



# Optimization Modelling of the Saskatchewan Energy Planning System in Response to GHG Control Strategies



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# RESEARCH PERSONNEL

Q. G. Lin

G. H. Huang

B. Bass

Y. F. Huang

## **ABSTRACT**

Under the Kyoto Protocol, Canada agreed to reduce greenhouse gas (GHG) emission levels to 94% of 1990 level by period 2008 - 2012. In the Province of Saskatchewan where the energy sector is the major part of the local economy, reducing GHG emissions could lead to substantial impacts on provincial energy industry. This research examines the detailed impacts on the Saskatchewan energy system, especially on crude oil, gas and electricity industries as well as refineries and heavy oil upgraders.

A MARKAL-based optimization model is developed for energy systems planning under various GHG-control strategies. Based on the developed model, one reference case and four policy cases are analyzed. The reference case is for an energy system without constraints on GHG emissions. The first policy case simulates the energy system with the reductions agreed to under the Kyoto Protocol. The second case corresponds to reductions in GHG emissions through five stages and can help evaluate the discounted and marginal cost of meeting the emission reduction targets. The marginal cost related to GHG emission reduction to meet the Kyoto target of electricity, natural gas production and processing and oil refinery are also reflected in this case. In these cases, nuclear power is not an option, but is included in the third case to assess its impacts on the discounted and marginal cost. The fourth case simulates the situation when the amount of imported electricity is limited.

A analysis of the modeling results showed that, if Saskatchewan reduces GHG emissions to 94% of year 1990 by the period of 2008–2012 (period 5), total discounted cost will increase from -\$591 million to \$897 million (\$1990). The marginal cost associated with GHG-emission reduction is \$30.0 (\$1990) per tonne CO<sub>2</sub> equivalent. Crude oil production, refineries and heavy oil upgraders will decrease while more renewable energy is used in generating electricity; the impacts on natural gas sector were minimal.

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The opinions and conclusions represented in this report are solely the responsibility of the authors. However, the authors shall not be responsible or liable for any consequences resulting from interpretation or recommendation made by others based in whole or in part on data presented in this report.

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