2012 Integrated Resource Plan

BC hydro

Appendix

3A-5

2010 Resource Options Report
Economic Development Attributes

2010 Resource Options Report

Economic Development Attributes
May 2011

Economic Development Attributes

This appendix describes the methodology, data and assumptions used by BC Hydro to develop economic development attributes for long-term resource planning.

BACKGROUND

The *Clean Energy Act* (2010) includes the objective of encouraging economic development and the creation and retention of jobs. As a result, economic development attributes have been developed and will be used to characterize the various portfolios of resources considered in resource planning to close electricity gaps under alternate scenarios. Having this insight into the economic development potential of resource portfolios will support the consideration of economic development in recommended resource planning actions.

The 2006 Integrated Electricity Plan (**IEP**) included consideration of socio-economic impacts and tracked temporary and permanent jobs associated with building and operating resource projects. The jobs were reported in full time equivalents. The targeted resource options update as part of the 2008 Long-Term Acquisition Plan (**LTAP**) did not include a further review of economic impacts.

APPROACH

Key criteria considered in the development of economic attributes for long-term resource planning included consideration that the attributes should be:

- Available at a high level provincial scale;
- Science-based, using current best practice methods and defensible;
- Measurable in a quantity-based approach that will facilitate comparison across resource options;
- Calculated using existing or easily acquired data;
- Useful in differentiating/characterizing portfolios of resources;
- Supportive of the *Clean Energy Act* objective with regards to economic development and the creation and retention of jobs; and
- Meaningful and easily understood by BC Hydro, First Nations & stakeholders.

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The following economic development attributes have been chosen for the long-term resource planning after taking the above into consideration:

- **Employment in B.C.** Employment opportunities in B.C. are created as a result of BC Hydro's activity and spending. Potential energy projects throughout B.C. provide opportunities during both the construction and operating phases of a project. Employment opportunities are created in both metropolitan and regional areas given the remote locations of many potential renewable energy projects.[1]
- **Provincial Gross Domestic Product (GDP).** GDP refers to the additional value of goods and services added above the cost of inputs used to produce the good or provide the service. GDP is the additional value created through labour or mechanical processing. GDP is a better measure of economic impact than output since GDP avoids double counting impacts.[2]
- **Government Revenue.** Tax revenue is generated as a result of BC Hydro's operations. BC Hydro helps generate revenue to government through personal and corporate income taxes, grants-in-lieu of taxes payable by BC Hydro as well as resource revenues such as water rentals.[3]

[1] Note: Employment estimates generated by the BC Provincial Input Output Model (**BCIOM**), are derived from estimated wage costs using information on average annual earnings in an industry. The employment impacts are not full-time equivalent (**FTE**) measures. Instead, they reflect the wages paid and hours spent on the job by a typical worker in an industry. For an industry where most employees work full time, the numbers will be very similar to FTE counts. However, in an industry where part-time work is more common, the job counts will be quite different from FTEs. The latest version of the BCIOM estimates employment impacts based on average wages in 2009. Source: BCIOM report, BC Stats 2010.

[2] Note: GDP is a measure of the value added (the unduplicated total value of goods and services) to the B.C. economy by current productive activities attributable to the project. It includes household income (wages, salaries and benefits, as well as income earned by proprietors of unincorporated businesses) from current productive activities as well as profits and other income earned by corporations. Only activities that occur within the province are included in GDP. Source: BCIOM report, BC Stats 2010.

[3] Note: Government tax revenue estimates generated by the **BCIOM** include income taxes as well as commodity taxes. *Provincial and federal tax revenues* include federal and provincial personal and corporation income taxes. Also included are the Harmonized Sales Tax (**HST**) and other *commodity* taxes such as gas taxes, carbon, liquor and lottery taxes and profits, air transportation taxes, duties and excise taxes. *Municipal tax revenues* are primarily related to accommodation taxes. The latest iteration of the BCIOM takes into account the current tax structure (as of August 2010) as well as the prevailing tax rates. Provincial government revenues include the provincial portion of the HST. Source: BCIOM report, BC Stats 2010.

