BC’s Electricity Options: Comparison of the Natural Gas Strategy for Vancouver Island with a Low Emission Alternative

By: Rose Murphy

With a view to surety of supply and faced with the need to replace existing power connections soon, BC Hydro proposed a natural gas-based strategy to maintain Vancouver Island’s electricity supply. Mark Jaccard and I recently completed a multi-attribute trade-off and risk analysis comparing this strategy with a contrasting, low emission portfolio based on Hydro’s own data.

BC Hydro’s Integrated Electricity Plan (IEP) for 2000 covers the period 2000 – 2010. It is dominated by a combined cycle gas turbine (CCGT) plant on Vancouver Island, fed by a new natural gas pipeline called the Georgia Strait Crossing (GSX, we’ll refer to the plan the GSX-CCGT).

BC Hydro’s IEP does not contain all of the necessary elements of multi-attribute trade-off analysis (MATA), a tool commonly used by electric utilities to evaluate alternative generation and end-use efficiency investments in terms of their financial, environmental and social attributes. We were concerned; the IEP did not consider a full range of options, there was no public involvement to assess values on intangible factors and trade-offs and an explicit risk analysis was not performed. So we conducted our own simple MATA to address some of the important issues we feel were overlooked in this latest planning process.

We developed an alternative to GSX-CCGT that we call the Low Emission Independent Power Producer (LOW-EM-IPP) portfolio. LOW-EM-IPP involves replacing and increasing underwater electricity transmission capacity to Vancouver Island, and encouraging IPPs to develop low emission resources such as retrofit cogeneration, wood waste and small-medium hydro throughout the province. These resources have positive environmental attributes and...
are low in cost relative to other environmentally desirable technologies.

We specified key attributes by which to compare GSX-CCGT and LOW-EM-IPP, two financial attributes (unit electricity costs, impact on residential electricity rates) and two environmental attributes (CO$_2$e and NO$_X$ emissions). The cost of CO$_2$e emission reduction was calculated by combining financial and environmental information. We also considered electricity security on Vancouver Island. Job creation was assessed qualitatively.

We evaluated the two options under a set of base case assumptions. We found the unit cost of the electricity produced under the LOW-EM-IPP portfolio to be 6.57¢ / kWh, only 0.62¢ / kWh more costly than GSX-CCGT at 5.95¢ / kWh. We estimated the residential rate for customers within the BC Hydro service area to be 6.69¢ / kWh under LOW-EM-IPP. This is less than 1% higher than the GSX-CCGT rate of 6.65¢ / kWh. Compared to GSX-CCGT, LOW-EM-IPP results in an increase in annual electricity costs of about $3.40 for the average residential customer.

The electricity generated under GSX-CCGT in 2010 results in 1.85 Mt of additional annual CO$_2$e emissions. Current annual emissions from the entire BC Hydro system are only about 2 Mt CO$_2$e. LOW-EM-IPP delivers the same amount of electricity with emissions of only 0.19 Mt, 1.66 Mt less than GSX-CCGT. LOW-EM-IPP also generates less NO$_X$ emissions, 9 t in 2010 in the Georgia Basin, 165 t less than that of the GSX-CCGT.

If one divides the additional costs of LOW-EM-IPP over GSX-CCGT by the difference in GHG emissions, the estimated cost of emission reduction is $20 / t CO$_2$e, making LOW-EM-IPP one of the cheapest options available in Canada for reducing GHG emissions. Moreover, if Canada eventually applies policies that result in GHG emission charges of at least $20 / t CO$_2$e or more, LOW-EM-IPP becomes the lower cost option of the two.

We conducted a risk analysis to account for the possible impacts of uncertainty around three key parameters: capital cost of GSX, CCGT generation cost (as influenced by natural gas prices) and cost of the electricity transmission upgrade. We examined how these uncertainties affect unit electricity costs. Figure 1 below shows the probability distributions around the unit electricity costs for the two options. The two distributions show considerable overlap, implying that, of the many possible outcomes, the cost ranking of the two options could be reversed. It also shows that GSX-CCGT is associated with significant risk in terms of electricity cost as its variability is considerably higher.

*Base case cost estimates are indicated with dashed arrows.
This past April (25th and 26th) I had the ‘grand plaisir’ of taking part in the 6th annual Canadian Pollution Prevention Roundtable put on by the Canadian Centre for Pollution Prevention. The experience was at once educational, fascinating, and, well, a bit frightening. Let me explain.

The Pollution Prevention Roundtable brings together experts and interest parties from all levels of government (30%), industry (~30%), environmental non-government organizations (ENGOs ~ 15%), consulting (~15%), and academia (~10%) to share experiences and insights regarding pollution prevention initiatives and research. I was attending as one of 2 graduate student speakers, selected through a national abstract competition to present my thesis research.

My talk presented the Canadian Integrated Modelling System (CIMS), EMRG’s resident end use model, as a useful model for aiding in the evaluation and design of policies to prevent pollution, with specific reference to air pollution. It focuses on the role that technology decision making and energy and material throughput play in determining the extent of pollution production and reduction possibilities. As an example, I discussed some preliminary results from my research regarding the consequences that federal policies aimed at greenhouse gas reduction can have on local air pollution (including CO, NO\textsubscript{x}, SO\textsubscript{x}, volatile organic compounds, and particulate matter).

