Forum

Forum provides an opportunity for commentary on articles published in ESR and for the expression of opinion on any other subject that relates to energy problems. Contributions are invited. (For further information see inside back cover.)

Achievable Conservation Potential in British Columbia: a Review and Critique

JOHN NYBOER and ALISON BAILIE

John Nyboer and Alison Bailie are both at the School of Resource and Environmental management at Simon Fraser University. Mr. Nyboer is a doctoral candidate and Ms. Bailie is a research associate.

"We've set the boundaries. Now tell us what can actually be conserved!" That was the job description facing the consultant hired to complete Phase II of BC Hydro's review of conservation potential (Synergetic Resources Corporation, 1994a, 1994b). In 1991, a Collaborative Committee of 13 "stakeholders representing 34 organizations" initiated Phase I of the Conservation Potential Review. The objective? Establish the boundary — What is the estimated unconstrained technological, social and economic potential for electricity conservation in BC Hydro's service area? (BC Hydro is British Columbia's dominant electric utility.) Phase 1 analysis, completed by mid 1992, suggested an enormous technical opportunity for electricity conservation in all sectors - industrial showed a 42% conservation potential, residential 76% and commercial 69% (compared to 1988 efficiency levels). The potential is large but what portion of that is attainable? And how would that be determined?

The Phase II analysis, designed to answer these questions by building on the information collected in Phase I, involved two parts: part 1 estimating conservation potential through technological and operating change, and part 2 estimating conservation potential through lifestyle change of individuals

"We've set the boundaries, now tell us what can actually be conserved!"

and society in general.

Part 1 analysis involved three elements: (1) a review of Phase I to update data reflecting changes in BC Hydro's current environment, (2) a review of demand-side management (DSM) program experience in other utilities, and (3) the development of five scenarios. Although some overlap of programs exists between the five scenarios, each one emphasizes one main type of initiative. The pricing scenario considers the impacts of changing capital costs of more efficient technologies and electricity prices. The education scenario models customer information programs. The regulatory scenario involves mostly actions from the BC government such as building codes, efficiency standards, and tax credits. The utility scenario has BC Hydro playing an aggressive role through rebates, leasing, financing, and performance guarantees. Finally, the integrated scenario includes joint utility and government initiatives such as incentives and education efforts at the initial stages of product development, followed by upgraded standards as the market accepts the product. Using a software planning tool called COMPASS (Comprehensive Market Planning and Analysis System), analysis yielded information about the market penetration of the various technologies being examined, energy impacts due to these penetration rates, and associated benefits and costs.

Part 2 analysis involved the assessment of two scenarios. The first scenario estimated the conservation potential in 2010 if all individuals responded favourably to a range of behaviour changes such as using cold water to wash clothing and shades or blinds to reduce solar loads in the commercial sector. Three sets of behaviours were investigated: behaviours with minimal life style impacts, moderate impacts and significant impacts. The second scenario was, in effect, a backcasting analysis consisting of two steps. First, the consultants, in conjunction with the Sustainable Society Project of Canada, developed a "visionary" scenario of a sustainable society in 2030. The scenario looked at the entire energy system and included changes to comprehensive lifestyle dimensions such as behaviour, infrastructure, society, and technologies. Second, the consultants used the 2030 scenario to estimate the "extent of societal changes that will have happened in the Province by 2010 if the 2030 sustainable society is achieved" (p.I-8).

Each part of the analysis forms a separately bound report with part 1 about four times larger than part 2. The main portion of part 1 consists of 6 chapters — introduction, key findings, one chapter for each of the residential, commercial, transportation sectors, and finally descriptions of the scenarios and methodology of the analysis. Thus, the results are displayed prior to descriptions of the assumptions and method of determining the results. This structure, though likely an accurate representation of the way the report will be read, runs the risk of hiding essential information at the back of the report.

The introduction chapter contains the general analysis methodology and brief descriptions of the 5 scenarios. The key findings chapter includes (1) a summary of the achievable potential for each scenario and each sector, (2) the costs and benefits by scenario and sector, (3) a sensitivity analysis to the cost of new electricity, and (4) conclusions. The achievable potential results are defined as the difference between electricity consumption in each scenario and the baseline electricity consumption. The baseline electricity consumption is never clearly defined; it seems to refer to a frozen efficiency scenario (electricity consumption if all new technologies purchased had the same efficiency as technologies purchased in the base year) but could reflect a BC Hydro sales forecast that excludes DSM measures. Although this chapter includes a table listing costs and benefits by scenario and sector, it excludes any type of explanation of the source or meaning of this information. In fact, no reference exists within the chapter to direct readers to more information, though determined readers will find some details in appendix D.