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Direct, Indirect and Induced Impacts

Economic impacts are generally discussed in terms of direct, indirect and induced impacts. Total economic impacts are estimated as the sum of the various direct, indirect and induced impacts, defined as follows:

- **Direct Impacts** refer to the economic impacts resulting from initial investment expenditures on a new facility or regular operational spending on an existing facility (e.g., home retrofits). Direct impacts occur as a result of a facility's or project's spending on B.C. suppliers.
- **Indirect Impacts** refer to the additional economic activity that is generated as B.C. suppliers of the incremental materials (e.g., insulation manufacture) purchase intermediate B.C. goods and services.
- **Induced Impacts** refer to the additional activity generated when the B.C. suppliers pay out wages to their employees, who in turn purchase more consumer goods and services.

The economic development attributes are summarized in Table A5-1 as follows:

Table A5-1

Economic Development Category	Sub-Category	Unit of Measure	Classifications
Provincial GDP	Construction/Operations	$ and $/per year	Direct
			Indirect
			Induced
Employment	Construction/Operations	Jobs (defined as person years)	Direct
			Indirect
			Induced
Provincial Government Revenue	Construction/Operations	$ and $/per year	Direct
			Indirect
			Induced

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APPLICATION

An input-output (**I/O**) analysis was undertaken to evaluate the direct, indirect and induced impacts of the various resource options in the IRP. I/O analyses highlight the relationships among producers and consumers (businesses as well as individuals) of goods and services. An I/O analysis is based on first identifying a basket of goods and services used by a specific project[4] and then tracing through all of the steps involved in producing those goods and services to identify the total extent to which the B.C. economy will be affected by project expenditures[5]. I/O accounts represent the basic structure and linkages between producers and consumers of goods and services in an economy.

The BC Provincial Input Output Model (**BCIOM**) developed and maintained by BC Stats, Government of British Columbia, was used to undertake the analysis. The BCIOM is a sub-model of Statistics Canada's Interprovincial Input-Output Model. Based on 2006 economic data, the model encompasses 300 industries, 727 commodities and 170 final demand categories. The model is comprised of three parts:

- The *input* matrix displays the cost of goods and services, labour and capital used by industry during production.
- The *output* matrix shows the goods and services produced by each industry.
- The *final demand* matrix shows the goods and services available for consumption.

Together, these three matrices form a complete representation of the B.C. economy, including all intermediate transactions between industries, primary inputs (e.g., wages), and commodity and export proportions.

Multipliers

The results of I/O analysis provide economic “outputs,” which express the total (direct, indirect and induced) economic impact as a multiple of the capital and operating expense. A high multiplier means that a particular expenditure generates more business (supplier) activity within the economy than expenditures with lower multipliers. The size of the multiplier depends on several factors, the most important being the degree of upstream processing (prior to final use) in the economy and the extent of imported goods used in that processing. In general, the more self-sufficient the B.C. economy is in a particular good or service (i.e., the fewer the imports), the higher the multiplier.

[4] Or, in the case of an industry analysis, the total value of production by one or more industries.

[5] BCIOM report, BC Stats 2010.

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Results

Similar to the environmental attributes, BC Hydro has derived and populated economic attributes for all of the at-gate values of the supply-side resource options as well as the five energy and three capacity focused demand-side management options.

Given the large number of potential projects identified in the IRP, a representative project was selected for each potential type of resource option. Detailed cost breakdowns of the selected representative projects were sent to BC Stats for I/O analysis. Results received (multipliers) from BC Stats were then scaled (i.e., linear scaling of attributes in accordance with cost) and results were recorded in the resource options data base (RODAT). This approach enabled BC Hydro to develop economic development attributes for the greater than 8,000 potential resource options with a reasonable amount of representative I/O modelling runs.

A similar approach was taken with regards to transmission projects. Representative transmission projects were selected based on typical costs per km for various voltages (25 kV through 500 kV) and submitted to BC Stats. Outputs from BC Stats could then be scaled based on km. Representative road costs associated with the transmission projects were also developed and submitted to BC Stats. Output results could then be scaled to all transmission projects based on km.

A comprehensive report summarizing BC Stats methodology and results has been included as Appendix A in this report.

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British Columbia Input Output Model (BCIOM) Assumptions

The BCIOM makes a number of explicit as well as implicit assumptions about the economy and the interactions between sectors of the economy. The major assumptions underlying the BCIOM are listed below[6].

