Regional Adaptation Collaboratives*
Data collection and monitoring No-regret	• Monitor impacts of climate factors on asset performance • *Provide local weather and hydrological observations*
Changing or developing regulations, standards, codes, etc. Low-regret	• Incorporate climate change risks into proposals, ESIAs and planning for new and existing assets • *Develop tariffs and incentives to manage climate risks* • *Require developers to consider climate change risks in proposals and contracts* • *Promote review of best practice design codes*
Raise awareness and develop organisational capacity No-regret	• Raise awareness of climate change and its impacts on generation and distribution and find champions in the industry • *Committee or collaborative organisation to oversee action on climate resilience*
Work in partnership No-regret	• Power-sector stakeholders and organisations dependent on the power sector could work together to understand risks and develop adaptation measures. • Set up joint initiatives

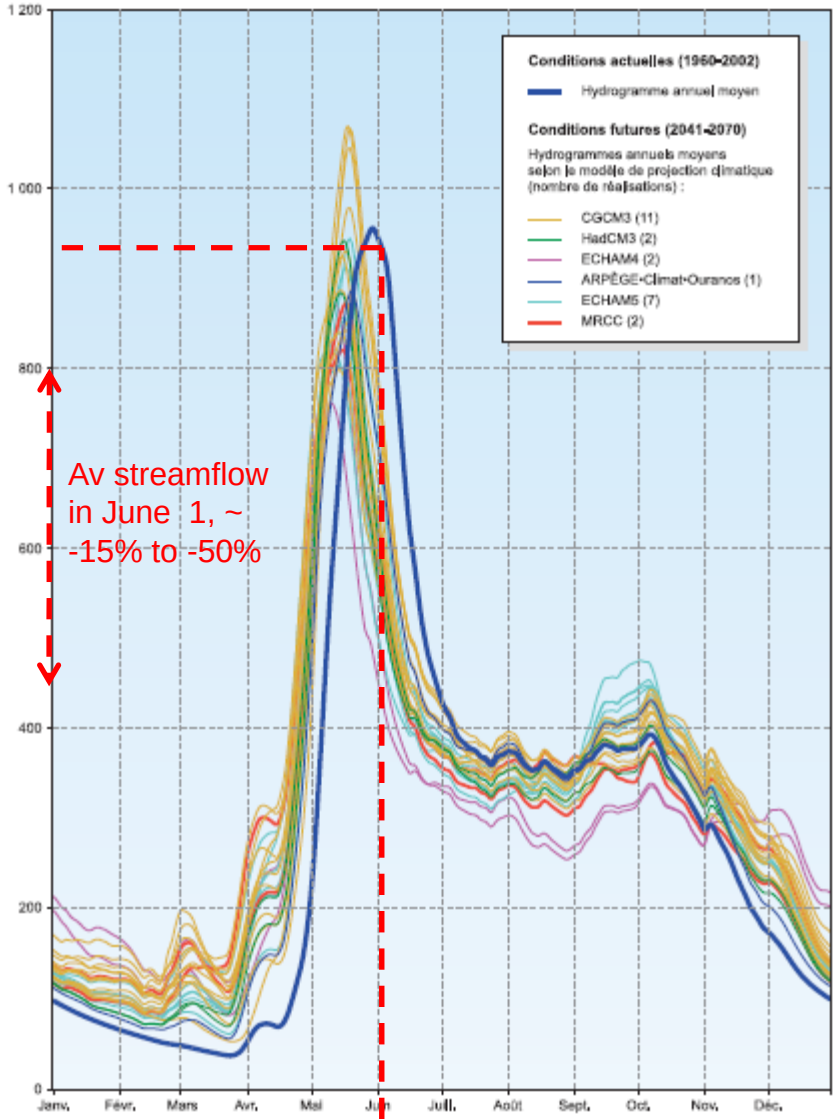
A checklist of actions to deliver adaptation benefits

Types of actions	Example and role for municipalities (as owners in black and as customers in red)
Spread and share impacts Mixed	• Diversify generation technologies • Regional energy trading could help to spread risks of disruptions to supply • Use of insurance mechanisms • *Review existing electricity strategy to promote diversification* • *Review of existing requirements by electricity regulators*
Avoid negative impacts Mixed	• Design new assets to be climate resilient • Engineering solutions could improve efficiency of generation, transmission and distribution • Contingency planning to support a response to increasing risk of heat waves and droughts • *Engage with utilities and require disclosure*
Exploit opportunities Low-regret	• Improve demand-side energy efficiency / Win-win • Identify and consider developing technologies favoured by future climate change conditions • *Set standards for energy efficiency and favourable electricity generation technologies*
Accept some impacts and bear some loss Low-regret	• Identify key assets at risk and plan for their future management • *Engage with utilities and require disclosure*

Examples of integration of climate change impact and adaptation into asset design

1. Hydro Québec ESIA for 'La Romaine' HPP
   - Considered climate change impacts on stream flow (m3/sec), see opposite
   - Found decreased stream flow in Jul-Sept, increase in Nov-April and earlier peak flows.

2. East Lakes 132kV substation, sub transmission line and cable routes ESIA (New South Wales, Australia)
   - Substation (E4) located on the banks of a lake and next to a wetland
   - Climate change modelling indicates:
     - By 2070, moderate flood risk (low GHG scenario) or high flood risk (high GHG scenario)
     - Recommended mitigation measure: all electrical equipment of E4 should be 2m above the probable max flood level (land movement risk considered low)



Hands On Energy Adaptation Toolkit (HEAT): A tool for municipalities as stakeholders

- **Risk-based process** to inform municipalities about how to adapt their electricity supply to improve resilience to climate variability and climate change.
- Process with **8 stages** based around 2 participatory workshops:

  # Workshop 1: Climate risks & vulnerabilities

  # Workshop 2: Climate risk management & cost-benefit analysis
- **Outputs** are:

  # **High-level (semi-quantitative) assessment** of key risks and adaptation options for the energy sector

  # **Greater awareness and deeper understanding among stakeholders**

  # Clarity on where subsequent **more in-depth analyses** should be focused

Climate Risk Management Frameworks: a tool for municipalities as owners. Example of BG Group

BG now includes mandatory requirements governing climate change adaptation as part of its Environmental Expectations Standard (EES).

