Feature Article:

Cost Curves: Capturing the Cost of Controlling CO₂

By: Dr. John Nyboer

One need not travel far in the literature on “Reduction of Greenhouse Gas (GHG) Emissions” to find that the question “What will it cost?” is one of the most difficult to answer. Many models are touted, many ideas are postulated, many approaches are taken; but somehow we need to provide decision makers in government offices, utility board rooms or industry associations with concrete information. Really, they seek to answer only two questions: What can be done? And how much will it cost?

Economists have suggested a number of approaches, just one of which I wish to describe here: develop a cost curve of potential reduction options to determine the actions society should undertake to reduce GHG emissions.

Well, what is a cost curve? How does it tell you what you should and shouldn’t do? And how do you go about making one?

What is a cost curve?

Defining a cost curve for the reduction of GHG emissions is relatively simple (see figure 1). The “x” axis defines emissions reduced, either in physical units (tonnes of GHG gases, as in figure 1) or in percent reduction from some starting point. The “y” axis reflects the cost per unit of executing a measure to reduce emissions, which can be negative (i.e., a benefit) or positive. After having defined a number of measures (e.g., add insulation to exterior walls, add insulation to ceilings, car pool with your neighbour, put in a more efficient boiler at the factory, etc.) in terms of their cost and reduction potential, we simply line the measures up on the graph beginning with the least expensive measure on the left, and see where the sum of measures takes us.

Some, such as carpooling, may provide a financial benefit as well as reducing emissions, while others may be quite expensive. The quantity of emissions reduced in the execution of a measure determines the distance we move (continued on page 2)
along the “x” axis. If we have a target to reach, say 50 tones reduced, we simply move to the right on the “x” axis to that target point and determine where the curve passes that point. Whatever lies to the left of that point -- all measures up to and including Meas. 4 in Figure 1 -- are measures that should be completed to attain the target, and whatever lies to the right need not be done. In this way, the least expensive measures are executed first and we spend only what is necessary in order to reach our goal. Cost curves are an excellent tool for providing information to decision makers; however, there are difficulties involved in defining measures and in generating curves from individual measures.

How measures are defined.
The problem for most analysts lies in defining measures in terms of their costs and reduction potentials. Are costs of implementation included? Are cost estimates based on discount rates which would be acceptable to a board of directors, or are they based on the cost of capital or the social discount rate? Do all potential measures penetrate 100%? Do measures provide the same benefits in all circumstances? In order to address these questions, models are required which are both technologically explicit and capable of simulating technology change in a matrix of real-world market behaviour.

Issues surrounding cost curves
Even if individual measures could be defined with perfect accuracy, a number of problems would remain. What are the interactive effects of one measure on other measures? Is “double counting” introduced in situations where one measure would eliminate the same tonne of emissions as another measure? How does one account for the beneficial/detrimental effects of a measure if they are not quantifiable? How does one account for any regional variation in cost/reduction potential? How comprehensive is the list of measures?

Space prevents us from looking at each of these issues in turn, but it is clear that just the first two -- interactions between measures and the potential for double counting -- could disqualify any cost curve from giving a true evaluation of the actual cost of meeting a target. What good, then, are cost curves?

There are a number of benefits that can be gleaned from a careful analysis of a detailed cost curve. Such a curve would provide significant insight into the potential costs and emission reduction benefits available from any particular measure or group of similar measures (e.g., developing programs to improve the efficiency of motor-driven auxiliary services or improving automobile efficiency by 5%). Through a critique of which measures may be economically appealing to a specific sector or industry, policy analysts, industry associations, energy utilities or other agencies can initiate various programs to reduce emissions.