Chapters 3 to 6 expand the results for each sector. Each chapter first describes any updates to the Phase I results that have occurred since the release of that report. It then displays the electricity savings by scenario and by end-use. The residential sector chapter includes a qualitative description of the technologies in each scenario that provide the largest electricity reductions. The chapters for the other two sectors exclude this valuable information. Each sector does include both results of sensitivity analysis on growth rates, discount rates, cost of new electricity supply, and environmental adders and conservation supply curves. The conservation supply curves (plots of energy savings versus levelised cost of energy saved in 2010) "indicate the portion of the achievable potential that is available at various costs of energy saved (p III-15)." These graphs also indicate which technologies provide energy savings at various costs and how much energy can be saved by these technologies. Chapter 7 describes the scenarios in detail, including the model input parameters used for each scenario, and briefly describes the methodology used for determining market penetration of energy-efficient technologies.

Appendices make up the greater half of the more than 250 pages of the Part I report. Appendices A to F present energy and economic data on technologies and programs. Appendix G is a report prepared by the American Council for an Energy Efficient Economy, *Achieving High Participation Rates: Lessons Taught by Successful DSM Programs.*

Part 2, written more informally than part 1, consists of 5 chapters. The introduction sets out the study objectives and approach. Chapter 2 analyses the effects on electricity consumption in 2010 of various lifestyle changes. Chapter 3 describes a possible picture of the energy consumption of a sustainable society in 2030. Chapter 4 considers the changes that would be needed by 2010 to achieve the 2030 picture described in chapter 3. Chapter 5 summarizes the findings of the study. The report concludes with appendices detailing the main assumptions and data.

Readers may assume the model outputs to be hard, forecasted numbers. This would be a mistake.

So, what are the results? Readers may assume the model outputs to be hard, forecasted numbers. This would be a mistake. The report emphasizes, and rightly so, that these are not forecasts; they are general indications for potential. Each part generated a set of values; since the two parts of the study were published separately, they are also considered separately in this evaluation.

Part 1 of the study identifies the following levels of achievable conservation potential (baseline electricity consumption minus scenario electricity consumption) for each scenario in 2010:

- Pricing scenario 11,357 GWh
- Education scenario 11,294 GWh
- Regulatory scenario 11,711 GWh
- Utility scenario 13,673 GWh
- Integrated scenario 13,800 GWh

These figures indicate significant (18%-22%) reduction in electricity consumption compared with the baseline of 62,261 GWh. However, as mentioned above, the baseline does not include any natural adoption of energy efficiency measures, i.e. purchases of more energy efficient equipment that would occur without any specific new programs or policies. The study did include a reference case to estimate the impacts of this natural adoption and the electricity savings over the baseline in 2010 are large, 8506 GWh. Since the achievable conservation potential figures for each scenario (as listed above) include the savings due to natural adoption, the actual savings that can be attributed to the scenario initiatives would only be 2851 GWh to 5284 GWh, significantly lower than the reported conservation potential.

The study compares the achievable conservation potential to the technical potential, as defined in Phase 1 of the review, providing some idea of the degree of possible conservation that can be attained. The scenarios manage to capture 44% to 53% of the unconstrained potential. Again, because these percentages include electricity conservation due to natural adoption of efficient technologies, the values are inflated.

Chapter 2 of Part 1 contains a table showing the net present value of the costs, the sum of both the utility's and the customers' costs, and the benefits, the avoided cost of new electricity supply, by sector and scenario. The appendices include the program and technology costs used to determine the net costs. The net present value of each scenario is positive, ranging from 1.4 billion dollars for the regulatory scenario to 2.2 billion dollars for the pricing scenario. The net benefits in the industrial sector tend to be 3 to 50 times greater than in the commercial or residential sectors, due to both lower costs and larger electricity savings.

As mentioned previously, virtually no explanation accompanies this table. Chapter 1 includes brief definitions of both the utility cost test and the total resource cost test, although the utility cost test never seems to be referred to again. Appendix D lists the program costs and the equations used for total resource costs. However, many questions are left unanswered. For instance, what discount rate is used when determining customer purchasing preference? Many studies have shown that private discount rates exceed social or utility discount rates, often by large amounts. Higher discount rates could greatly increase the net present value of the costs of the scenarios. The report does not even report the ratio of costs paid by customers to costs paid by the utility. The reader also does not know whether the electricity savings, used to calculate the benefits from the avoided cost of new electricity supply, include the savings due to natural adoption of more efficient technologies. As mentioned above, the majority of savings result from changes likely to be made without any changes in policies or programs. If these savings are included as benefits in the reported figures, the actual benefit of the scenario initiatives may be greatly exaggerated.

