

Climate Change Adaptation Program at BC Hydro Transmission

by

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BC Hydro Transmission and Distribution
Research and Development



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Power Systems Engineering Research Centre
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Outline

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Introduction

- Climate conditions, such as temperature, precipitation and wind, play a major role in the design, operation and asset management of transmission systems.
- The Intergovernmental Panel on Climate Change (IPCC) has presented compelling evidence of climate change that will impact transmission risk exposure.

What is greenhouse gas (GHG)?

Gases that trap heat in the atmosphere are called greenhouse gases.

- Carbon dioxide
- Methane
- Nitrous oxide
- Fluorated gases – potent greenhouse gases , sometime referred to as High Global Warming Potential (GWP) gases (SF₆, CFCs)
- Using 1 liter of gasoline produces 2.4 kg of CO₂
- 1 kg of SF₆ has 23,900 kg of CO₂

Introduction

- The British Columbia Government has declared that all Crown Corporations will play a key role in supporting the Government's Climate Change Agenda.
- At least 33% reduction in GHG in BC below 2008 levels by 2020
- All Crown Corporations will be carbon neutral by 2010
- Net zero GHG emission.
- Reduction will occur at-source and via purchase offsets for residual emissions.

Background

BC Hydro Transmission

- Responsible for planning, operation & asset management of BC's transmission infrastructure (challenging terrain & weather conditions)
- 18,600 km of high voltage electrical transmission lines
- 300 substations
- Backbone of the BC economy

Components of BC Hydro Transmission Program

- 1. Compliance (meet government, regulatory and voluntary requirements)**
- 2. Risk and Financial Management (identify and manage emissions, assess and manage climate change risk and impacts)**
- 3. Innovation and Engagement (innovative technologies & processes, employee education and participation)**

The Difference between Weather and Climate

- **Weather is the condition of the atmosphere over a short period of time.**
- **Climate is how the atmosphere behaves over a relatively long period of time (typically 30 years).**
- **“Climate is what you expect and weather is what you get”.**

What can we expect from climate change ?

More severe and extreme weather patterns



Background

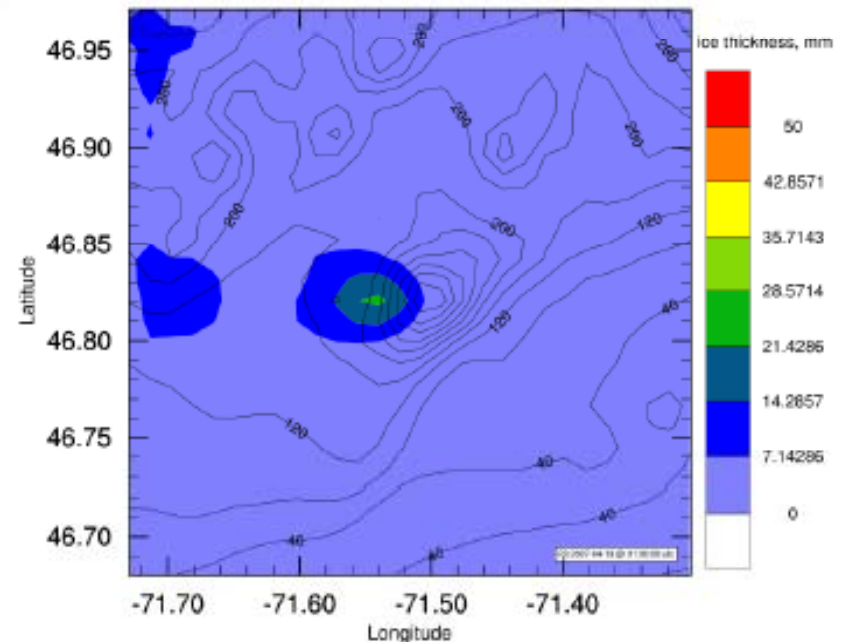
Our Studies

- Selected the year 2050 as a base year for considering climate change impact
- Collaborations with Environment Canada, University of Victoria, University of British Columbia, Pacific Climate Change Consortium, University of Alberta, and others

Investigative Measures

- Downscaling global climate models (UVic, UofA)
- High resolution modeling of long term climate impacts at location of transmission assets

