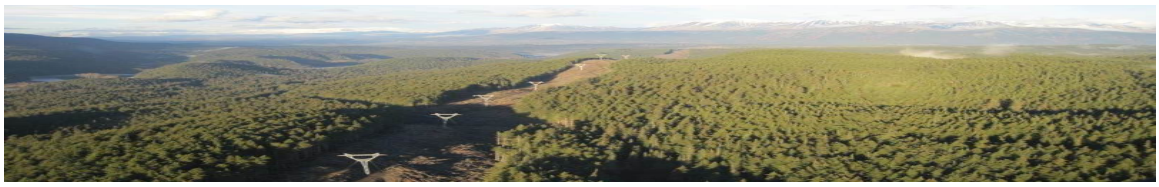
July 2014

The 2060 Project:

Integrated Energy Pathways for British Columbia and Canada



BC Hydro NW Transmission Line Photo credit: Valard LP

The 2060 Project is hosted at the Institute for Integrated Energy Systems at the University of Victoria (IESVic - http://www.iesvic.uvic.ca) and is funded by the Pacific Institute for Climate Solutions (PICS) (http://pics.uvic.ca). PICS is a four-university consortium with a mandate to undertake research and partner with governments in order to better inform policies and actions particularly those that impact climate change. The Research team is led by Dr. Andrew Rowe (Associate Professor, Mechanical Engineering, UVic) and includes Dr. Peter Wild (Professor, Mechanical Engineering, Director, IESVic), Dr. Ned Djilali (Professor, Mechanical Engineering, Canada Research Chair, Advanced Energy Systems Design and Computational Modelling), and Dr. Lawrence Pitt (Associate Director, PICS). The current team includes a post-doctoral fellow, three PhD students and a co-op student.

The 2060 project will examine potential impacts of integration on large-scale energy systems in Canada under various carbon policies and global growth scenarios. The analysis will result in both qualitative and quantitative knowledge that can be used effectively by policymakers, academics, industry and others to shape programs to reduce greenhouse gas emissions. Initially, the project is focused on the provincial electric systems in Alberta and British Columbia while also considering the impact of the rest of the Western Interconnect on those grids. The research is expected to illuminate how further grid integration will influence costs, system structure and reliability, and emissions intensity. Future work will expand the domain of analysis to other jurisdictions across Canada and/or the Western Interconnect.

Objective:

The principal objective of the project is to demonstrate pathways for reduced CO_2 emissions from an integrated multi-provincial system. Initially the system boundary is BC and Alberta (figure 1). Toward this end, energy system costs, technology mixes,

and potential of renewables will need to be determined in a coupled system under a range of scenarios that are consistent with limits on new investment, fuel availability, trade, and market penetration rates for new technologies.

Specific issues to be addressed include: impacts of climate change on hydropower production and heating and cooling demands; impacts of demand-management policies and smart-grids; the extent to which BC's hydro resources can support wind power, assuming interprovincial cooperation and appropriate transmission capacity; the impact of carbon emissions taxes on an integrated interprovincial electricity system; and, determining the impact of seasonal variations of resource availability and energy demands. Project findings will quantify: the value of British Columbia's water-storage for limiting carbon emissions on a larger-scale; the potential impacts of climate variability on water supply and system operation; and, the impacts of new resource sector loads on electrical demand and generation requirements.

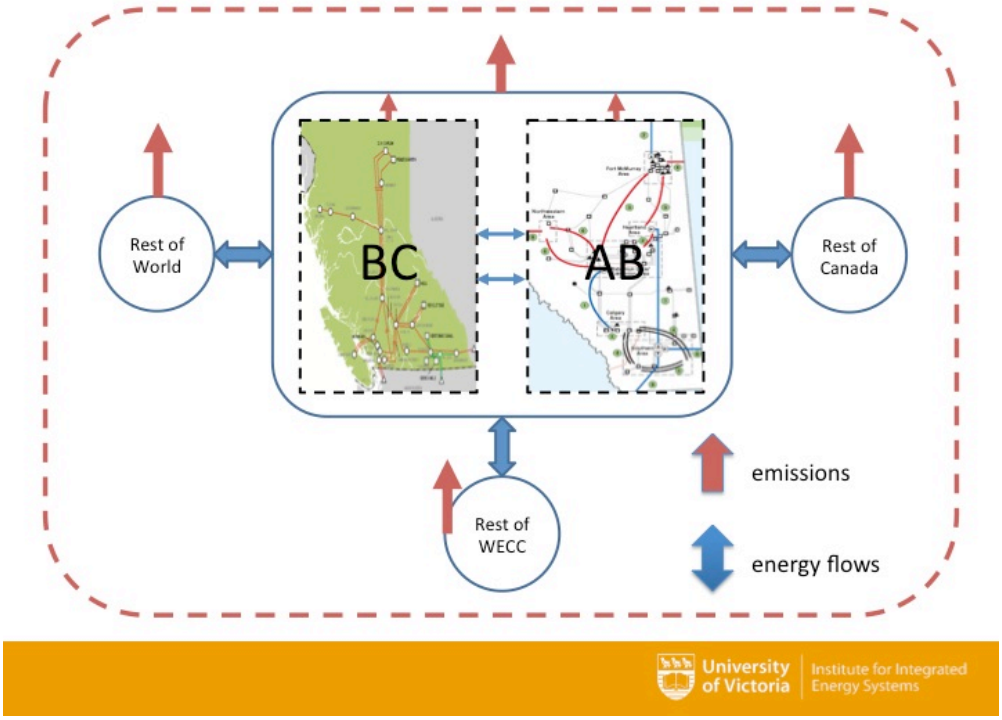


Figure 1. *Initial system boundary*

The Approach:

The multidisciplinary research team will comprise energy engineers, economists, regional climate modelers, hydrologists and energy policy experts. This team will use integrated optimization models that incorporate transmission capacity (real and hypothesized), reservoir dynamics, electricity economics (market pricing, carbon and water taxation structures, technology costs including demand-side management and distributed assets, cross-border electricity trading), growth projections, conventional and renewable generation sources, and projected changes in western Canadian hydrology. In parallel, the team will focus on the natural gas system via examination of fuel substitution impacts on transportation, heating, and electricity generation. Results will be used to identify feasible pathways and enabling policies that will stimulate interprovincial cooperation and aggregate reductions in carbon dioxide emissions in BC and Alberta. Three types of models (Figure 2.) will be employed: optimization, integrated assessment, and simulation. The Open Source Energy Modeling System (OSeMOSYS) is a transparent optimization model for long-term energy planning that, being open source, requires no up-front financial investment. The Global Change Assessment Model (GCAM) is a freely available partial equilibrium model designed to examine long-term changes in the coupled energy, agriculture, and climate system. It has been used extensively in the Energy Modeling Forum, the U.S. Climate Change Technology Program, the U.S. Climate Change Science Program and IPCC assessment reports. PLEXOS is an energy market simulation and optimization tool based on mixed integer programming (MIP). PLEXOS is used by system operators, utilities, generators, and governmental agencies for: day-ahead generation scheduling (unit commitment and economic dispatch) to minimize cost or maximize profit, variable energy resource integration analyses, integrated resource planning, portfolio risk evaluation, market analysis, and transmission (Network) analysis.

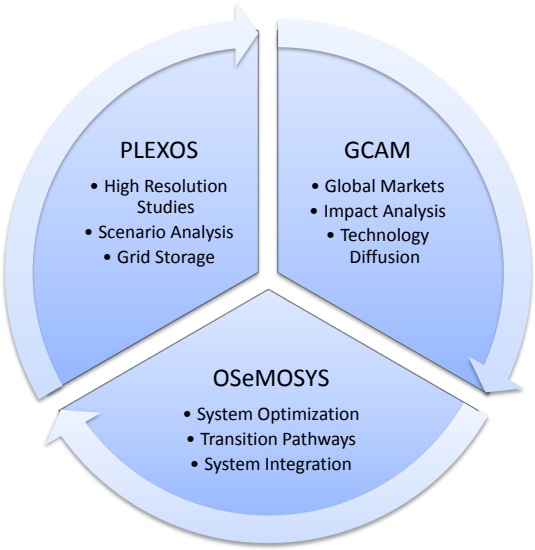


Figure 2 - *Modeling tools, applications and linkages.*

The project goal is to broaden the system boundaries of the study to integrate larger regions (Figure 3).

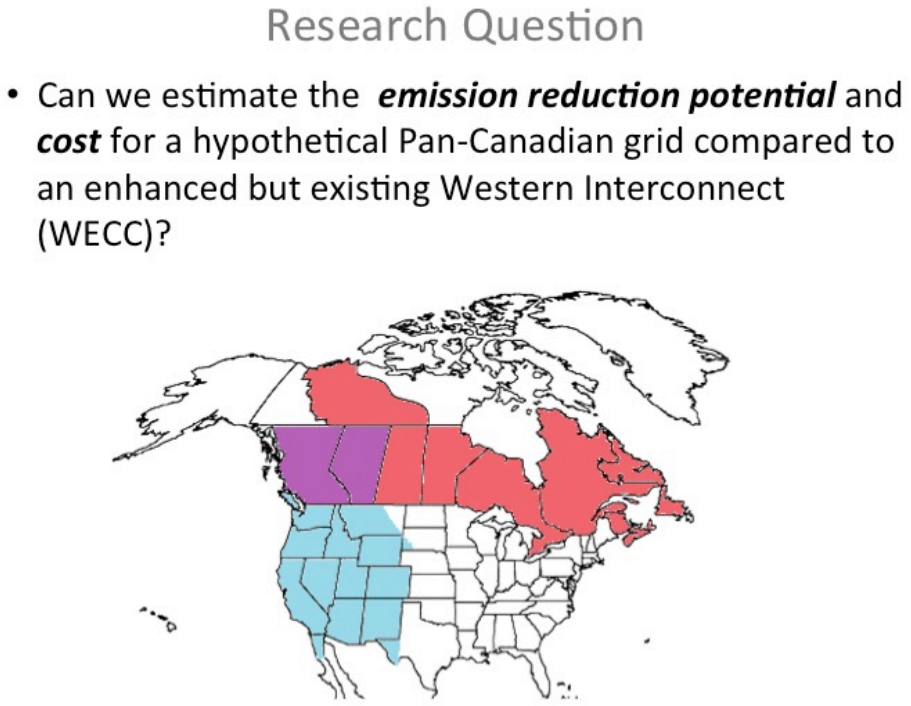


Figure 3. *Future system boundaries and overarching research question.*

Output from 2060 Research Team:

Recent Publications

Sopinka, A. and Pitt, L. "Taming WECC's Carbon Diet: Are We Losing Weight Yet?" ***The Electricity Journal***, in press, 2014

Ouellette,A., A. Rowe, A. Sopinka, P. Wild. "Achieving emissions reductions through oil sands cogeneration in Alberta's deregulated market" ***Energy Policy***, in press 2014.

Sopinka, A. and Pitt, L. "The Columbia River Treaty: Fifty-years After the Handshake" ***The Electricity Journal***, Volume 27, Issue 4, pp. 84-94, 2014

Sopinka, A and Pitt, L "Variable Energy Resources: New Electricity Markets by Design or Desperation?" ***The Electricity Journal***, in press 2013

Sopinka, A. and Pitt, L. "Variable Energy Resources: VERy Interesting Impacts for the Western Interconnect" ***The Electricity Journal***, Volume 26, Issue 6, pp. 20-25, 2013

Sopinka, A., and Pitt, L. "British Columbia Electricity Supply Gap Strategy: A Redefinition of Self-Sufficiency" ***The Electricity Journal***, Volume 26, Issue 3, pp 81-88, 2013

Sopinka, A and Pitt, L. "Trends in the Western Electricity Coordinating Council: Retrospect and Prospect" (2013). Available from pics.uvic.ca

Kiani, B., Rowe, A., Wild, P., Pitt, L., Sopinka, A., and Pedersen, T. "Optimal electricity system planning in a large hydro jurisdiction: Will British Columbia soon become a major importer of electricity?" ***Energy Policy***, published online 20 December 2012, ISSN 0301-4215, 10.1016/j.enpol.2012.11.040.

Recent Presentations

Lyseng, B., Rowe, A., Wild, P. "Operational strategies for power-to-gas energy storage" Energy Systems Conference, Energy Institute, London, UK, June 24- 25, 2014

Sopinka, A., Ouellette,, A, Pitt, L. "Carbon reduction benefits and costs from continental-scale grid integration" Energy Systems Conference, Energy Institute, London, UK, June 24- 25, 2014.

Sopinka, A., Ouellette, A , Pitt, L. Estimating an Idealized Carbon Tax Via Dispatch Protocols International Association for Energy Economics 37th International Conference, New York City, June 15 -18, 2014

Sopinka, A, Pitt, L, Carbon Emissions in the Western Interconnect - Estimating the Impact of VERs International Association for Energy Economics 37th International Conference, New York City, June 15 -18, 2014

Oullette, A., Rowe, A., and Wild, P. "The Role of Oil Sands Cogeneration in the 2030 Alberta Generation Mixture" presented at Third Climate Change Technology Conference, Engineering Institute of Canada, Concordia University, Montreal, QC, May 27- 29, 2013

Lyseng, B., Wild, P. and Rowe, A. "Emission Reduction Through Carbon Taxes on Alberta's Electrical System" presented at Third Climate Change Technology Conference, Engineering Institute of Canada, Concordia University, Montreal, QC, May 27- 29, 2013

Sopinka, A. "The Environmental Impact of Increasing Wind Penetrations in a Thermally Dependent Electric System" presented at Third Climate Change Technology Conference, Engineering Institute of Canada, Concordia University, Montreal, QC, May 27- 29, 2013

Sopinka, A. "Emerging Trends in the Western Interconnect: Coal, Carbon and Capacity" presented at University of Calgary, Faculty of Science, Energy and Environmental Systems (EES) October 2013

Sopinka, A, Pitt, L, "British Columbia Electricity Supply Gap Strategy: A Redefinition of Self-Sufficiency" 32nd USAEE/IAEE Conference, Anchorage, AK July 28-31, 2013.

Recent Op-eds

Sopinka, A. and Pitt, L., BC Hydro making move toward revenue self-sufficiency, Vancouver Sun, August 30, 2013, http://www.vancouversun.com/Hydro+making+move+toward+revenue+self+sufficiency/8855299/story.html

Sopinka, A. and Pedersen, T., B.C. hydro power wasted as Alberta baked, Calgary Herald, Vancouver Sun, Tuesday July 24, 2012, available from: http://www2.canada.com/calgaryherald/news/theeditorialpage/story.html?id=452cf9ac-acd6-4bf6-92aa-856495a32992