MANITOBA HYDRO CLIMATE CHANGE STUDIES

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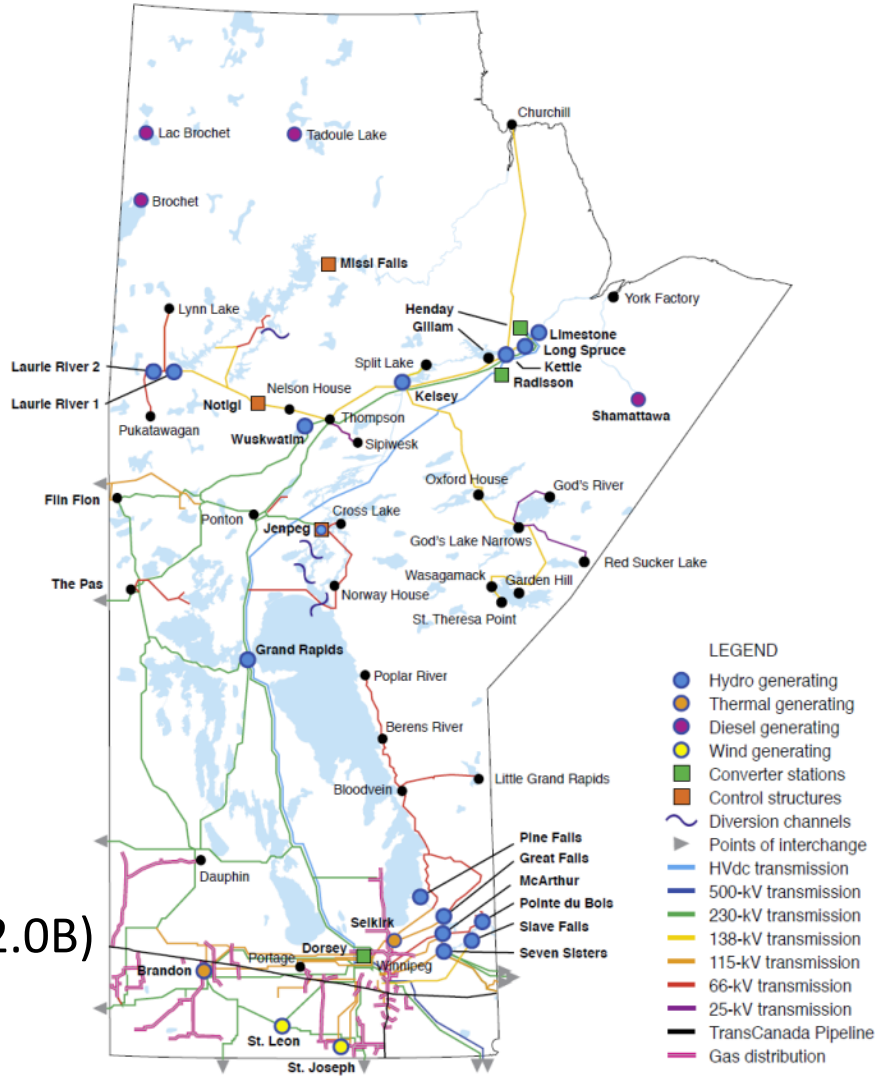
Manitoba Hydro

MANITOBA'S ELECTRICITY: 97% HYDROPOWER

- 17 Generating Stations:
  - 15 Hydroelectric Dams
    +1 under construction
  - 2 Thermal Stations
  - +2 Independent Wind Farms

- Linear Infrastructure:
  - 18,500 km transmission lines
  - 68,100 km distribution lines

- Some Major Risks:
  - Catastrophic Infrastructure Failure (>$2.0B)
  - 5-year Drought (>$1.4B)



Electricity Sector is Sensitive to Climate

Water Supply
- Energy production
- Resource planning
- Generation operations

Energy Demand
- Decreased winter heating
- Increased summer cooling

Infrastructure
- Generating stations (powerhouses, spillways, dykes)
- Transmission and distribution towers
- Transportation (access roads, bridges)

