Addressing Uncertainties about Climate Change in Project-level Environmental Impact Assessments

Philip Byer
Professor, Department of Civil Engineering &
Centre for Environment
University of Toronto

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Overview

- Planning infrastructure for climate change
- Practices in Canada
- Methods for addressing uncertainties with illustrative example
- Communicating the results
- Current project on decision-making

Planning for climate change

- At strategic level (policies, programs)
- At project level:
  - Effects of project on climate change through GHG emissions:
    - Directly (fossil fuel plants, hydroelectric project)
    - Indirectly (new highway, transit line)
  - Effects of climate change on project: Design to adapt to climate change - **The Focus Here**

Effects of climate change on environment and on projects

- Streamflow ----> Hydroelectric plants
- Water levels -----> Marinas
- Rainfall ----> Stormwater collection systems
- Winds ----> Structures
- Permafrost -----> Pipelines

UNCERTAINTIES

Review of EA reports in Canada

EAs in 1990's:

- Climate change not acknowledged or addressed in most EAs
- Uncertainties about climate change addressed even less well
- Climate change addressed inconsistently between similar types of projects

More recent EAs:

- Most now refer to climate change
- General conclusion that climate change will have very little effect on project
- Little or no explanation of basis for this

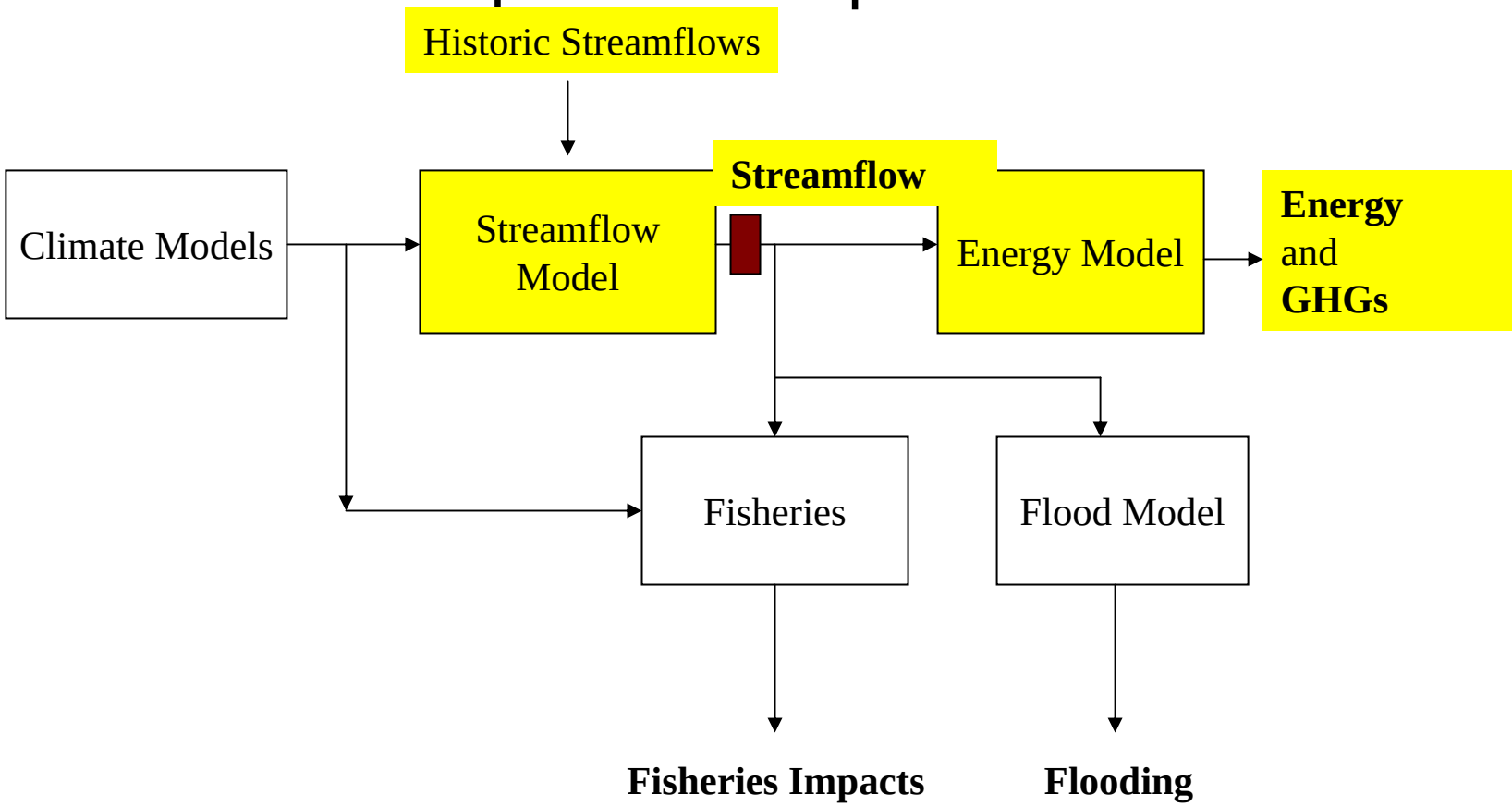
Methods for addressing uncertainties

- **Scenario analysis** - focus in this talk
- Probabilistic analysis
- Sensitivity analysis
- Combinations of above