Cost curves for Canada
We at ERG have proceeded to develop detailed cost curves for Canada. With over 450 measures spread over all regions of Canada in all energy-consuming sectors, these cost curves provide some very interesting results. Our results are still preliminary, and are presently undergoing more detailed analysis and revision. Once this process has been completed, ERG will be releasing some of the results and conclusions -- stay tuned for the Spring Edition of ERG

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“What’s Up Doc?”
ERG Goes to Albuquerque
By: Chris Bataille

The annual North American Conference of the International Association for Energy Economics was held in Albuquerque, New Mexico this last October 18-21st. ERG members who attended the conference were happy to escape the Vancouver “winter”, and were impressed by the stunning landscape of New Mexico as well as its ancient and highly sophisticated First Nations heritage. As if that weren’t enough, they also presented three papers and presided over a debate.

The theme of the conference was “Technology’s Critical Role in Energy and Environmental Markets.” Special consideration was given to the role of technology and the market in the ongoing North American debates over energy market deregulation, the Kyoto Protocol, Demand Side
Management (DSM), mandated energy efficiency, oil and gas market evolution and the diffusion of information technology.

ERG presented new research and discussed its implications for deregulation, jurisdictional issues, energy modeling and the costs of meeting the Kyoto Protocol. Dr. Mark Jaccard, director of ERG, presented "Bridging the Gap Between Performance Based and Rate of Return Regulation: Recent Developments in a North American Jurisdiction", an article based on his experiences as the British Columbia Utilities Commissioner. Reflecting ERG's position as a leader in technology simulation modeling in North America, Dr. Jaccard was also asked to present at a panel session entitled "Technology In Energy Modeling: Key Insights and Future Directions." Also included on the panel were Andre Plourde of the University of Alberta; Jay Hakes, administrator of the Energy Information Administration of the US Department of Energy; and Hill Huntington, executive director of the Energy Modeling Forum at Stanford University. Dr. Jaccard completed his hat trick by presiding over a General Session Debate: "Federal / State Jurisdictions for Electricity Restructuring."

One of ERG’s research associates, Chris Bataille, presented "New Evidence on Capital for Energy, Inter-fuel, Capital for Carbon and Own Price Carbon Elasticities: Results and Implications from a Disaggregated Technology Simulation Model" Chris focussed on two findings and their implications for the cost of greenhouse gas emission reduction. The first finding was that inter-fuel substitution may be relatively easy compared to energy substitution. This was demonstrated through a comparison of inter-fuel elasticities vs. capital for energy elasticities. High inter-fuel substitutability implies that switching from more CO2 intense fuels (e.g. coal) to less CO2 intense fuels (e.g. natural gas) may be a relatively inexpensive way to reduce CO2 emissions. The second finding was that de-carbonization may be relatively easy compared to de-energization, as demonstrated by some ongoing work on capital for CO2 and own price CO2 elasticities.

Finally, who could forget the absolutely superb meals (who said networking was unpleasant?), especially the filet mignon which prompted a certain ERG vegetarian to fall off the wagon. All in all, conference participants enjoyed themselves immensely and were extremely productive.

The Forum took this information and developed a set of recommendations for the BC government. The recommendations included 18 consensus actions ranging across all sectors of the economy. These actions were estimated to reduce GHG emissions between 2 and 5.1 million tonnes by 2010 from the Business-As-Usual projections. Actions that the Forum did not attain consensus on could lead to a further reduction of 1.5 to 3 million tonnes. While these reductions are significant, even if all these actions were implemented and reduced emissions to the maximum estimated amount, BC emissions in 2010 would still be about 21% above 1990 emissions. However, identifying these potential actions and their likely impacts are important early steps in the road to limiting climate change. The BC GHG Forum has recently submitted their final report to the appropriate BC ministries and it can be downloaded from the website http:\www.env.gov.bc.ca, under climate change.

ERG NEWS

Helping BC Act Early to Reduce GHG Emissions

By: Alison Bailie

During the early summer, the Energy Research Group was subcontracted by Compass Resource Management on a project for the BC Greenhouse Gas (GHG) Forum. The project developed recommendations for the BC Ministers of Energy and Environment to apply to their Early Actions Plan. The Forum interpreted “Early Actions” to mean any actions started before the Kyoto Protocol is ratified and before Canada has developed a national plan to meet the Kyoto Protocol commitments.

