Canada’s Integrated Energy & Macro Economic Modeling of Energy Efficiency Gains

Presentation to the IEA Workshop on Capturing The Multiple Benefits of Energy Efficiency

Session 5:
Paris, France
January 25, 2013

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Using integrated energy & macroeconomic models to estimate macro benefits from Canadian energy efficiency gains

- Illustrate approach from 2 modeling approaches
  - Environment North East using the REMI Model
  - Integrated Energy 2020/Informetrica Model

- Results
- Challenges and Considerations
Two Approaches - Partial-equilibrium Models

Environment North East (ENE) REMI Model

Integrates with energy savings developed outside model

Integrated Energy/Macro Model

Figure 7: REMI Economic Forecasting Model – Basic Structure and Linkages

- Reduced local sales tied to lower energy/fuel demand
- Investment tied to new technologies

Marketing Strategies
- Population & Labor Supply
- Labor & Capital Demand
- Wages, Prices, & Profits
- Ratepayer effects
- Energy savings to participants

Monitoring Consensus/Experts Project Analysis

Informetrics Canadian Models
- U.S./Other Foreign MacropAdvisers Model
- National Population/Demography
- Detailed Integration of D/S/P
- Energy Prices
- Energy Conservation by Industry
- Industry G.O./Y

Systematic Solutions
- Demand/Supply/Price
- GDP/ET/Y
- G.O./Y
- Gross Output/Income
**Policy and Scenario Development**

## Illustration of Strategic Direction of Scenarios

<table>
<thead>
<tr>
<th>Summary</th>
<th>BAU+ Scenario</th>
<th>Mid Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree to which low cost measures are pursued (e.g. CFLs, Education, etc.)</td>
<td>Aggressive</td>
<td>Very Aggressive</td>
</tr>
<tr>
<td>Degree to which high cost measures are pursued (e.g. building envelope, ground source heat pumps)</td>
<td>Moderate</td>
<td>Aggressive</td>
</tr>
<tr>
<td>Financial support</td>
<td>30-40% of costs</td>
<td>50-60% of costs + Financing</td>
</tr>
<tr>
<td>Government policies</td>
<td>BAU (w/consideration for funding mandates)</td>
<td>BAU &amp; Innovative financing (w/consideration for funding mandates)</td>
</tr>
</tbody>
</table>

**Figure 2.8 Secondary energy use, with and without energy efficiency improvements, 1990–2010**


- Energy savings developed at NRCan using historical sectoral energy database models developed to track energy efficiency trends
Avoided costs

- Electricity avoided spending at the margin based on utility plans
- Natural gas based on Gaz Metro Forecasts
- Heating oil, propane, and kerosene from the National Energy Board

Net annual energy costs savings (avoided costs less efficiency costs)

- 5% for electricity, 4% for natural gas and 10% for liquid fuels

Energy2020/Informetrica

Energy Savings

- To approach the goals set by the input data (efficiency gains by sector less adjusted for regulatory impact)
- Changes to efficiency of new devices are increased over a five year period and held constant causing energy efficiency to gradually reach goals.

Results are provided by sector by fuel type

- Then weighted to estimate GDP savings (at 1997$ prices) as input to Macro model
Savings Inputs to Modeling Frameworks

**ENE**

Regional energy savings (avoided costs) versus 15 years of program and participant investment

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**Energy E2020/Informetrica**

Estimated Energy Saving Value

Net Present Value (Discounted $Mns)

- Participant Costs
- Efficiency Program Costs
- Energy Benefits

$1997 Mns

Total Value of Consumer Energy Saving

- Service Producing Industries
- Goods Producing Industries

**Estimated Energy Saving Value**

- 2011
- 2013
- 2015
- 2017
- 2019
- 2021
- 2023
- 2025
- 2027
- 2029

- Total Value of Consumer Energy Saving
- Service Producing Industries
- Goods Producing Industries
Summary Results
## ENE – Cumulative regional impacts (2012-2040)