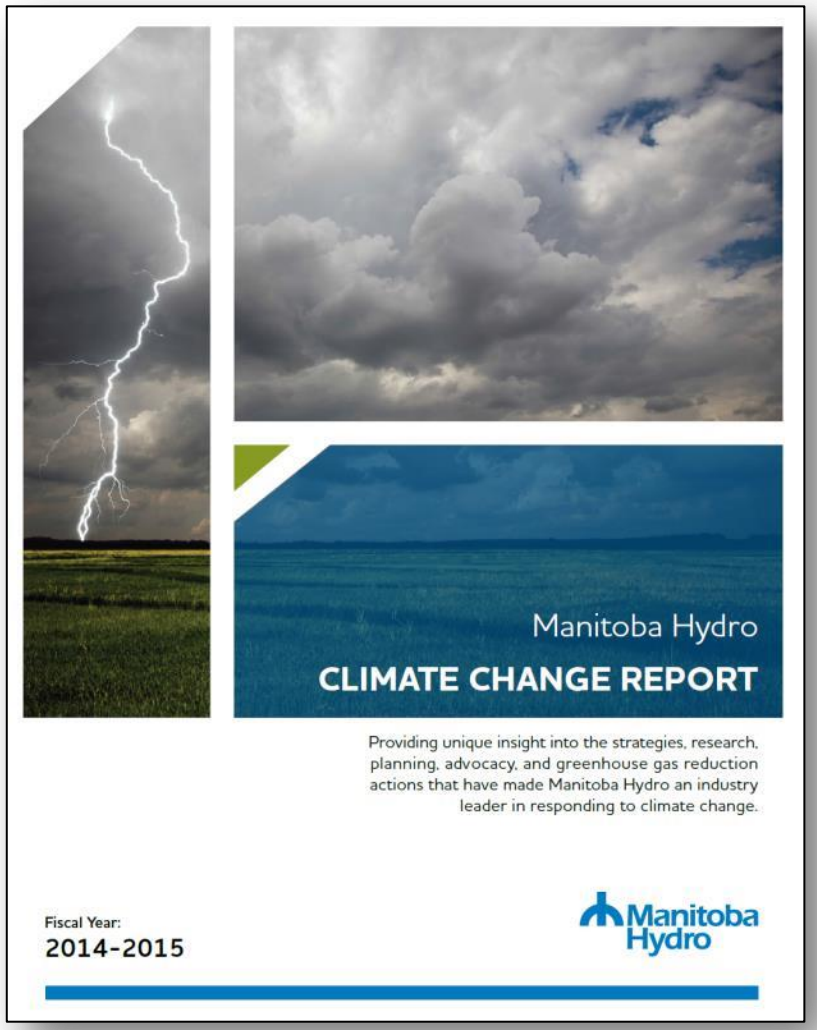
Environmental & Social Licenses
- Physical environment studies
- Economic studies
- GHG Life cycle assessment and emission reporting

- Long lived assets
- Designs and investment decisions depend on climate
- License acquisition facilitated by solid understanding of climate change

MANITOBA HYDRO CLIMATE CHANGE STRATEGIES

Corporate climate change strategies to shape the organization's response to climate change:

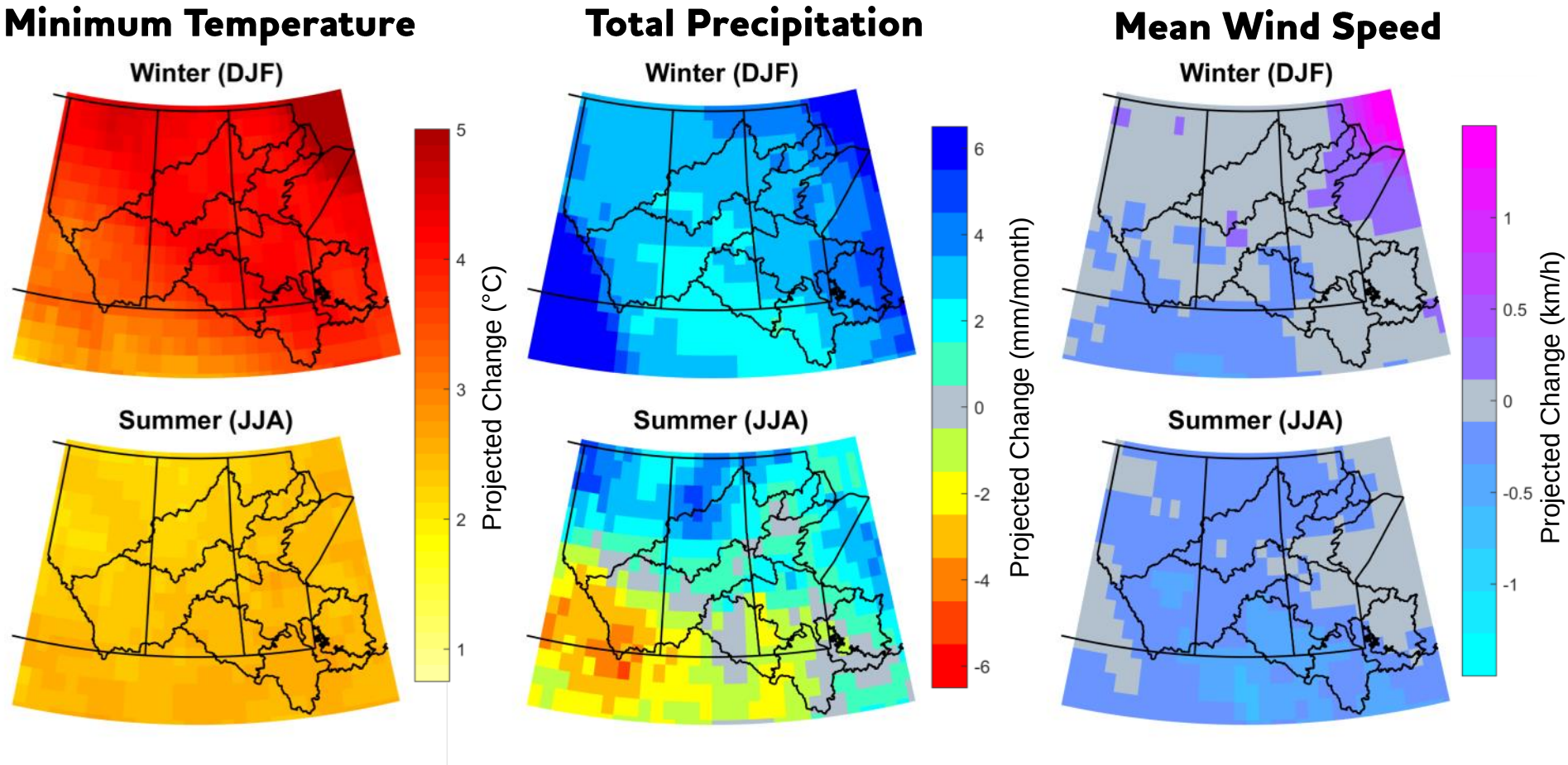
1. **Understand the Changing Climate**
2. GHG Measurement and Reporting
3. Contribute to GHG Emission Reductions
4. Support GHG Policy and Market Development
5. **Adapt and Plan**



Report accessible at: https://www.hydro.mb.ca/environment/publications/climate_change_report_2014_15.pdf