- The BCIOM can be considered to be a snapshot of the B.C. economy at some point in time. The current BCIOM reflects the B.C. economy in 2006. Some sectors in the model may have changed since then and may continue to do so.
- While the structure of the model is based on 2006 data, tax revenue and employment estimates are generated using the most recent data available.
- The relationships between industries are assumed to remain constant over time.
- The model assumes that adjustments resulting from a change in demand occur immediately rather than over a period of time.
- The BCIOM does not, at present, distinguish between regional effects. For instance, the economic impacts of a change in demand are assumed to be the same regardless of whether the change occurred in a metropolitan area or in a rural area.
- The relationship between a change in demand and the resulting impacts is linear. That is, the model assumes that a change in demand for a commodity will translate into a proportional change in production.
- There are no capacity constraints to any increased production. The model assumes that no new capital investment is needed to increase production, which may not be true in the case of some sectors.
- All industries are operating at full employment. Any increase in production by domestic industries will require new proportionate labour (employment). That is, an increase in demand for labour will cause an increase in employment as opposed to a deployment of existing workers.
- Income impacts, wages and salaries, rents and profits earned by the factors of production do not take into account opportunity costs (alternative use) of these factor inputs. The opportunity cost of a factor input is the value of its best alternative use.
- All industries are operating at constant returns to scale. However, industries in some sectors may exhibit increasing returns to scale in the short term (e.g., early stages of development).
- The assumption of industry's fixed proportions of inputs does not permit any substitution among inputs due to technological invention (change), relative price changes, or shifts in demand patterns.

[6] BC Stats.

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BC Hydro Assumptions

- In general, various input costing assumptions followed the same approach taken into consideration when calculating the Unit Energy Cost (**UEC**) for all potential resource options in the IRP.
- Government Revenues provided from BC Stats include: HST, gas tax, corporate and personal income tax, and carbon tax.
- In addition the following were added to government revenue from BC Hydro: Water Rentals (Energy and Capacity - BC Hydro Estimate), and Land Tax (Kerr Wood Leidal Estimate from Run-of-River Report/Database).
- Operational $(M) is the sum of: annual fixed Operation, Maintenance and Administration (OMA), variable OMA, and sustaining Capital (capital expenditures associated with maintaining heritage assets).
- Contingency: Cost estimates of various supply-side resource options vary in terms of "contingency" included in them. Some cost estimates have contingencies embedded in some of the major cost elements; some others include a percentage (varying percentages) of contingency as a separate cost item. It was decided that BC Stats would include contingency in I/O modelling, for consistency. Where applicable, the contingency estimate was split over the major cost elements, in proportion with the contribution of each major cost element to the total project cost.
- Overhead: Cost estimates of various supply-side resource options vary in terms of "overhead" included in them. Some cost estimates have overhead estimates embedded in some of the major cost elements; some others include it as a separate cost item. It was decided that BC Stats would include overhead in I/O modelling similar to the approach taken for the UEC calculation in the IRP.
- Interest During Construction (**IDC**): IDC has been excluded from consideration in I/O modelling by BC Stats on the basis of it being predominantly a non-productive activity.
- Sustain Capital: BC Stats to include in I/O modelling on the basis of it being productive spending, and was treated the same as Operation and Maintenance (OMA) costs.
- Property Tax: It impacts resource options such as run-of-river, access roads, transmission and interconnection projects, and substations. In the cost estimates for these resources, the property tax appears as a separate cost item of operational expenditure and was included in the Direct Tax revenue result.
- Land Allowance Cost: This is an allowance for purchase of land. It has been excluded from consideration in I/O modelling by BC Stats on the basis of it being predominantly a non-productive activity.

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- OMA Assumptions (Labour vs. Material) Split: BC Stats has made generic assumptions on the labour vs. material split of O&M cost estimates for I/O modelling purposes. These assumptions are based primarily on BC Stats judgement.

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Appendix A

BC Stats Report

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BC Input-Output Model Report

BC Hydro Projects

Background

This report describes an input-output analysis that was used to assess the economic impacts associated with various capital projects and demand side expenditure scenarios under consideration by BC Hydro.

The British Columbia Input-Output Model (BCIOM) was used to generate the estimates. A description of the BCIOM, and the assumptions underlying input-output analysis, is included in the Appendix.

