Case Study on the Role of Fiscal Policy in Hydrogen Development

Executive Summary

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The objective of the NRTEE's EFR and Energy program is to develop and promote fiscal policies that consistently and systematically reduce energy-based carbon emissions in Canada, both in absolute terms and as a ratio to Gross Domestic Product, without increasing other pollutants. From the assumption that a number of emerging technologies have the potential to help in the achievement of this long-term objective, the NRTEE has commissioned this study on hydrogen. The National Roundtable on the Environment and the Economy is particularly interested in how barriers that limit 1) demand for hydrogen technologies and 2) infrastructure for hydrogen technologies can be addressed using fiscal policy. At the same time, the NRTEE ultimately wants to develop recommendations on fiscal instruments that can be presented to the Government of Canada.

To that end, the Pembina Institute and the Canadian Energy Research Institute were commissioned to complete a study on the role of fiscal policy in promoting hydrogen development and reducing greenhouse gas emissions in Canada. There are two products from this exercise, a Baseline Report and an Economic Analysis Report. The Baseline Report describes the state of hydrogen development in Canada, the existing policy framework for hydrogen and completes an initial policy evaluation of a range of policy options for promoting hydrogen development. The policy evaluation completed in the Baseline Report resulted in the identification of seven fiscal policies capable of providing a direct incentive to hydrogen technologies while explicitly addressing a barrier currently limiting technology penetration. Of the seven policies (investment tax credits, producer tax credits, accelerated capital cost allowances, research and development, grants, consumer tax credits and pilot projects), the evaluation was focused on producer incentives designed to reduce the cost of hydrogen production and consumer incentives to reduce the cost of end-use hydrogen technologies. More specifically, the fiscal policies considered in this analysis reduced the cost of hydrogen production, stationary fuel cells, fuel cell vehicles and buses, and hydrogen internal combustion engine vehicles. The Economic Analysis Report presents the results of the modeling exercise undertaken to test the impact of these fiscal policies on particular hydrogen technologies.

To test the effect of the producer and consumer incentives on the penetration of hydrogen technologies and associated changes in greenhouse gas emissions, we employed the Energy 2020 model, a national macro-economic model. Using the Energy 2020 model, we simulated two different hydrogen production methods, the use of steam methane reformers (SMR) and hydrogen production from electrolysis. The modeling began with the completion of a 'Reference Case' or business as usual modeling run. We then added producer incentives and consumer incentives. The 'Fiscal Scenario' results presented below and in the Economic Analysis Report reflect the impact of the *combination* of producer incentives *and* consumer incentives equivalent to a 25% decrease in costs for hydrogen technologies and production. For the transportation sector, where two different hydrogen production methods were simulated, we present results for both hydrogen production methods.

The fiscal policies resulted in an increase in energy demand associated with the hydrogen technologies in all relevant sectors. In the transportation sector, while the energy demand associated with hydrogen technologies in the Fiscal Scenario was not significant in absolute terms (constituting between 0.03 and 34.87 PJ of demand in 2030 depending on the particular region), the *increase* in hydrogen related energy demand resulting from the introduction of the Fiscal Scenario was significant. Nationally, energy demand associated with hydrogen related vehicles increased from 64.36 PJ in 2030 in the SMR Reference Case (62.24 PJ in 2030 in the Electrolyzer Reference Case) to 96.26 PJ in 2030 in the SMR Fiscal Scenario (93.25 PJ in 2030 in the Electrolyzer Fiscal Scenario); an increase of almost 50%. In terms of number of vehicles, the Fiscal Scenario lead to an increase of 47,312 fuel cell vehicles, 33,371 hydrogen ICE vehicles and 218 fuel cells buses in the case of hydrogen production from SMR. Similar results were realized for hydrogen production using electolyzers. On a regional basis, the Fiscal Scenario resulted in an increase of over 45% in hydrogen related energy demand for most provinces and territories.

Like the transportation sector, the commercial and residential building sectors realized an increase in the energy demand associated with stationary fuel cells as a result of the fiscal policies. Energy demand from stationary fuel cells in the residential sector increased from 2.61 PJ in 2030 in the Reference Case to 14.45 PJ in 2030 in the Fiscal Scenario; an increase of 454%. Similarly, for the commercial sector, energy demand from stationary fuel cells increased from 0.41 PJ in 2030 in the Reference Case to 2.81 PJ in 2030 in the Fiscal Scenario, an increase of 592%. In terms of the number of stationary fuel cells being introduced to the residential and commercial sectors, in the residential sector, 15,770 more stationary fuel cells were introduced by 2030 as a result of the Fiscal Scenario. For the commercial sector, that increase was 90.

As the penetration of hydrogen technologies increased as a result of the Fiscal Scenario, greenhouse gas emissions associated with the transportation, residential and commercial sectors declined. For the transportation sector, emission reductions equaled 1,240 kilotonnes in 2030 for hydrogen production using SMR. If we assume that hydrogen is produced from a source with almost no greenhouse gas emissions (i.e. wind or nuclear power), the emission reductions that could be achieved would increase to 2,650 kilotonnes in 2030. The penetration of stationary fuel cells in the residential and commercial sectors lead to a decline in emissions of 710 kilotonnes from these sectors by 2030. Taking into account the impact of the mobile and stationary fuel cells, total greenhouse gas emissions in Canada declined by 1,940 kilotonnes for hydrogen production from SMR. These figures include emissions associated with hydrogen production. Taking into account only those emissions associated with hydrogen consumption (i.e. assuming that the hydrogen is produced from zero greenhouse gas emission sources or that emissions are captured) leads to reductions in emissions of 3,360 kilotonnes in the SMR case and 3,370 kilotonnes in the electrolyzer case.

The modeling analysis revealed that the reduction in emissions that occurred as a result of the penetration of hydrogen related technologies came at a fairly high cost on a per

tonne basis. This is due to the combined effect of the limited greenhouse gas emission reductions that were actually realized and the existing cost barriers associated with hydrogen technologies. The producer and consumer incentives that were simulated had the effect of reducing the capital and operating costs by 25% each. However, given the high capital costs associated with hydrogen technologies (initially 50% more than conventional technologies in the case of the transportation sector) the magnitude of funds required to reduce these costs by 25% was significant. The combination of the high costs for the policy and the relatively limited emission reductions that were achieved results in high costs per tonne of reduction.

This analysis revealed that fiscal policy is capable of facilitating an increase in the market penetration of hydrogen technologies in the transportation, residential and commercial sectors. In all regions for all sectors, the introduction of fiscal policies leads to an increase in energy demand associated with hydrogen technologies. This result holds true on an absolute basis and also as a percent of total energy, where the hydrogen technologies captured a greater share of total energy with fiscal policies in place. Despite these trends, even with the fiscal policies, the penetration of the hydrogen technologies was still relatively minor and the reduction in greenhouse gas emissions that was achieved was also relatively small.