Understand the Changing Climate

2050s GCM Projections

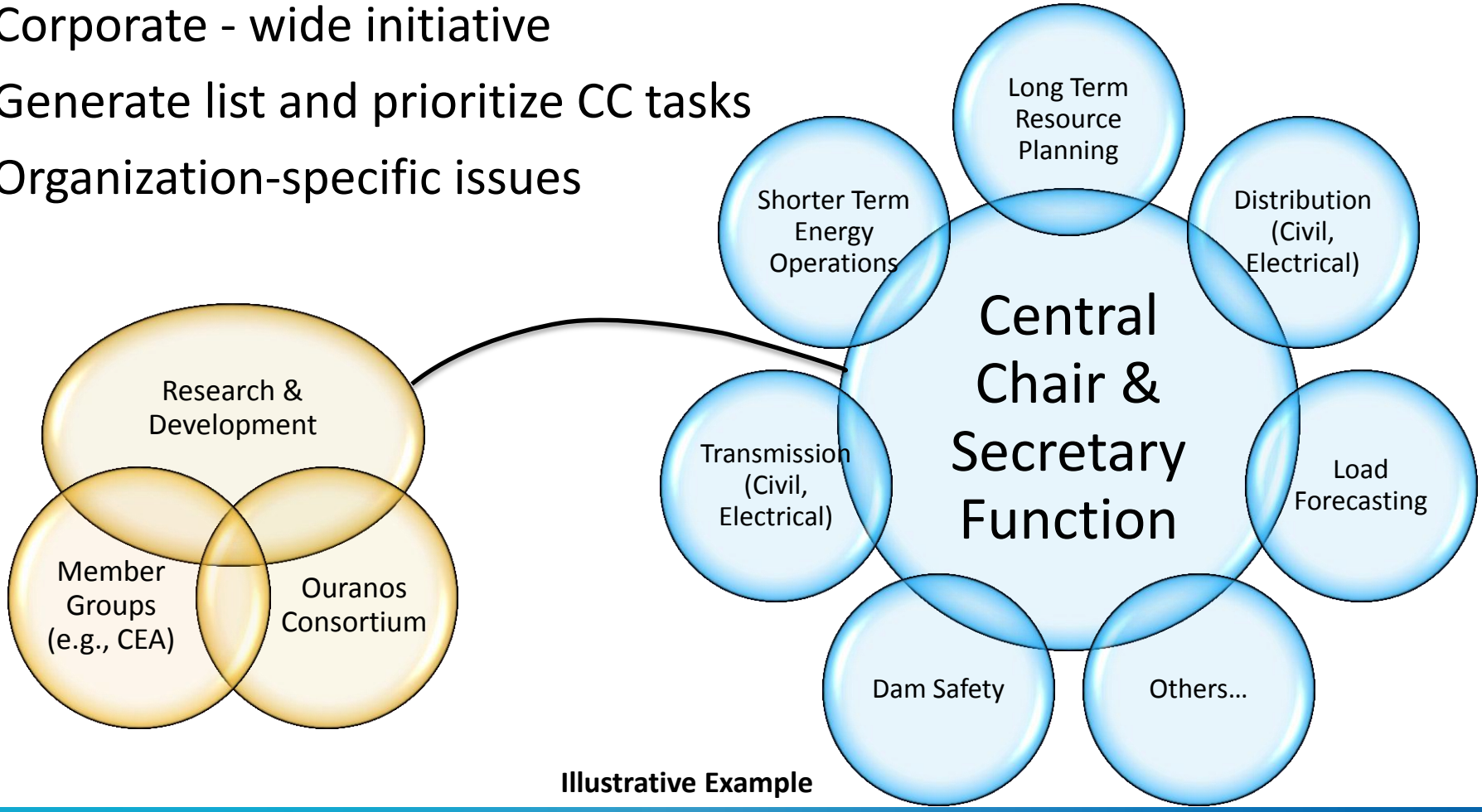


- Interest in changes to extreme events accompanied with large uncertainties

ADAPT AND PLAN

CCORA WORKING GROUP IN PROGRESS

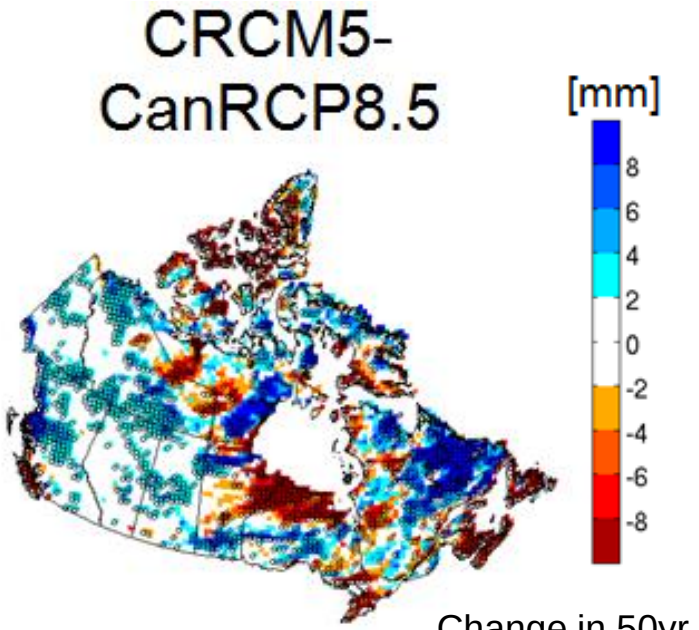
- Climate Change Opportunities, Risks and Adaptation (CCORA)
- Corporate - wide initiative
- Generate list and prioritize CC tasks
- Organization-specific issues