Using the BCIOM for economic impact analysis

Input-output analyses highlight the relationships among producers and consumers (businesses as well as individuals) of goods and services. The data underlying the BCIOM is based on a snapshot of the BC economy taken at a specific point in time. For each industry, the model data includes the value of the goods and services, plus labour and other inputs (including a return to capital) used to generate its output.

Relationships among industries are used to estimate the overall economic impact associated with a particular project or expenditure. This is done by first determining which industry, or group of industries produces the goods and services used by a project, and then tracing all of the transactions that have occurred back to the beginning of the supply chain. Known relationships among industries that are available in the model data are used to do this.

Industry shocks versus commodity shocks

The model can be run in two different ways: as an industry shock or as a commodity shock. An industry shock makes the assumption that existing industry cost structures can adequately represent the cost structure for the project being considered. This approach is most appropriate when assessing the overall economic impact of an industry as a whole, or for a project where the cost structure is very similar to the industry average.

An industry shock is not appropriate if project expenditures are atypical, if the relative mix of goods and services used is thought to have changed since the IO year (e.g., if labour costs have increased at a different rate than the cost of materials), or if project expenditures involve new, or less frequently used, types of technology that cannot be adequately represented by existing industry cost structures. In these cases, a commodity-based approach, which uses the actual (or estimated) expenditure patterns associated with the project to determine the overall impact on all BC industries, is more appropriate. All of the impact analyses were based on commodity shocks.

BC Hydro Scenarios

More than 70 different supply side and demand side scenarios were considered.

The ***supply side scenarios*** assessed the economic impacts associated with construction and (in most cases) operating costs for a variety of different types of electric power production and transmission projects including:

- Biogas
- Biomass (wood-based, sawmill & roadside)
- Biomass (wood-based, standing timber)
- Geothermal (flash and binary technology)
- Hydro (Resource Smart REV 6)
- Hydro (1000 MW facility)
- Hydro (Mica)
- Municipal solid waste)
- Ocean (tidal and wave)
- Solar
- Roads
- Run of River (6 types of projects)
- Site C
- Substation
- Thermal coal
- Thermal gas
- Transmission (5 types of projects)
- Wind (offshore and onshore)

The ***demand side management (DSM***) scenarios involved different assumptions about costs and expenditures for a variety of DSM programs and incentives.

Mapping input data from BC Hydro into BCIOM categories

Running commodity shocks involves first identifying a list of commodities (goods and services, including labour) used by a project. This information is then used to shock the model to determine the overall impact of these expenditures on the BC economy.

In most cases, expenditure information provided by clients is not available at the level of detail required to run the BCIOM. There are 727 different types of goods, services and "value added" components (labour, operating surplus, mixed income, subsidies and commodity taxes) identified in the model. Not all of these commodities are relevant for a particular analysis. However, expenditure data provided by clients must be mapped into the appropriate BCIOM categories before it can be used to shock the model.

Expenditures are typically reported using broad categories, such as "fuel", or "supplies" or "overhead". These categories could potentially include many different types of goods and/or services.

The approach taken by BC Stats when doing an impact assessment is to obtain as much information as possible from the client, and allocate aggregate expenditure groupings to the relevant BCIOM categories based on industry averages, or other information that may be available. For example, labour costs typically include both wages and salaries paid to workers and supplementary benefits such as contributions to pension plans paid by employers on behalf of their employees. Information on total labour costs provided by a client will be allocated to wages and supplementary benefits based on the industry average allocation between these two categories. Similarly, categories such as "fuel" would be allocated to different types of fuel (e.g., diesel or motor gasoline) based on average expenditure patterns in the most closely-related industry.

In other words, BC Stats uses as much project-specific information as possible and when the required detail is not available, model averages (or other information) are used to determine the appropriate allocation of expenditures to relevant sub-categories. Depending on how much information has been provided, it may be necessary for the analyst doing the coding to make judgement calls about the most appropriate allocation of reported expenditures. Wherever possible, additional information about the types of goods and services typically included in various expenditure categories is either obtained directly from the client, or by researching alternative sources of information.

BC Hydro Supply Side Scenarios

Many of the technologies being analyzed involve non-traditional ways of generating power. Therefore, there was no suitable standard industry information that could be used to assess the economic impact of constructing and operating these power generation projects.