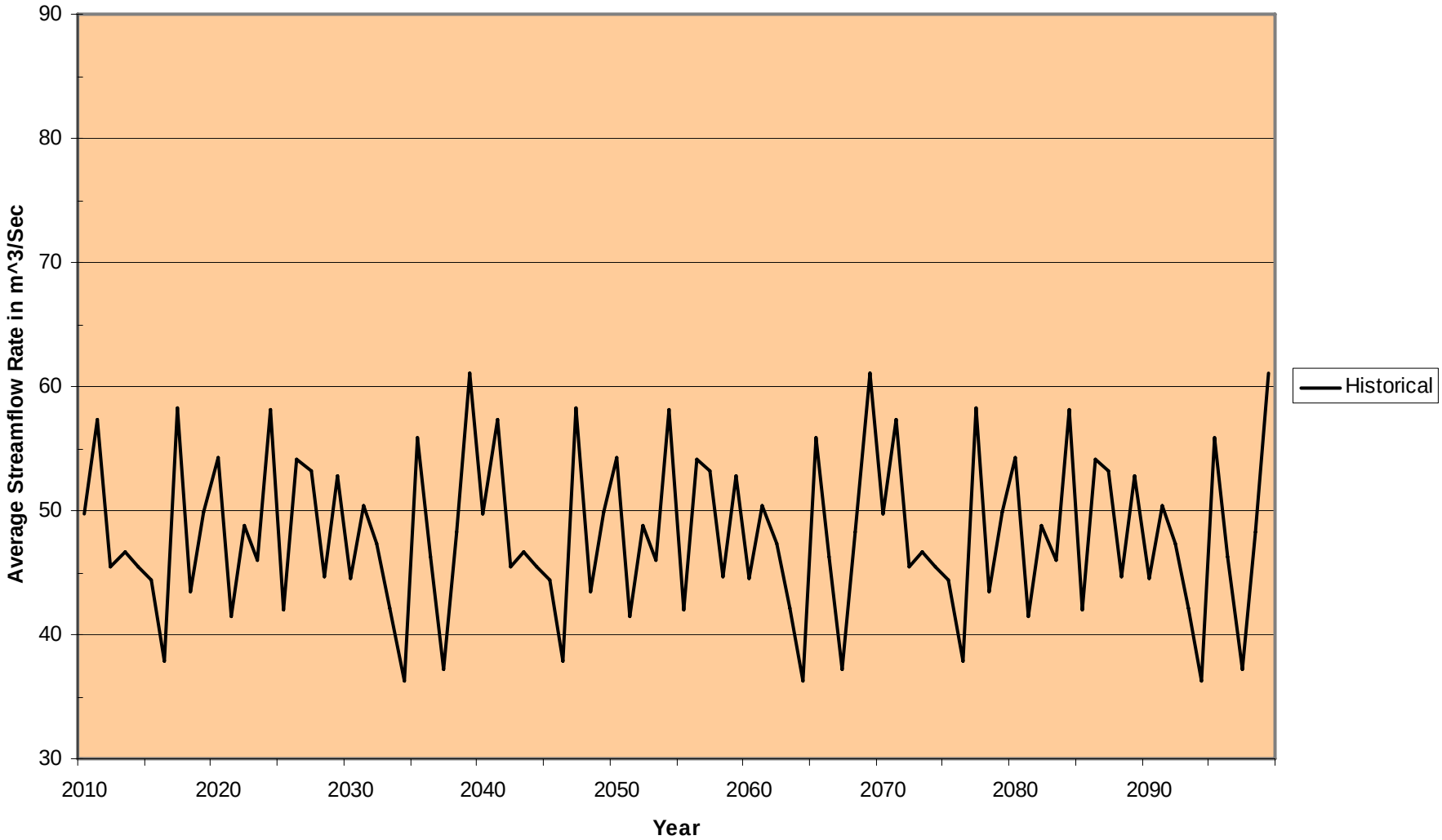
Hypothetical example

- Based on real case: Proposed hydroelectric project in northern Ontario
- Climate change will affect streamflows and hence energy production

