

## **Changes in Energy Intensity in Canada**

### **Executive Summary**

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Canada is one of the top ranked energy users and CO<sub>2</sub> emitters among the OECD countries. Although energy intensity, i.e., energy consumed per unit of output and measured by the ratio of energy consumption to GDP, has been declining in Canada recently, it is still 1.3 and 2.4 times greater than that in United States and Germany, respectively. The lower energy intensity in Canada may have been caused by either an improvement in technology or moving away from energy-intensive sectors. Therefore, understanding the factors driving the changes in energy intensity is vital to any policy designs addressing high energy consumption. This is particularly important in Canada because Canada is committed to reduce its greenhouse gas emission 17 percent below its 2005 level by 2020, and more than 80 percent of Canada's greenhouse gas emissions are generated from energy production and consumption. This paper seeks to investigate the underlying factors affecting energy intensity changes in Canada using decomposition and econometric methods at national, provincial and industry levels.

The decomposition results, both at the national and provincial levels, suggest that most of the reduction in energy intensity has occurred in the 1990s and mainly due to improvements in energy efficiency, not to shifts from energy-intensive to less energy-intensive economic activities. Specifically, energy efficiency improvement accounted for more than 82 percent of the overall decline in energy intensity. Among provinces, Ontario, the manufacturing based province, experienced the greatest improvement in energy intensity with (1.8% decline annually), and Saskatchewan and Alberta (oil producing provinces) had the lowest average annual decline rates (0.5%). Within the industries, while energy intensity increased significantly in mining and oil extraction industries, it experienced a significant decline in manufacturing mostly due to an improvement in efficiency. The energy intensity has remained rather stable in other industries.

The panel data regression results also indicate that on average higher energy prices have led Canadian economic structure to move away from energy intensive activities, while rising income has been the most significant factor in increasing energy intensity. Even though population growth is relatively low in Canada, it has positive and significant effect on energy intensity. Energy intensity increases with a decline in temperature, but the effect of warmer climate on energy intensity is relatively limited. The provincial and industry level study show increasing use of energy-intensive capital has raised

energy intensity, implying that that capital and energy are complementary on average across provinces and industries. Investment ratio, which captures the turnover of capital stock, has also contributed to the declining in energy intensity in provinces. The industry regression results also confirm the investment effect and shows that it has contributed to energy efficiency in utilities and mining and to changes to less energy-intensive activities in manufacturing and transportation industries. Technological advances have been most effective in increasing energy efficiency in construction and utilities and in switching to less energy-intensive activities in manufacturing industries. The regression analysis for the two energy-endowed and less energy-endowed provinces also reveals heterogeneous responses of energy intensity indexes to explanatory variables. Specifically, energy prices and income have stronger negative and positive effects, respectively, in less energy-endowed provinces. Also, policy effects are different in the two groups with liberals having increased energy intensity in energy-endowed provinces and decreased it in less energy-endowed provinces. The energy demand elasticities results indicate that energy is price inelastic and changes in energy prices will reduce energy demand only in less energy-endowed provinces. However, breaking down the energy prices into electricity and natural gas prices in the regression reveals that while all provinces respond significantly to changes in natural gas prices, the electricity price elasticity is significant only in the less energy-endowed provinces. Furthermore, a rise in income will increase energy demand mostly due to a rise in high energy-intensive activities particularly in energy-endowed provinces.

Our study shows that Canada is slowly reducing its high energy intensity with a focus on increasing energy efficiency through economic forces such as investment and technological advances. However, increasing activities in energy-intensive sectors, such as oil and mining and transportation, partially offsets the efficiency gains in own and the other industries. This is particularly true as about 50 percent of the greenhouse gas produced in Canada is concentrated in oil and gas and transportation industries and in two oil producing provinces: Saskatchewan and Alberta. Thus, the pace of energy intensity reduction will increase rapidly, should efficiency improve significantly in the energy-intensive industries, or provinces move to less energy-intensive activities. Since the latter is not a realistic option for Canada as a major oil-exporting country, the government policy to encourage R&D in those energy-intensive industries will help meet the CO<sub>2</sub> reduction targets in due course.