In the case of the BC Hydro supply side scenarios, the available level of detail varied considerably among the different scenarios considered. In some cases, it was possible to code detailed expenditure information directly to model categories. In other cases, however, the available information was much more limited or used categories that could not be mapped directly into BCIOM commodities.

The approach taken by BC Stats was to research alternative sources of information about the technology and costs associated with various methods of power production. BC Hydro also provided assistance and advice regarding the appropriate treatment of some types of expenditures included in the input information.

This information was used to help determine the most appropriate allocation of broad expenditure categories. Key assumptions made during this coding process (e.g., splits between labour and materials) have been explicitly noted in the summary tables provided. Other assumptions made during the coding process have been documented in the spreadsheets used to develop the BCIOM input vectors.

Where industry averages were used to allocate broad expenditure categories, the allocations were based on spending patterns for the industry that was deemed to most closely match the type of activity being considered. In many cases, the patterns relied on industry averages for the electric power engineering construction or electric power generation, transmission and distribution industry.

In some instances, other industry expenditure patterns were thought to be more appropriate. For example, model information on the types of goods and services used in electric power engineering construction reflect the projects that were built during the model year. These were primarily transmission projects. Thus, the industry average was very appropriate for allocating broad expenditure categories for the transmission line components, but less appropriate for some other types of construction that would involve more heavy engineering. In these cases, expenditure patterns used to allocate subtotals were based on "other engineering construction" instead.

Supplementary information obtained from various published reports and studies was also helpful in terms of indicating the types of activities (and, in some cases, typical costs) involved in installing some power production facilities, such as solar, offshore and onshore wind, tidal, wave and biomass projects. For example, in the case of ocean tidal capital expenditures, it was assumed that materials and services used in grid connection would include water transportation, and other services such as engineering, professional services, equipment rental and wire and cable. Water transportation services are not an input typically used by the electric power engineering construction industry, but they are required when construction occurs offshore.

It is important to keep in mind that this approach was only used to disaggregate subtotals in cases where the information provided by BC Hydro was not detailed enough to be run directly through the model. It should be noted that the BCIOM input data used to shock the model reflects the cost structure provided by BC Hydro for each scenario.

BC Hydro Demand Side Scenarios

The BC Hydro demand side scenarios represented a mixture of utility, partner, and customer expenditures on various types of goods and services associated with demand side management programs, conservation rate structures, and codes and standards. The level of detail provided by BC Hydro made it possible to

directly code the expenditures to BCIOM categories, with very little allocation required.

Market prices versus basic prices

Reported expenditures usually reflect the market price of a particular good or service. The market price of a commodity typically differs from the price received by the producer of a good or service because it includes:

- the price received by a producer at the factory gate;
- transportation, wholesaling, retailing, or other services included in the selling price; and
- taxes such as the HST or fuel taxes that are included in the selling price.

For example, the selling cost of a litre of gasoline includes the actual value of the gasoline at the refinery gate, plus federal and provincial excise taxes, the carbon tax, HST, the cost of transporting the fuel from the refinery to the gas station, and a retailing margin for the reseller.

If gasoline costs for a particular project are expected to be $1,000, only a portion of that amount actually represents the value of the gasoline that has been produced. Some of the $1,000 will go to government in the form of commodity and excise taxes, some will go to the retailer, and some will go to the trucking company that transported the fuel from the refinery to the gas station.

This is important, because the economic impact associated with *producing* $1,000 worth of gasoline could be quite different from the economic impact associated with *purchasing* $1,000 of gasoline from a reseller. In the first instance, the only direct beneficiary from the sale of the gasoline is the refinery. In the second instance, the value of the gasoline sold includes payments to the refinery, the government, the trucking company and the gas station. The $1,000 expenditure does not translate into $1,000 of gas that has been produced.

To further complicate matters, if the gasoline was imported for resale in BC, the economic impact in BC should only include the cost of the goods and services produced in BC—in this case, provincial and federal taxes, transportation and retailing services.

Transforming the data inputs used to shock the model

All of the economic transactions that are traced by the model reflect basic (or producer) prices, not market prices. Therefore, the initial input data, coded to BCIOM categories, must be transformed. The steps involved in doing this are outlined below.