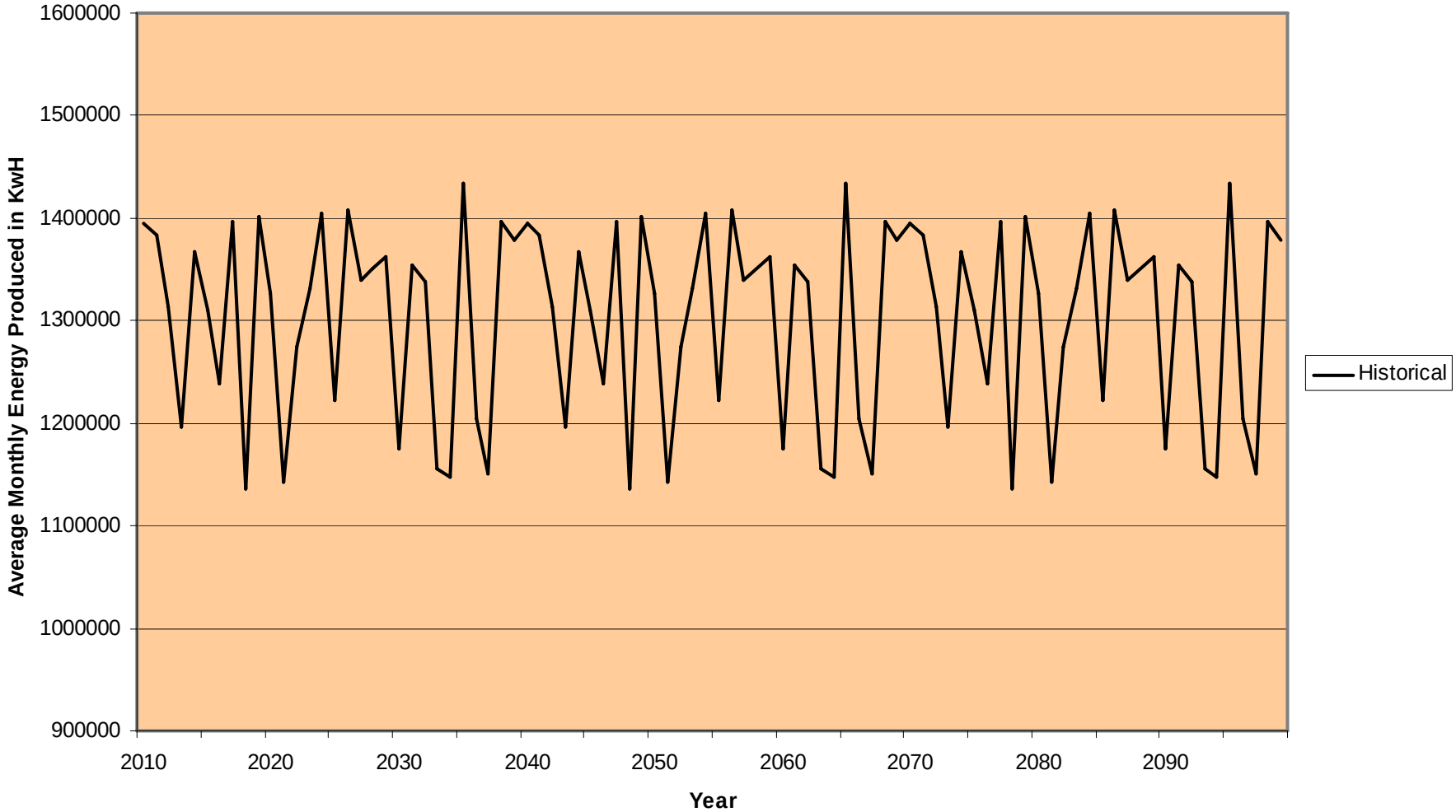
Hydroelectric Example based upon Historic Data