<table>
<thead>
<tr>
<th></th>
<th>BAU+</th>
<th>Mid</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Efficiency Program Costs ($2011 Millions)</strong></td>
<td>5,768</td>
<td>14,460</td>
<td>28,600</td>
</tr>
<tr>
<td><strong>Net Increase in GDP ($2011 Millions)</strong></td>
<td>45,238</td>
<td>83,955</td>
<td>113,250</td>
</tr>
<tr>
<td>Increased GDP per $1 of Program Spending</td>
<td>7.8</td>
<td>5.8</td>
<td>4.0</td>
</tr>
<tr>
<td><strong>Increase in Employment (Job years)</strong></td>
<td>330,110</td>
<td>625,110</td>
<td>867,650</td>
</tr>
<tr>
<td>Maximum Annual Employment Increase (Jobs)</td>
<td>23,880</td>
<td>42,670</td>
<td>52,327</td>
</tr>
<tr>
<td>Job-Years per $Million of Program Spending</td>
<td>57</td>
<td>43</td>
<td>30</td>
</tr>
<tr>
<td>Job-Years per $Million of Program &amp; Participant Spending</td>
<td>29</td>
<td>27</td>
<td>22</td>
</tr>
</tbody>
</table>
ENE - Employment Impact by Source

“Sum of Regions” annual job impacts (thousands) by demand source under the All Fuels, Mid Scenarios (2012-2040)

Cumulative Job Gains of 625,000
The significant increase in economic output would generate a net increase in collections of personal income tax, corporate income tax, and sales tax even with a reduction in revenue from fuel sales tax.

<table>
<thead>
<tr>
<th>Province</th>
<th>Sales Tax</th>
<th>Personal Income</th>
<th>Corporate Income</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Brunswick</td>
<td>$4</td>
<td>$4</td>
<td>$1</td>
<td>$9</td>
</tr>
<tr>
<td>Nova Scotia</td>
<td>$11</td>
<td>$12</td>
<td>$4</td>
<td>$27</td>
</tr>
<tr>
<td>Prince Edward Island</td>
<td>$1</td>
<td>$1</td>
<td>$0</td>
<td>$2</td>
</tr>
<tr>
<td>Quebec</td>
<td>$91</td>
<td>$116</td>
<td>$36</td>
<td>$243</td>
</tr>
<tr>
<td>Federal²</td>
<td>$51</td>
<td>$250</td>
<td>$56</td>
<td>$312</td>
</tr>
</tbody>
</table>

1 These values should be interpreted as more indicative of revenue changes near 2012, rather than 2040, since the fuel tax rates are current. No projection of tax policy has been attempted.
2 The federal values are collections of the federal tax across the four provinces and do not include potential effects in provinces outside the region of study.
• Electric power prices provide competitive advantage combined with direct and induced impact of energy savings and investment stimulus

• Employment in the directly impacted construction and manufacturing industries from investment contribute 15% of total gains, indirect and induced effects in services account for 84% of employment.
Two approaches but similar conclusions

- Investment shock is overshadowed by gains from avoided costs by energy consumers through the indirect and induced effects.
- More work needs to be done on the income and price effects from energy price changes in this context.
- Trade is an important component, in these models, through changes to competitive advantage.
- Energy efficiency gains can be an engine of growth.
Modeling Challenges and Considerations

• Time and effort to develop front-end estimation of assumptions on energy efficiency investment, avoided costs

• Energy market in play (is it competitive)
  • Energy price implications from reduced energy demand – can have a larger impact than investment (both modelers were surprised by this)
  • Energy trade and capacity –
    • Do producers anticipate demand reductions?
    • Is surplus energy available for export?

• How will Government treat increased revenues?

• Rebound effect – implicitly included – neither study developed specific assumptions on rebound but embedded in their models
http://oee.nrcan.gc.ca/statistics