Step 1: Going from market prices to basic prices

Input data is transformed from a market price concept to a basic price concept using model information. Using the gasoline purchase as an example, the first step is to determine the average shares for each of the elements included in the selling price. These shares can then be used to decompose the $1,000 expenditure as follows:

- The HST and excise taxes embedded in the cost will be reported as a project direct tax revenue to the appropriate level of government.
- Transportation costs embedded in the selling price will be treated as a purchase of transportation services. Similarly, wholesaling, retailing and other margins will be allocated to the appropriate producing industries in BC.
- The remainder will be treated as a purchase of gasoline, valued at the factory gate.

This process is repeated for each of the commodity expenditures that have been identified for the impact analysis. The end result is an expanded list[7] of expenditures in which each cost item is reported at basic prices.

Step 2: Identifying the import component of each expenditure item

Only goods and services produced in BC have an impact on other industries in the province. The economic activity related to producing the imported goods or services benefits producers in the rest of Canada, or in other parts of the world. Therefore, it is necessary to eliminate imported goods and services from the basic price expenditure amounts generated in step 1.

There are two ways of doing this: either directly (if the import component is known), or using model information to estimate the imported component. In the absence of other information, the model will determine (based on historical data), an import ratio that indicates the average import component for each commodity. In some cases, such as lumber (most of which is produced in the BC), the import ratio is quite low. In others, all, or most, of the commodity is expected to be imported. For example, BC does not produce any refrigerators, so the import component associated with an expenditure on fridges would be 100%.

The estimated value of imports from other provinces and countries, plus withdrawals from inventory (inventory withdrawals come from past, rather than current, production) is calculated using these ratios, and the imports are removed from the expenditure data. The leakages are reported in the table entitled "Allocation of Project Expenditures".

Step 3: Project expenditures on wages, taxes and other valued added components

Wages, salaries and benefits paid to workers, taxes, and other value added components (such as operating surplus) that have been included in the expenditure data are identified and removed from the list of commodities used to shock the model. The reason for doing this is that there is no *industry* impact directly associated with these activities.

It is important to note that these expenditures are not ignored. They are reported as project direct costs in the table entitled "Allocation of Project Expenditures". An estimate of income tax revenues associated with project direct wages and operating surplus is calculated and also reported in this table. Moreover, the project direct wages and salaries are included when the induced impacts associated with the project are calculated.

The wage bill is also used to estimate project direct employment (using information on average wages in the relevant industry)

Step 4: The direct BC supply

This is the amount that is used to shock the model (i.e., the change in supplier industry output). It includes all project expenditures on goods and services *produced by BC industries*.

The direct BC supply is reported in the table "Allocation of Project Expenditures". It also shows up as the change in supplier industry output in the table entitled "Total impact, including project expenditures and supplier industry impacts", and as the total output amount in "Supplier Industry Impacts".

Step 5: Transforming commodity expenditures into industry outputs

The model operates from an industry perspective. Therefore, it is necessary to transform commodity expenditure inputs provided by clients into information on the associated activities in BC industries that produce those goods or services. This is done using information about which industries produce each commodity used by the project. (One commodity could potentially be

[7] The additional expenditure categories would be transportation, retailing and wholesale margins, pipeline and storage margins, if applicable and commodity taxes embedded in the market price of a good or service.

produced by many different industries, so there is not necessarily a one-to-one mapping between commodities and industries.)

Based on this mapping, commodities are reallocated back to the producing industries. In other words, the commodity shock is restated as an industry shock.

Step 6: Using the model to estimate indirect and induced impacts

Once the data has been transformed into the required format, the rest of the work involves running the model to estimate indirect and induced impacts. These estimates are based on the model structure and the results are summarized in the table entitled "Supplier Industry Impacts".

A note about the DSM scenarios

The supply side scenarios show the economic impacts associated with the construction and operation of various types of power production facilities and related infrastructure. In contrast, the DSM scenarios focus on the impacts associated with adopting various types of energy-saving technologies and products (for example, improvements to building envelopes, or the replacement of fridges, light fixtures and light bulbs with more energy-efficient products).