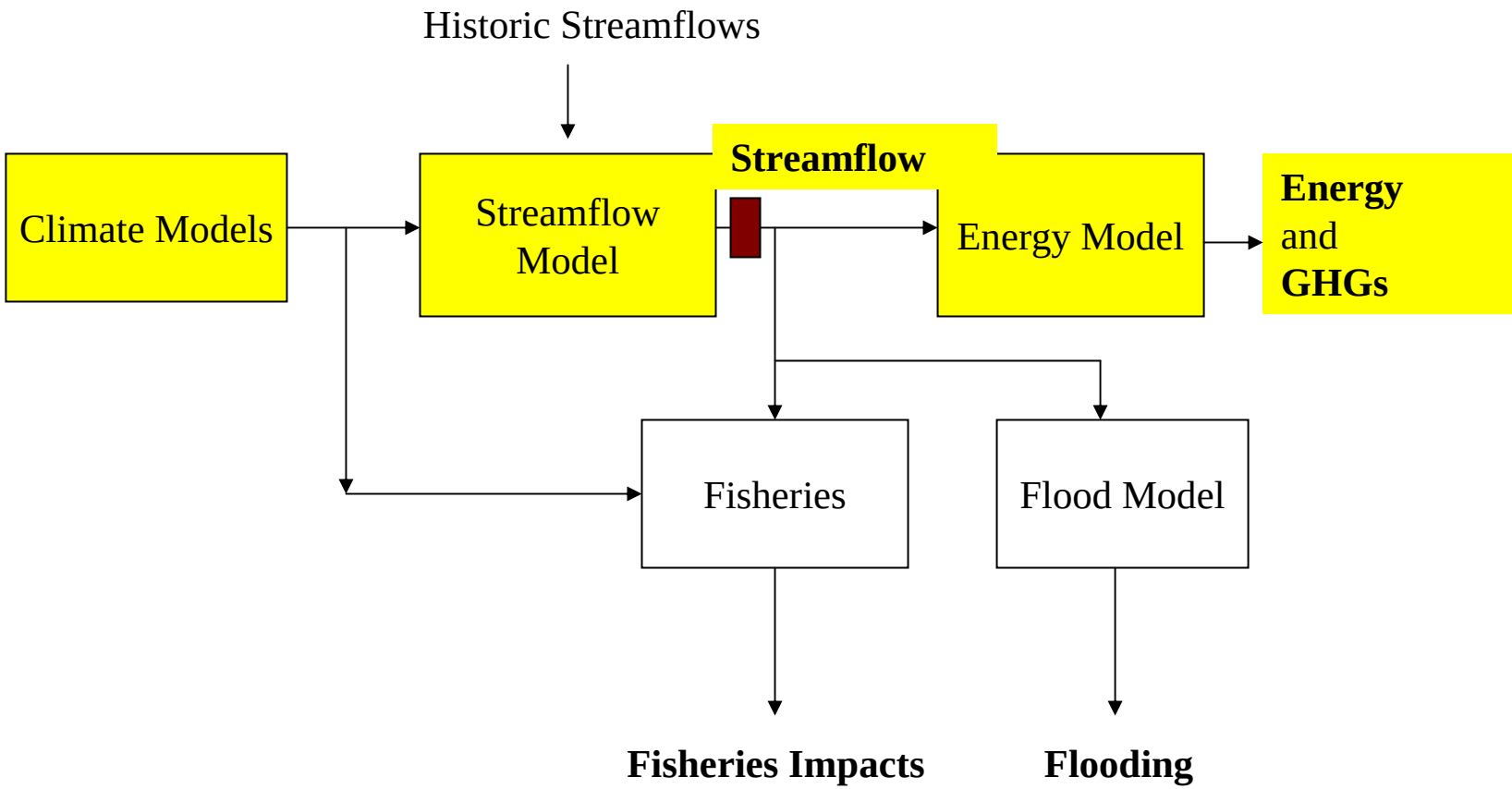
Average Rate of Monthly Streamflow under a Projection of Historical Data



Average Monthly Energy Produced Each Year under the Historical Scenario by the Hydro Facility Designed Using Historical Data