This sets out how BG assesses risks to operations from foreseeable environmental changes arising from climate change

- A Climate Change Risk Management Framework (CCRM) developed by Acclimatise supports all assets and new projects in delivering against the EES.
  - Specifies the step-by-step procedure to follow, based on the BG Group Business Risk Management Process.
  - The CCRM uses a database developed by Acclimatise, that identifies and provides all the current information for relevant climate parameters for each of the 25 geographical areas in which BG operates.
  - BG staff can interrogate the system to identify the latest information relevant to their asset or project.
- BG recognizes that this is a new challenge based on predictions that are uncertain.
- Climate risk assessments are now being carried out on both existing assets and new projects.
- In new projects the risks identified are incorporated within the project engineering design process

Thank you

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Additional information: IBM / Acclimatise
Prepare-adapt: 10 questions for electric utilities

- Questions to senior executives developed in 2009 with IBM as part of a series of reports for the Carbon Disclosure Project

- To aid senior executives of electric utilities take the right steps towards building business resilience by exploring risks, opportunities and responses.

- Can be a tool for municipalities worried about the climate resilience of electricity supply to engage with utilities by promoting disclosure

Your risks

1 What are the operational impacts on your company of climate change?

- What are the implications for the operating performance and efficiency of your existing assets under changing climatic conditions?
- How will the impacts of climate change on the other operators in the electricity value chain affect your business?
- How will changes in water resources and water quality together with increased competition from other users affect your operational capacity?

2 Are your current and planned major operating assets located in areas vulnerable to climate change impacts and what are the implications?

- What steps are you taking to design new assets against future climate impacts, what costs would be involved to relocate (where appropriate) and undertake remedial works to provide resilience to existing assets?
- What are the implications of depreciating, abandoning or writing-off assets or of extending asset life through optimisation actions?
- How will the operational performance of your asset portfolio change over time?

Your risks

3 How sensitive is demand for your products and services to climate change impacts?

- How will customer needs, buying behaviour and ability to pay change and over what timescale?
- What are the implications of increasing urbanisation and changing energy demand profiles?
- What are the implications arising from changes in the demographics of the countries in which you operate?

4 How could current and future climate change regulations and industry standards affect your organisation and its reputation?

- What is your level of regulatory and financial exposure to the introduction of prescriptive legislation on adaptation, together with further legislation on urgent mitigation action, as the reality of climate change becomes more pressing?
- How effective and auditable is your process for reporting regulatory and policy compliance?
- Which areas of your business are sensitive to media, NGO and local community concerns?

Your opportunities

5 What new and enhanced existing products and services can you offer your customers?

- What steps are you taking to develop new or enhanced business opportunities that will provide competitive leadership?
- How will you develop brand stretch to take advantage of changes in customer behaviours and develop climate related markets?
- Can you provide products and services that that will help commercial and domestic customers predict, monitor, and adapt to the impacts of climate change as well as enhance their efforts to reduce their emissions footprint?

6 What benefits could you realise from better managing your response to climate change?

- How can you improve the attractiveness of your company to investors, banks, credit rating agencies, employees and potential recruits?
- How will you use the current economic crisis as an opportunity and an incentive to revisit your business model and respond to the growing social, environmental and economic challenges?
- What are the cost advantages if you can secure more favourable insurance cover by demonstrating strong operational risk management processes limiting potential consequential loss claims?

Your response

7 How clear and effective are your internal management responsibilities for climate change and your engagement with stakeholders?

- To what extent are your internal climate change leadership and management roles clearly defined, supported and empowered to meet fiduciary responsibilities?
- How are you sharing information with and influencing governments, regulatory bodies, NGOs, consumer groups and the media to manage and forecast exposure?
- What actions are you taking to ensure that the investment community, your bankers and insurers understand and support the steps you are taking regarding climate risk?

8 How well structured is your approach for managing climate change?

- How effective is your process for exploring longer term scenarios and identifying risks and opportunity signals as they emerge to plan and act accordingly?
- How are you assessing the vulnerability of your raw materials and resources, suppliers, assets, operations, workforce and markets to changing risks?
- What steps are you taking to ensure that climate change driven business risks and opportunities are integrated into your decision making through optimisation, growth of existing capabilities, and acceleration of new commercial technologies?

Your response

9 How can you ensure that your approach is based on robust information and assumptions?

- How have you integrated the latest available climate science and climate change scenarios to inform your business planning and decisions?
- Are your management information systems for raw materials and resources, assets, supply chains, operations, markets and customers reporting on and monitoring climate change KPIs using real-time, interconnected and intelligent data?
- Can your information systems provide an early warning of climate change driven signals of changes in operational performance and demand profiles?

10 How can you demonstrate that your climate business resilience plans are realistic and financially viable?

- What actions have you taken to understand and manage future liquidity and ensure sufficient contingency funding in preparation for more intense and frequent extreme climatic events?
- How do your business continuity and crisis management plans reflect the changing risk profiles due to climate change and are they well-rehearsed?
- What steps are you taking to involve your employees, develop new skills and expertise to grow your internal capability and accelerate the commercialisation of new technologies?