Optimization Modelling Climate and Population Variations on GHG Emissions from Energy Sector in Toronto-Niagara, Canada

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CONTENTS

Abstract

Climate changes in global terrestrial have been concerned by more and more researchers, policy-makers and stakeholders from industrial, agriculture, environmental, and other departments. While the extreme weather such as severe ice storms, flood and hurricane will undermine progress on every aspect of human development and ecosystem protection, including built infrastructure, food production, bio-diversity, human health, and the natural systems that support growing economies. The global warming causes the significant effects on human activities, environmental system and directly on energy system including the generation, transmission or transportation, especially consumption of electricity, oil and natural gas. For example, when the air temperature rising, the energy demands for primary heating in winter season will decrease while those for A/C and refrigeration in summer will increase. MARKAL model is a technology oriented dynamic linear programming modelling system, designed to evaluate the impacts of environmental behaviour on international, national and regional energy system by the least-cost strategy. With the TNR (Toronto-Niagara Region) MARKAL model, this study emphasis on evaluating the impacts of variations of temperature and population on TNR's energy system and assessing the abatement costs related to GHG emissions reduction in TNR area in the period of 2010 to 2032 in respond to Kyoto commitment.

With the data of temperature drawn from Canadian Climate Impacts Scenarios (CCIS), one Business as Usual (BAU) case and three scenarios are developed and analyzed. The BAU case is to model the energy system and GHG emissions based on forecasting energy demand from social and economic development. The scenario 1 reflects variations of energy demand in response to the mean temperature change. Scenario 2 includes the population growth into scenario 1. Scenario 3 involves population growth combined with the maximum temperature change in summer and minimum temperature change in winter rather than mean temperature. Three perturbation cases are developed to reflect the impacts of Kyoto target on TNR's energy system. The abatement costs and marginal costs related to the GHG emission reductions are presented in each scenario or case.