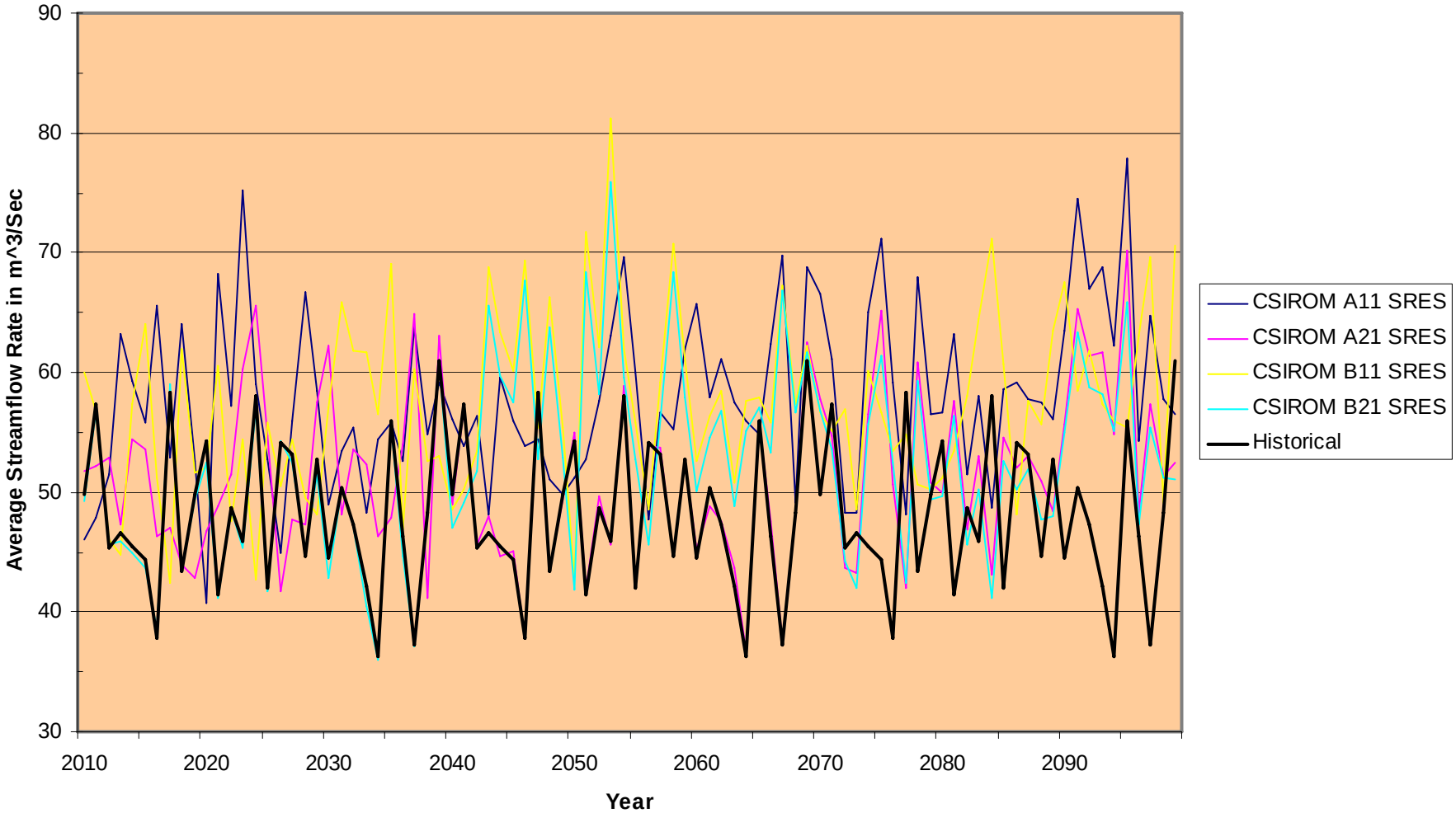
Hydro Example based upon Climate Change Data



Scenario analysis

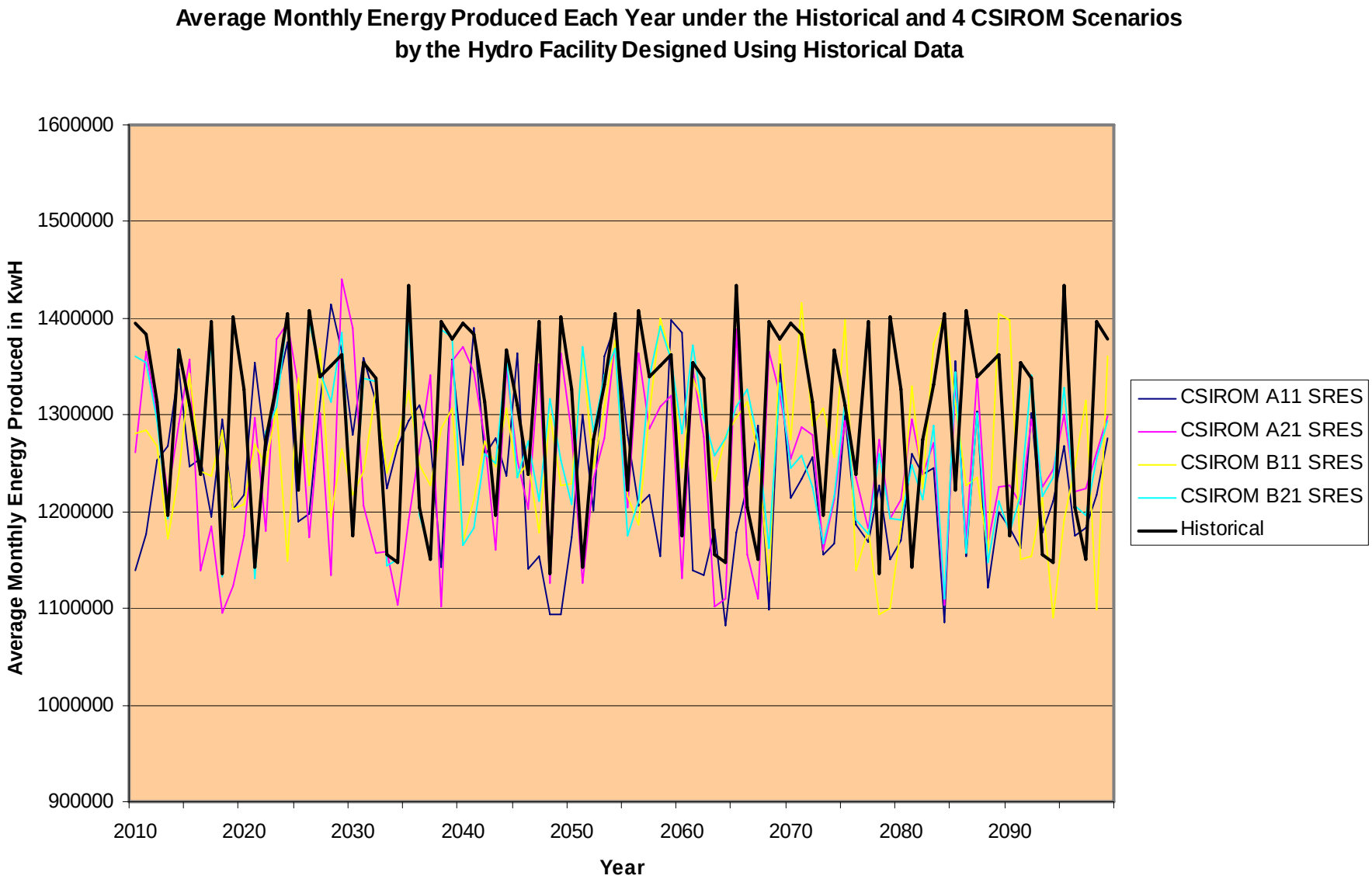
- Scenarios - sets of “futures” - developed by IPCC and other groups
- Canadian Climate Impacts Scenarios
- Projection of HISTORICAL streamflow data into the period 2010-2099
- Use range of scenarios