The study includes sensitivity analysis on alternative growth rates, discount rates, and costs of new supply, but it excludes sensitivity analysis on the model parameters. The report on participation rates in DSM programs (appendix G) shows a wide range in participation levels even with very similar programs. This wide range could logically lead to wide ranges in maximum penetration rates of technologies, yet the study does not probe the sensitivity of results to these rates.

In fact, neither the maximum penetration rates nor the achieved penetration rates are shown anywhere in the report, though the tables in appendix F could easily accommodate this information. Without knowing penetration rates of specific technologies, the reader must completely rely on the writers to judge whether the results are reasonable and to explain the differences between scenarios. This information exclusion limits the usefulness of the study.

The methodology section (chapter 6) describes the study's conceptual framework but it lacks some vital information. The incomplete description of the COMPASS methodology does indicate that market penetration of DSM options follows an "S"-shaped curve over time with the maximum penetration depending on the payback acceptance. Tables and descriptions explain the general scenario initiatives and the values of COMPASS's 13 main parameters used to model these initiatives. However, the report never justifies the choice of parameter values. For instance, in the education scenario, initiatives such as labeling and workshops are simulated by decreasing the payback acceptance period by six months. Why six months? Why not 12 months?

The parameters for COMPASS are based on the consultants' experience and market analysis of DSM programs, mostly in the U.S . While some characteristics of technology penetration remain consistent between regions (the sigmoid shape of the penetration curve), others can vary considerably (the degree of market acceptance and the assumed maturity of the technology). For example, penetration of air conditioners in the BC market may follow the typical S-curve of air conditioners everywhere but there are bound to be significant differences between rates of penetration in BC and the rest of Canada, or regions in the US. In fact, there are bound to be significant differences between the lower mainland and more central regions within BC.

To calculate payback for a technology requires comparing its capital costs and energy consumption to some base technology that provides the same service. The report structure implies that the base technology is the technology with the lowest efficiency. More realistic would be to use the technology most likely to be purchased (in absence of DSM programs) as the base technology. The large difference in electricity consumption between the baseline and the reference case indicates that the technology with the lowest efficiency is often not the technology most likely to be purchased. This methodology also seems to ignore the effects of competing technologies on market penetration — why would a rational consumer purchase an efficient device with a reasonable 2-year payback when a technology with a 6-month payback period is also available?

There are a number of other, more physical phenomena we were left wondering about. What about technological interactive events? Use of household and commercial appliances and lighting technologies have some impact on HVAC requirements. There is significant potential for cogeneration of electricity in commercial as well as industrial applications. Community energy planning and increased consideration of industrial ecology can significantly reduce overall energy demand. In industry, specific process technologies (such as pulp digestors and cement kilns) that compete to provide the required service may have varying demands on auxiliary devices and other support services. Changing process technologies (say, a batch pulp digestor to a continuous digestor) may have more impact on overall electricity demand than increasing the efficiency of the motors and auxiliary devices needed to provide support services to this process technology. In other words, choosing technologies that reduce overall pump demand may show greater potential than choosing to replace inefficient pumps and motors with more efficient ones. In the Phase I analysis, significant potential for reduction in electricity demand existed in this area. Phase II contained no evidence that this potential was accounted for.

If it is difficult to estimate consumer purchasing behaviour, it is even more difficult to get a picture of "lifestyle" behaviour. The first scenario assumes that society views conservation of resources, including energy, at the forefront; it "sees efficient use of energy as a critical and ongoing goal, even at the expense of accustomed levels of service and certain personal comforts" (p.II-1). Although beginning with such an assumption may be valid in the context of this analysis (it may have been part of the Terms of Reference), it denies, to some extent, the rather complex nature of society, of the aspirations of many whose view extends beyond, or perhaps doesn't even include, the issue of energy, and specifically electricity, conservation.

In the first scenario, the conservation potential in 2010 is 6000 GWh for minimal lifestyle impacts, 10,000 GWh for moderate impacts and 15,000 GWh for significant impacts, compared to the baseline 58,737 GWh. This potential only refers to reductions due to lifestyle changes. The analysis does not consider the potentially large interaction between technological changes and lifestyle changes. At minimum, a realistic analysis would consider the electricity savings due to lifestyle changes with the Part 1 reference case, natural adoption of more energy efficient technologies, as the base. More important is the question of whether these lifestyle changes are achievable. The discussion of the first scenario includes the following warning:

> It is crucial to note it is quite unlikely that 100% of the eligible customer market will adopt all lifestyle changes — or even adopt any particular one. Therefore, the achievable savings to BC Hydro will in actuality be less than the unconstrained potential savings reported in Table II-4 (p. II-17).