Icing map: absolute discrete scale



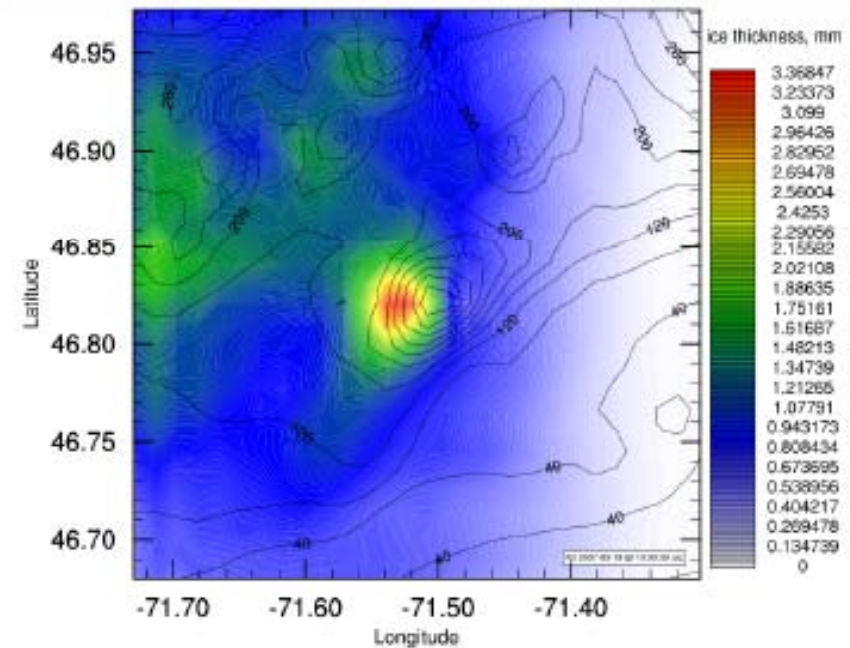
Event: Mt. Belair, April 15, 2007 – 6.1 mm of ice

Map from Petr Musilek's presentation on "Modeling and Forecasting Icing Events Using Regular Weather Models
CEATI Project # T073700-3344"

Investigative Measures

- **Thematic Maps:**
 - **Overlay specific climate information on a geographic view of the transmission system**
 - **Compare patterns of two or more climate variables**

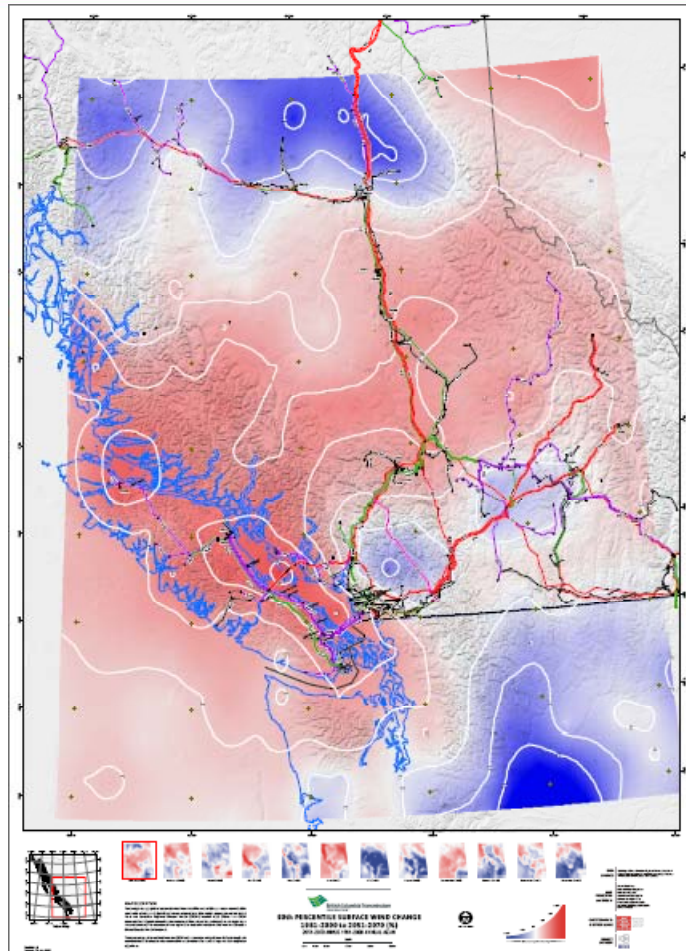
Icing map: relative continuous scale



Event: Mt. Belair, May 17, 2007 – 2.6 mm of ice

Map from Petr Musilek's presentation on "Modeling and Forecasting Icing Events Using Regular Weather Models
CEATI Project # T073700-3344"

Wind Change Study



90th PERCENTILE SURFACE WIND CHANGE 1981-2000 to 2051-2070 (%)

2051-2070 MINUS 1981-2000 ANNUAL MEAN

Dr. Charles Curry: A Study of Present and
Projected Surface Winds in Southwestern BC

Sponsored by BCTC, BC Hydro and MITACS

BC hydro 
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Temperature Change

Climate modeling indicates BC's average temperature will increase, with more extremes (higher and lower than usual)

Impact:

- **Mountain Pine Beetle infestation**
- **Drier summers (fire risk, mudslides, slope stability issues)**
- **River erosion, flooding**
- **Woodpeckers**
- **Changes to energy and peak load consumption patterns**

Temperature Change Impact

Mountain Pine Beetle Infestation



An example of MPB infestation. From “BC’s Bioenergy Strategy: Growing BC’s Natural Energy Advantage”, Feb 22, 2008