Average Rate of Monthly Streamflow under a Projection of Historical Data and Several CSIROM Scenarios



Design based on historical data

- Climate change not considered when deciding capacity (size) of hydroelectric plant

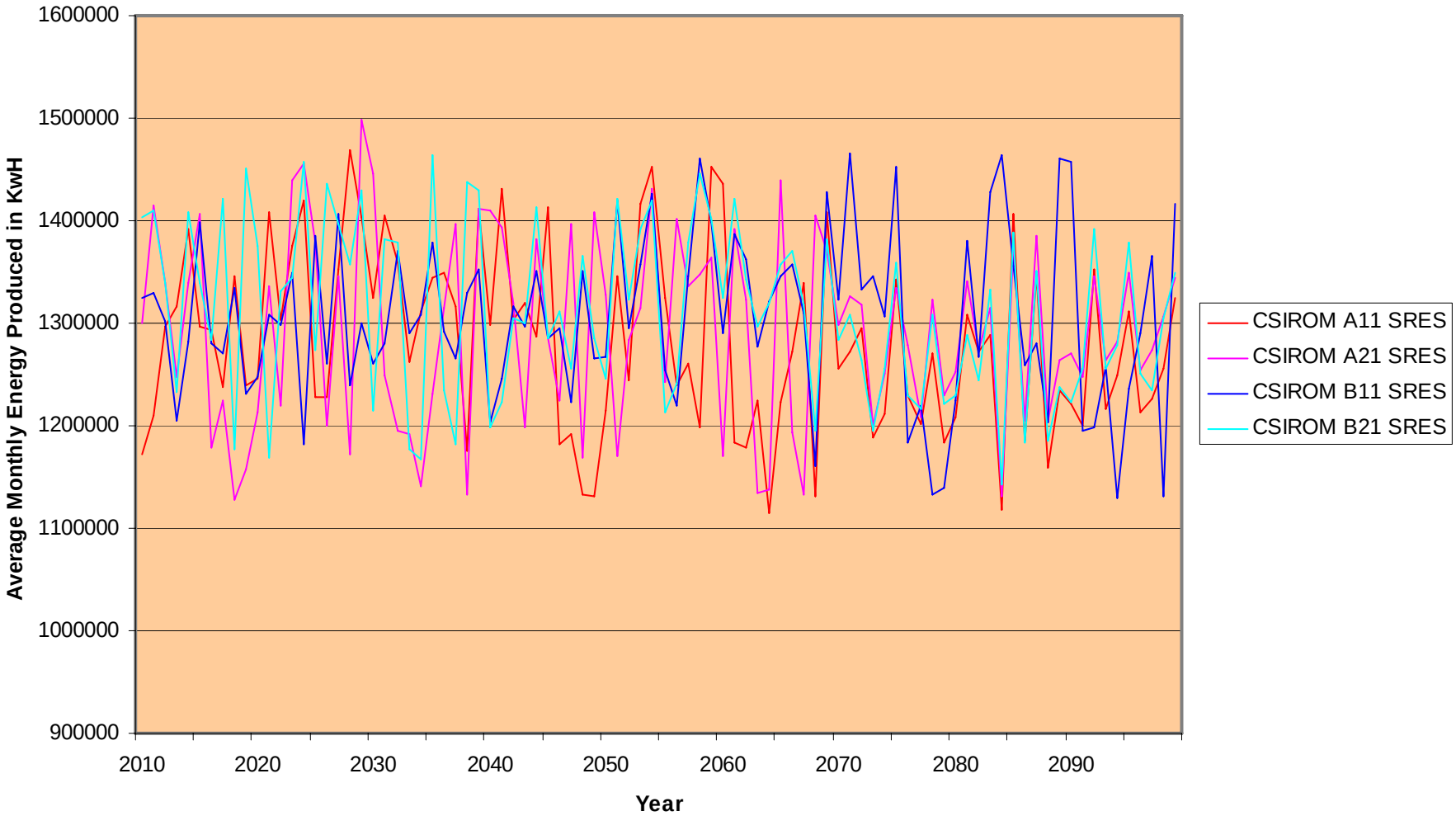

Average Monthly Energy Produced Each Year under the Historical and 4 CSIROM Scenarios by the Hydro Facility Designed Using Historical Data
Average Monthly Energy Produced in KwH
1600000
1500000
1400000
1300000
1200000
1100000
1000000
900000
2010
2020
2030
2040
2050
2060
2070
2080
2090
Year
CSIROM A11 SRES
CSIROM A21 SRES
CSIROM B11 SRES
CSIROM B21 SRES
Historical

Expected Monthly Energy Production & GHG Reductions 2010-2099		
Scenario	**Facility Capacity Based Upon Historical Data**	
	Average Monthly Energy in kwh	Annual Reduction in GHG Emissions in Tonnes CO_2
Historical	1,301,307	14,054
CSIROM A11	1,239,742	13,389
CSIROM A21	1,250,407	13,504
CSIROM B11	1,261,209	13,621
CSIROM B21	1,268,823	13,703