Using the electricity sectors in Alberta, Ontario and Quebec for comparison my talk emphasized that the extent of CAC reductions that could be realized with GHG-focused measures depends to a great deal on the current ‘structure’ of electricity production in each province. As might be expected, preliminary analysis showed that large reductions in CAC emissions could be realized in provinces with mostly thermal-based electricity production (Alberta and Saskatchewan), somewhat less in heterogeneous sectors such as Ontario and with much less potential for reductions in hydro-dominated Quebec, Manitoba or BC.

So what was so frightening? Given that my audience was hearing mostly about hands-on experiences, and that the speakers on my panel were discussing topics as diverse as golf course management and office design – my challenge was to communicate both the concept of modelling as a useful policy-informing exercise, and to describe CIMS (that deceptively simple model of ours) in a way that provided enough information and yet was easily understood by individuals with a variety of backgrounds – and didn’t put anyone to sleep. And let me tell ya’, composting toilets are a hard act to follow!

Luckily, my audience was ripe for a discussion of federal air pollution policy (perhaps thanks to a keynote address by Federal Environment Minister David Anderson on the subject). Questions ranged from the ability of CIMS to evaluate cap-and-trade scenarios to whether or not I thought Ralph Klein would pay heed to our analysis.

At the end of the weekend I was exhausted and exhilarated. I had survived my first large conference presentation, and met and mingled with a diverse array of pollution concerned professionals. I also had the opportunity to explore beautiful Quebec City, and experience some authentic, French-Canadian hospitality.
Table 1 summarizes the results of our analysis in a multi-attribute trade-off matrix. This presentation highlights the advantages and disadvantages that must be weighed in choosing between GSX-CCGT and LOW-EM-IPP.

### Table 1: Multi-Attribute Trade-Off Matrix

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Portfolio</th>
<th>GSX-CCGT</th>
<th>LOW-EM-IPP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial</td>
<td></td>
<td>Slightly better – if no pipeline cost overruns and gas prices low</td>
<td>Slightly poorer - may end up better depending on pipeline and natural gas costs</td>
</tr>
<tr>
<td>• Unit Electricity Cost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Rate Impact</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental</td>
<td></td>
<td>Poorer</td>
<td>Much better</td>
</tr>
<tr>
<td>• GHG / CO&lt;sub&gt;2&lt;/sub&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• NO&lt;sub&gt;x&lt;/sub&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Vancouver Island</td>
<td></td>
<td>Better, but remains energy dependent</td>
<td>Same as now</td>
</tr>
<tr>
<td>Electricity Security</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Job Creation</td>
<td></td>
<td>Less; Limited to Vancouver Island</td>
<td>Greater; Provincewide</td>
</tr>
</tbody>
</table>

Given that the costs and security outcomes of the two options are so similar, the dramatically superior ranking of LOW-EM-IPP in terms of GHG and NO<sub>x</sub> emissions is revealing. One would have to value this environmental advantage at close to zero in order to prefer GSX-CCGT. This is a troubling finding, given BC Hydro’s stated commitment to balancing financial, social and environmental objectives in everything it does.

We should caution that while we rely almost exclusively on BC Hydro’s data, there may be additional factors of which we are unaware that have some influence on its decision. Nonetheless, our work highlights the need for further clarification and examination of the assumptions behind recent planning decisions made by BC Hydro, and demonstrates the value of considering alternatives to a GSX-CCGT path.

In past editions of **EMRG News**, we’ve explained how, as a result of increased activity on the GHG front, and higher levels of concern with the possible costs of GHG emissions abatement, the researchers at EMRG are updating their detailed end use model, the Canadian Integrated Modelling System (CIMS), to increase its flexibility and usefulness. The task has proven to be much more onerous than expected and the team members decided that a highly focused, concerted effort was needed to bring the task to completion.

While the model is still useful for analysis as is, the research team has laid aside many tasks and refused new work until the model’s revision is complete. The schedule calls for the model to be able to run for one province all sectors, including the integration of supply and demand components by the end of June, 2002. Given that this will be the largest step, Alison Laurin, project manager, feels that the “rest of Canada” will be in place by the end of August. We all look forward to its completion—and the party!

**Congratulations to Kevin Washbrook** on the completion of his project and other requirements to obtain his MRM degree. Kevin’s project, entitled *Assessing the potential of road and parking charges to reduce demand for single occupancy vehicles commuting in the Greater Vancouver region*, focused on commuter preferences in the lower mainland of BC.

**Congratulations to Margo Dennis** (nee Sadler) who was married June 1, 2002 to Karl. The EMRGers wish you and Carl all the best in your life together!

**Welcome** to two new students to EMRG this fall! Paulus Mau and Jimena Eysaguirre will join the group beginning this September. You’ll see more on these new students in the next edition of **EMRG News**.

**Nic Rivers, Matt Horne** and Margo Dennis are looking at revising how CIMS applies technology choice algorithms. Reviews focus an analysis of the applicability of Discrete Choice Models. More on this in the next **EMRG News**.

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