The first scenario, unfortunately, reflects "lifestyle" changes in the industrial sector only with reference to light and heat (HVAC), a very tiny, if not insignificant component of the whole. It may be difficult to assess the impact of lifestyle changes on the rest the technologies that consume electricity in the industrial sector, but it is faulty (but not surprising) to conclude that the residential sector contributes more than half of the potential gains for lifestyle change portion.

The second, backcast, scenario begins by clearly stating the major assumptions and inputs to the analysis then summarizes the total energy demand (not just electricity) in 2030 by sector. The report briefly explains, qualitatively, the structure, technology and behavioural changes in each sector. The 2010 "snapshot" lists the energy demand by sector and by fuel. Energy demand for both 2030 and for 2010 is listed in petajoules, highly frustrating for readers hoping to compare this analysis with the first scenario or with the results from part 1, (*Conservation Through Technology and Operating Change)*, where it is listed in GWh. The report offers little assistance, not even qualitative explanations, to readers trying to determine and understand differences between scenarios. Due to the major sustainability assumptions of this scenario, the results of this analysis may be even more difficult to achieve than the first scenario.

...lifestyle analysis is really only a picture of potential for electricity conservation, not realizable conservation.

But then again, the lifestyle analysis is really only a picture of potential for electricity conservation, not realizable conservation. This is an "if only" and not a "how to" analysis. The report does provide a bit of a list on how to get to the "how to." It recommends that we ask questions about:

- what motivates (drivers) and inhibits (barriers) behaviour of consumers?
- what utilities can do to promote drivers and mitigate barriers?
- how can behavioural-based conservation be sustained?
- how can behavioural-based conservation be measured? (p. V-2)

This study is part of a new, largely unexplored area of research for electricity utilities, promoting and planning for electricity conservation. While it succeeded in considering the effects of various initiatives on consumers' decisions when purchasing and using technologies, its shortcomings limit its usefulness. The three main shortcomings of this report are (1) lack of relevant information, (2) questions on the methodology, and (3) lack of connection between part 1 and part 2.

Most of the information gaps have been described previously. Here we just re-emphasize the major gap in the information delivered, the impact that various programs and regulations will have on the rates of penetration of the various technologies. This is, after all, the point of the exercise — what impact will these scenarios have on capturing potential electricity conservation. The report is quite clear about what impacts will be assumed to occur on these penetration curves but it is less clear on how these impacts were determined and provides no information on any testing of variations on these impacts. Without penetration rate data, we cannot judge the advantages and disadvantages of the various scenarios. We do not know which initiatives have the most impact on electricity conservation nor are we ever sure if the scenarios and their subsequent electricity conservation are realistically achievable.

The lack of detail in the report makes it difficult to properly assess the modelling methodology. However, we do question the validity of using information from other studies without explicitly determining their similarities to the British Columbia context. Also, simulations of technology purchase decisions should account for competition between the many available competing technologies. Finally, interactions between technologies can greatly influence electricity demand and must be carefully considered.

The collaborative committee should be commended in acknowledging the potential for lifestyle changes in electricity conservation. This huge area often receives very little attention. However, the lack of interaction between the two analyses limits the benefits of this work. The main body of the technology and operating change report never mentions the existence of the companion lifestyle change report.

There is no doubt that dealing with achievable conservation potential is a difficult issue, the uncertainty of purchasing behaviour being what it is. There are lots of soft areas in this analysis — perhaps a good measure of it could never be "hardened." A project of this nature is fraught with uncertainty, phenomena to which we can attach no probability of occurrence. To make any analysis credible, the areas of uncertainty should be clearly stated, and mitigative procedures clearly outlined. The report does show that valuable conservation potential exists out there to be captured, and that it appears to be quite substantial. Because of significant levels of uncertainty, it also shows areas of research on which we should be spending a lot more time and funds. If electricity conservation potential exists, a potential economically competitive with supply alternatives, analysis and evaluation must continue and these uncertainties made more certain.

References

Synergetic Resources Corporation (1994a) 'Phase II Achievable Conservation Potential Through Technological and Operating Change,' *Electricity Conservation Potential Review, 1988-2010*, report prepared for Conservation Potential Review Project Collaborative Committee, BC Hydro, Vancouver.

—(1994b) 'Phase II Conservation Potential Through Lifestyle Change,' *Electricity Conservation Potential Review, 1988-2010*.