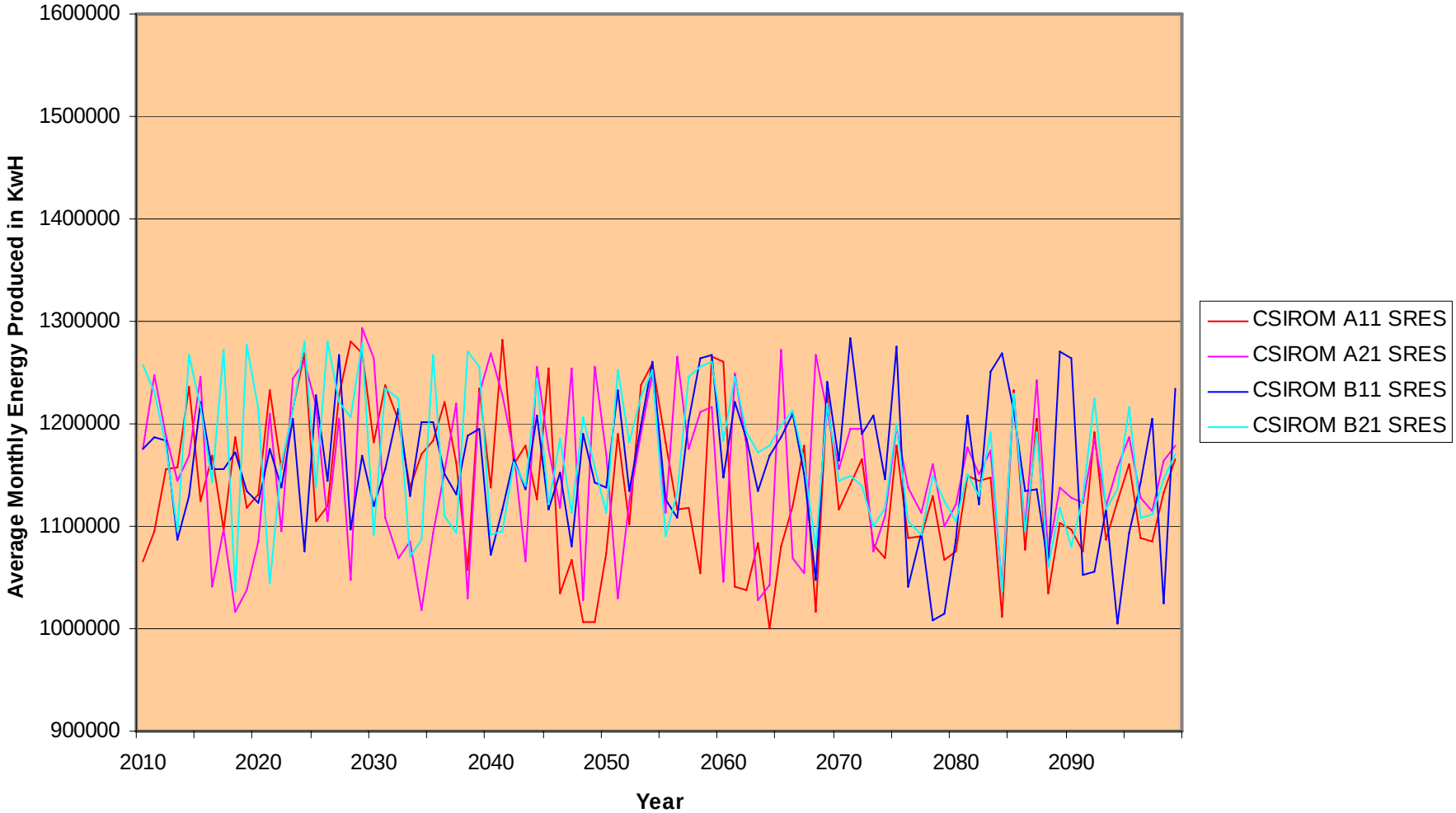
Redesign for climate change

- Choose capacity (size) based on a future climate change scenario

Average Monthly Energy Produced Each Year under 4 CSIROM Scenarios by the Hydro Facility Designed Using Data from CSIROM B11 (the Scenario with the Highest Energy Output)



Average Monthly Energy Produced Each Year under 4 CSIROM Scenarios by the Hydro Facility Designed Using Data from CSIROM B21 (the Scenario with the Lowest Energy Output)



Expected Monthly Energy Production in kwh for 2010-2099		
Scenario	**Facility Capacity Design Based Upon Data From:**	
	CSIROM B21 Scenario	CSIROM B11 Scenario
Historical	1,194,325	1,344,701
CSIROM A11	1,140,190	1,282,184
CSIROM A21	1,152,737	1,291,820
CSIROM B11	1,158,754	1,305,290
CSIROM B21	1,168,313	1,311,126

Which scenario to design for?

- Higher capacity facility produces more energy under all scenarios

But

- Higher cost for facility

Make decision given high uncertainty

Focus of current research project

Need to communicate **clearly**

To decision makers and stakeholder

- **Results** of the analyses and their uncertainties
- Information about the **degree of belief** in the results

Communication of uncertain results

Quantitative results:

- Range
  - 0.98 to 1.60 Gwh/month
- Mean and confidence
  - 1.27 ± 0.65 Gwh/month (90% confidence)
- Thresholds and vulnerability levels

Degree of belief (trust, confidence)

Belief in the results depends on:

- Models used
- Data sets employed
- Assumptions made

Communication of belief in results

Model:	Source	IPCC/CICS	Consultant
	Rep. of reality	Unknown	Medium
	Theory/Sch.of thought	School	Est. Theory
	Peer review	Yes	No
	Acceptance	Variable	-
Data:	Source	Various	MNR
	Primary/Sec.	Primary	Primary
	Theory/Sch.of thought	-	-
Key Assumptions:			
	Rep. of reality	Medium	High
	Acceptance	Variable	High
Resulting Estimates:			
	Indep. review	Yes	No
	Acceptance by review	Medium	-
	Overall confidence	**Medium**	**Low-Medium**

Consultant
High
Est. Theory
No
-
-
-
-
High
High
No
-
Low-Medium

Current research project: decision methodologies

Expected Monthly Energy Production in kwh for 2010-2099		
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Approaches

- Criteria for d-m under uncertainties
  - Maximin benefits
  - Minimax regret
  - Etc.
- Adaptive management
  - Build in flexibility to change in future

Decision-making under uncertainties: Which is best?

Possible Futures	Decision A	Decision B
Scenario 1	60	40
Scenario 2	70	10
Scenario 3	30	100

More to come

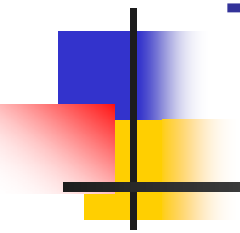
- Draft report and workshop in 2010
  - Let me know (byer@ecf.utoronto.ca) if interested in participating
- Report in 2011

Acknowledgements and Publications

- Canadian Environmental Assessment Agency for funding
- Our report for first project available at:

  http://www.ceaa-acee.gc.ca/default.asp?lang=En&n=A246A4F7-1&toc=show&offset=1

- Journal papers:
  - Byer, P. and J.S. Yeomans, “Methods for addressing climate change uncertainties in project environmental impact assessments,” Impact Assessment and Project Appraisal, Vol. 25, No. 2, June 2007, pp. 85-99.
  - Byer, P., M. Lalani and J.S. Yeomans, “Addressing and communicating climate change and its uncertainties in project environmental impact assessments,” forthcoming in Journal of Environmental Assessment Policy and Management.



Thank you

Questions/Comments?