The economic impacts associated with these expenditures are two-fold. First, an increase in the demand for various types of goods and products (e.g., new windows) stimulates economic activity in the province, and the overall impact of this can be measured using the standard commodity-based approach. The results of this analysis are summarized in the tables included in the excel spreadsheet entitled BC Hydro Result Summary.xls.

The cost savings resulting from investments in demand side management free up resources that can be spent elsewhere in the economy. A set of economic impact estimates were generated based on assumptions made about how these savings would be re-spent.

The results of that analysis are included in another spreadsheet (BC Hydro Re-Spend.xls). These results were derived by looking at the impacts associated with a $1 million total expenditure by residential consumers, by industry and by commercial businesses (this amount was chosen for ease of scaling the results).

In the case of residential consumers, the assumption was that the money would be used to purchase the types of goods and services typically included in personal expenditures. In other words, it is assumed that if consumers have an additional $1 million of after-tax income, they will spend the money on goods and services in the same way that they would spend any other income that they have.

In the case of commercial businesses and industry, the impacts reported in the spreadsheet reflect the additional economic activity associated with investment expenditures (equipment and new construction). In other words, it is assumed that any savings by businesses will be reinvested in capital or equipment rather than re-distributed in the form of dividends to shareholders. It is also assumed that the savings will not be used to finance an expansion of the workforce (based on the principle that a profit-maximizing business would only hire additional workers if they were needed to satisfy an increase in demand for their products).

It is possible that some of the additional income could be re-distributed to shareholders in the form of dividends rather than being reinvested in capital equipment. However, the extent to which this is likely to benefit BC residents is not clear. In recent years there has been an increasing trend towards more foreign ownership of Canadian shares, and based on the available information (summarized in the spreadsheet), it appears unlikely that, if BC businesses are similar to other

Canadian businesses, there would be a significant redistribution of retained earnings.

However, the multipliers could potentially be used to estimate the economic impact associated with various different spending scenarios. This could be done by applying the consumer spending multipliers to an estimate of the amount (*after taxes, since dividend payments would be subject to some tax*) of money that might be redistributed to shareholders in BC, and combining this with the total economic impact associated with investment of the remainder of the savings in structures and equipment.

Understanding Model Outputs

This section describes the summary tables included in the excel spreadsheet entitled *BC Hydro Result Summary*.

Total impact, including project expenditures and supplier industry impacts

This table summarizes the overall economic impact associated with the project. It shows the direct, indirect and induced GDP, employment and tax revenue impacts associated with the project.

It should be noted that the project cost amount includes the change in supplier industry output, so these two values should not be added together. For all other categories, the project cost and the supplier industry impacts are additive.

Multipliers

The summary table also includes multipliers which are derived from model results. The multipliers can be interpreted as showing the increase in direct, indirect and induced output, GDP, employment, and government revenue generated for every dollar of output in direct supplier industries (i.e., expenditures on goods and services produced in BC). The multipliers are calculated from the information in the supplier industry impact table.

Allocation of Project Expenditures

This table shows how the input data initially provided to the model is transformed into the direct BC supply. The information in this table is calculated directly from data provided by BC Hydro.

The project expenditure (the starting point for the impact analysis) is reported as ***total expenditures***. It includes all direct expenditures associated with the project. Some project expenditures, such as purchases of land, represent a transfer of ownership and do not necessarily have an associated economic impact. These have been explicitly excluded from the analysis. Any exclusions have been noted in the summary tables produced for each model run.

As indicated previously, there are no jobs, GDP or output associated with the production of goods and services that are imported into the province. Therefore an estimate of the value of imported goods and services is deducted from project direct spending. The table shows the estimated import and other leakages calculated in step 2 above.

Any wages, salaries, benefits and operating surplus identified in the project expenditures, plus commodity taxes net of subsidies (provided by the client, or calculated in step 1 above) are also reported. As discussed in the previous section, these amounts are deducted from the total in order to derive the ***direct BC supply***.

It should be noted that wages, salaries, taxes and employment represent direct benefits associated with project expenditures. Although they are not produced by any BC industry, and do not have an indirect impact on supplier industries, these amounts should be included in the reported overall economic impact of the project.

