Notice of the Final Oral Examination
for the Degree of Doctor of Philosophy

of

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MASc (Queen’s University, 2013)
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“Decarbonization Pathways for the Western Canadian Electricity System”

Department of Mechanical Engineering

Friday, December 13, 2019
9:00 A.M.
Engineering Office Wing
Room 108

Supervisory Committee:
Dr. Andrew Rowe, Department of Mechanical Engineering, University of Victoria (Co-Supervisor)
Dr. Peter Wild, Department of Mechanical Engineering, UVic (Co-Supervisor)
Dr. Bryson Robertson, Department of Mechanical Engineering, UVic (Member)
Dr. Adam Monahan, School of Earth and Ocean Sciences, UVic (Outside Member)

External Examiner:
Dr. Eric Bibeau, Department of Mechanical Engineering, University of Manitoba

Chair of Oral Examination:
Dr. Scott Watson, Department of Political Science, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies
Abstract
Decarbonizing the electricity system (i.e. eliminating generation from fossil fuels and replacing it with non-emitting sources) is widely considered a necessary step to limiting anthropogenic emissions and minimizing the impacts of climate change. Selecting which non-emitting generators should replace existing fossil fuel sources, and when to build them, is critical to the success of this transition. The optimal pathway to decarbonisation is highly region-specific. It is impacted by both factors such as availability of renewable resources, existing generation resources, and government policy.

This dissertation presents a techno-economic model that is used to assess the decarbonisation of the combined British Columbia and Alberta electricity system. It is found that high levels of decarbonisation are possible through a combination of new wind generation, particularly in Alberta, and increased trade between Alberta, British Columbia, and the United States. Following on this finding, the variability related to high penetrations of renewable generation is introduced to the model and its impact is assessed. These results indicate that variability will be an important constraint in planning decarbonized energy systems. Finally, the representation of British Columbia’s existing hydroelectric resources is expanded to determine the ability to buffer variable renewable generation with these resources. This study finds that, while existing hydroelectric resources can support much of the variability in a highly renewable energy system, additional technologies and/or policies are needed to reach a fully zero-carbon system.

The findings in this thesis show that British Columbia and Alberta, with an expanded interconnection between the provinces, can reach high penetrations of variable renewable energy. The majority of this generation consists of wind energy in Alberta, which is abundant and low-cost compared to other generation options. While comparatively little generation is added in British Columbia, the existing hydroelectric resources in the province provide significant flexibility to support the variability of this wind generation.