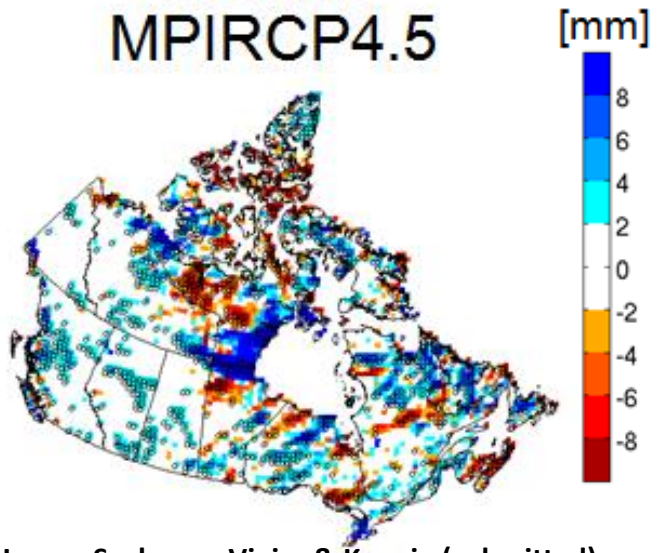
Illustrative Example

Recent Project Examples

- Transmission tower design criteria
  - Environmental Assessments
  - CSA electrical code part III
  - Canadian Regional Climate Model version 5
    - Freezing precipitation + ice growth model
    - Wind speed
    - Two simulations shown*
    - Considerable uncertainty
    - 44km resolution
  - Comparison with WRF (4km) output



Change in 50yr radial ice event



Jeong, Sushama, Vieira & Koenig (submitted)

Research Needs/Opportunities

- Compare outputs from multiple models
  - e.g., radial ice loads, extreme winds
- Future extreme temperatures
  - Energy demand, UHI, transmission limitations
- Understanding historic events:
  - Environmental Studies
    - Effect of lakes on local climate, wind & shoreline erosion
  - Mapping of severe loading zones
  - Driving mechanisms and improved prediction
  - Detection and attribution

Wind Event in September 1996

- Climate Change Adaptation:
  - How does Manitoba Hydro adapt?
    - e.g., Ice Vision
  - Opportunities and Risks?
  - Will the engineering profession adapt?
  - Who guides changes in engineering standards?


Ice storm in early 1980s

SUMMARY

- Manitoba Hydro is dedicated to understanding the changing climate and adapting its business practices
- Developing in-house expertise with network of researchers
- Next Steps include development of the CCORA Working Group

THANKS

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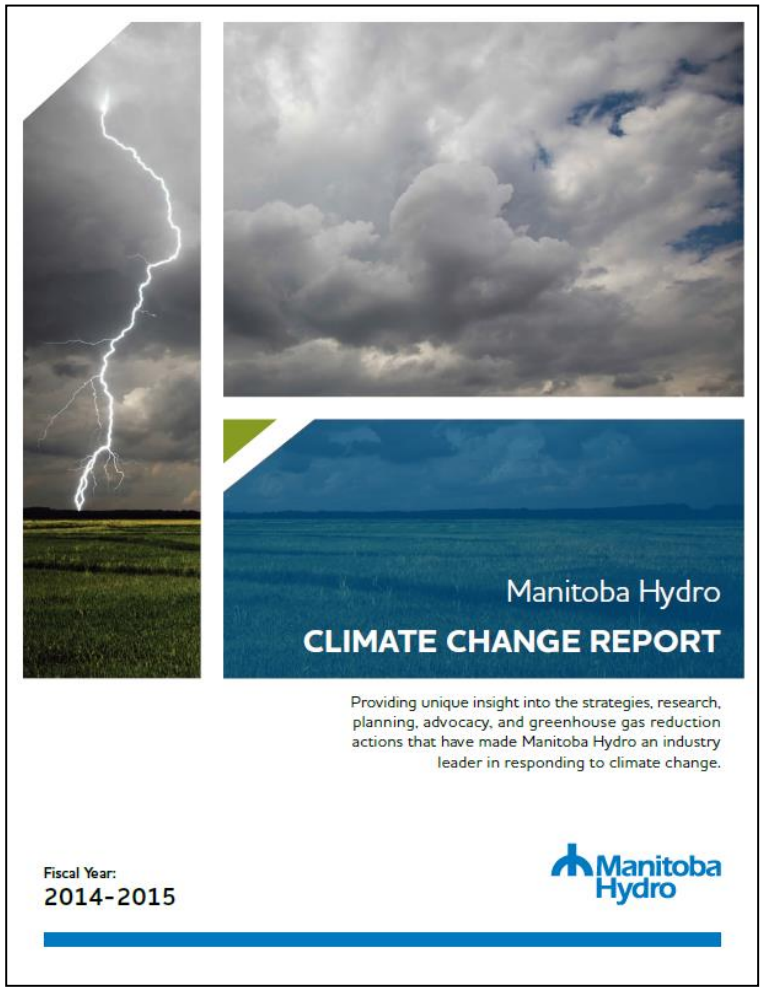

CORPORATE CLIMATE CHANGE REPORT:
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CSA Loading Map (*C22.3 No. 1-15)*