ERG’s contribution to the project was to work with Compass Resource Management to suggest an initial set of potential measures for reducing GHG emissions and to estimate the emission reduction and costs of these measures. ERG/Compass grouped the measures, using a short list of criteria including costs and non-GHG benefits, into 4 categories: no net costs, justifiable, may be justifiable and not likely to be justifiable. ERG/Compass then linked the measures with possible policy instruments to develop potential actions (i.e. Action = Measure + Policy Instrument).
On the Usefulness of Energy Intensity Indicators...

by: Mallika Nanduri

Changes in energy intensity, the amount of energy input per unit of physical or monetary output, are often construed as indicators of changes in energy efficiency and their use as policy-making tools, especially in the context of climate change and CO2 mitigation, is on the rise. The study I did looked at some of the problems associated with the development of these indicators, and examined their potential application to climate change policy analysis/policy-making.

There are two main problems associated with the development of energy intensity indicators. The first problem is that different physical units of output make it very difficult to obtain measures of physical energy intensity at aggregate levels. The use of GDP or Gross Output to generate monetary intensity indicators gets around this aggregation problem, but these are affected by structural effects (factors that are unrelated to improvements in technical energy efficiency). The second problem is how to remove structural effects through “decomposition” methods.

In the first part of my study, I examined the aggregation problem associated with physical intensity indicators. The Composite Indicator Approach gets around the aggregation problem by adding the energy-weighted percentage change in energy intensity for different industries/sub-sectors to develop aggregate level physical composite indicators. This method was applied to a Canadian Industry Energy End-Use Data and Analysis Centre (CIEEDAC) data set, and was found to allow for the development of reliable aggregate level physical indicators.

The second part of the study used a “test-case scenario” format to examine the effect different decomposition methods, and different approaches to setting up a decomposition analysis, had on economic intensity indicators. The numerical results appeared to be consistent in the majority of cases, varying only by a few percentage points here and there.

Finally, although energy intensity indicators certainly provide analysts with important information, and are valuable for monitoring purposes, they fall short as climate change policy-making tools. Such indicators cannot provide policymakers with any information regarding the costs of mitigating climate change, nor can they help to establish which industries should be targeted and how to target them. Furthermore, such indicators represent “the past”, and the trends they exhibit may not be indicative of the future. Simulation modelling could be used to address these issues.

Robert D’Abate — A New Addition to ERG

Robert is yet another immigrant from la belle province where he graduated from both McGill University (Finance & Accounting) and Concordia University (Honours Economics). A brief stint in the public sector has left him with a strong desire to shoulder some meaningful and challenging work. Robert will be pursuing the exciting field of electricity modelling through the famed electricity supply model ESSM. The role of inter-provincial trade in electricity as a means of reducing CO2 emissions will be the major focus of his research.

Background

The Energy Research Group (ERG) at Simon Fraser University (SFU) is comprised of individuals who are pursuing academic study in energy management and policy, and/or are working in the field of energy systems modelling. The majority of the modelling work makes use of the demand-side modelling environment, ISTUM (Intra-Sectoral Technology Use Model). Models have been developed for electricity supply forecasting (ESSM), community energy planning and transportation planning.

The ISTUM user group is open to all, and includes ERG members, Centra Gas (BC), BC Hydro, Marbek Resource Consultants Ltd., NRCan, the Ontario Ministry of the Environment and Energy, Willis Energy Services Ltd., Battelle Pacific Northwest Labs, the University of Washington and Roger Peters and Associates.

Most ERG members focus their “energy” on completion of the Resource and Environmental Management (REM) programme at SFU. Projects are often undertaken for interested utilities and organizations. New projects requested by various energy focused organizations are always considered and may be completed, depending on the availability of student and supervisory time.

Announcements

- Farewell to John Oliver who has defected to BC Hydro
- Congratulations to Chris Bataille who has graduated from the REM program with flying colors
- ERG welcomes Bryn Sadownik as a full time Research Associate
- Congratulations also to Chris Bataille and Mallika Nanduri who have been accepted into the REM