Temperature Change Impact

Mudslides, slope stability issues



Temperature Change Impact

- Woodpeckers
- Other animals

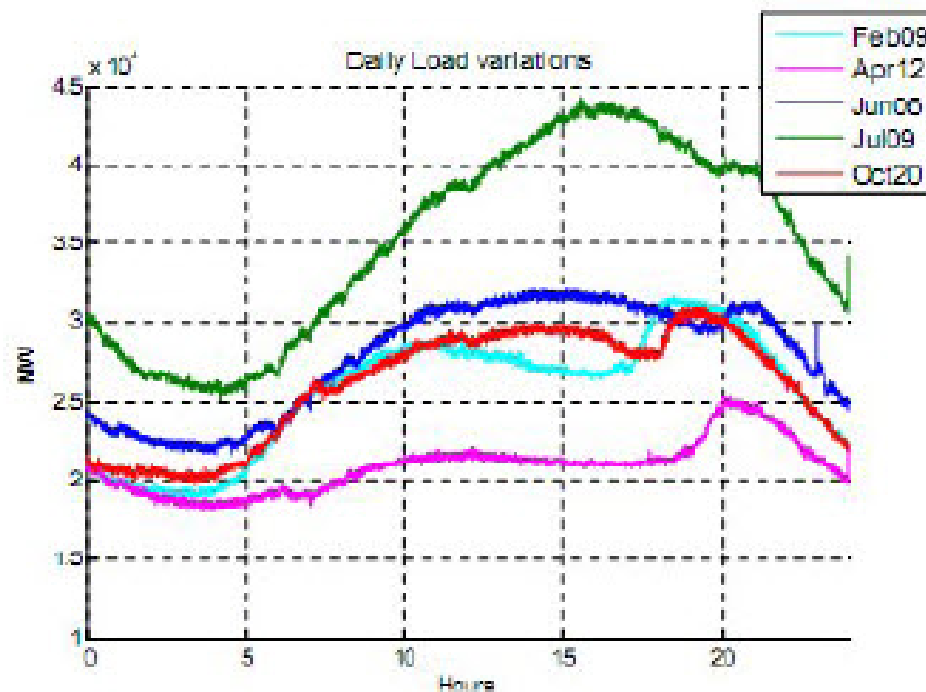


Temperature Change Impact

Changes to energy and peak load consumption patterns

How can it be so different?

Typical daily load variations in California in various seasons, in 10,000 MWs



Source: CEC. June 2010

Precipitation Change

Many parts of BC will experience significant increases in precipitation.

Impact:

- Outages from mudslides, flooding, trees falling from weakened roots
- Increased corrosion rates on transmission hardware
- Reduced opportunity for live-line work due to rainy days
- Projected increase in severity and duration of wind and ice storms
- Higher frequency and severity of hail storms

Wind Change

Studies predict the average wind speed will increase significantly in certain parts of BC.

- **Changes in wind speed (gusts and turbulence) and direction will increase failures, recovery time, and overall reliability.**
- **Changing wind direction damages trees that have adapted to dominant wind direction**
- **Need to adjust vegetation control practices**
- **Wind withstand levels of transmission hardware will need to be increased.**
- **Future wind generation impact**

Rising Sea/Ocean Levels

- Expected that sea/ocean water will rise up to 90 cm by 2100.
- Facilities estuaries could be in danger.
- Seaside facilities at high voltage undersea cable terminal could be under water.

Taxeda Island 500 kV
sea shore terminal



Changing Permafrost

- Expected that permafrost areas will melt.
- Facilities in permafrost will be affected.
- Maintenance and structural integrity of transmission lines could be affected.

Winter maintenance at a transmission line in permafrost area



Other Climate Issues

- **Expected increase in lightning activities during storms. Impact: increase risk of transmission outages and forest fires.**
- **Fog increase in certain areas. Impact: limit line access and increased cloud icing and flashovers.**
- **Change in vegetation growth rates. Impact: vegetation maintenance frequency and cost.**

Other Climate Issues

- Reduced helicopter and rights-of-way access due to hydrology and extreme weather conditions. A driver for robotics and remote sensing.
- Transmission line thermal ratings could be affected since they depend on ambient temperature, wind speed, solar radiation, etc.



SIREX helicopter

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Hydro Quebec Linescout

Adaptation Measures

- Develop specialized weather prediction services (UBC, UofA)
- Identify tree failure risks as a function of storm severity (UBC)
- Modify current maintenance and design standards for lines
- Research and demonstrate dynamic thermal ratings for lines and equipment



Shaw ThermalRate Dynamic Thermal
Rating System

Adaptation Measures

- Researching and applying high performance corrosion resistant materials for transmission hardware and structures
- Review of emergency response measures
- Incorporate climate change risks into corporate risk model
- Future plans to apply probabilistic planning techniques to assess the reliability risks of climate change



Crossarm made of advanced high performance composite material (developed with BC Hydro R&D)

Transmission Innovations Inc

Conclusion

- Climate change will have adverse impact on the planning, operation, and asset management of the high voltage transmission system.
- Electric utilities must address this issue by adopting new:
 - Weather / climate modeling and forecast tools
 - Risk analysis
 - Asset management practices
 - Design standards.

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