The table also includes a summary section showing the tax revenue derived directly from project expenditures. This includes commodity taxes (reported by the client or calculated in step 1 above) as well as personal and corporate income taxes, which are calculated from information on wages and operating surplus supplied by the

client. For example, personal income taxes are calculated from the wages and benefits included in total expenditures.

Project direct employment is derived based on the project's wage bill and estimates of average annual wages in the industry.

Household income is includes project direct wages, benefits and mixed (unincorporated business) income.

Taxes on products net of subsidies are calculated in step 1 using information on average sales and other tax rates associated with each good or service purchased by the project.

An estimate of ***corporate and personal income taxes*** associated with project direct expenditures is calculated using information on average tax rates.

Supplier Industry Impacts

This table summarizes the overall economic impact associated with the purchases of BC goods and services used by the project.

The model is shocked using the direct BC supply to determine the total economic impact of the project on the BC economy.

Direct impacts

The *direct impact* measures the change in economic activity required to satisfy the initial change in demand. The *direct output impact* is equal to the direct BC supply calculated in step 4–the change in the economic activity of the industries producing the goods and services purchased by the project.

The *direct GDP impact* is the GDP generated as a result of the activities of the industries that produce the goods and services used by the project.

The *direct employment impact* shows total employment in these industries, while the *direct household income impact* is a measure of the wages, salaries, benefits and other income earned by these workers.

The *direct tax revenue impact* includes personal, corporation, sales and other taxes generated as a result of the activities of the industries that supply the goods and services used by the project.

The allocation of tax revenues to federal, provincial and local governments is based on model averages.

Indirect impacts

The *indirect impact* measures the impact on BC industries that are further back in the supply chain. The indirect impact is cumulative, and includes transactions going all the way back to the beginning of the supply chain.

Induced effects

The *induced effect* measures the impact associated with expenditures by workers, and includes purchases of a variety of goods and services, including housing. The induced effect is calculated based on wages earned by workers employed by direct and indirect supplier industries, as well as those employed directly on the project.

Variables used to measure economic impacts

Output, GDP, employment and tax revenues are the key measures used to assess the economic impacts associated with a project. In order to properly interpret the results of a BCIOM analysis, some background information about what these measures represent and how they are calculated may be helpful. A brief explanation of terms and concepts follows.

Output is simply a measure of the total value of production associated with a project. In a commodity shock, it can be measured as the total dollar amount of all spending on goods and services produced by BC industries.

Gross Domestic Product (GDP) is a measure of the value added (the unduplicated total value of goods and services) to the BC economy by current productive activities attributable to the project. It includes ***household income*** (wages, salaries and benefits, as well as income earned by proprietors of unincorporated businesses) from current productive activities as well as profits and other

income earned by corporations. Only activities that occur within the province are included in GDP.

Employment estimates generated by the model are derived from estimated wage costs using information on average annual wages in an industry*. They are not full-time equivalent (FTE) measures. Instead, they reflect the wages paid and hours spent on the job by a typical worker in an industry.* For an industry where most employees work full time, the numbers will be very similar to FTE counts. However, in an industry where part-time work is more common, the job counts will be quite different from FTEs.

Government tax revenue estimates generated by the model include income taxes as well as commodity taxes. *Provincial and federal tax revenues* **include federal and provincial personal and corporation income taxes. Also included are HST** and other *commodity* taxes (taxes on products) such as the carbon tax, gas taxes, liquor and lottery taxes and profits, air transportation taxes, duties and excise taxes. Municipal commodity tax revenues are primarily related to accommodation taxes. Property taxes are included *in taxes on factors of production*.

A more detailed explanation of input-output modelling in general and the BCIOM in particular is included in the Appendix.

Output or GDP: which measure should be used to evaluate economic impacts associated with a project?

Output and GDP are both valid economic measures. However, there are some key differences between them that should be kept in mind when analyzing the results of an input-output analysis.

Output measures correspond to total spending or production, but may overstate the economic impact of a project because the value of a good or service would be counted each time it changes hands.

If one is only looking at direct effects, output is a meaningful measure since it shows the total dollar value of industry production. However, there is a danger of double-counting when activities in industries further up the supply chain are also included. Output measures may overstate the indirect economic impact associated with a particular project since the activities of every industry that has contributed in some way to the creation of a final product are counted each time a good or service changes hands.

For example, when a construction company builds a house, the selling price of the house includes:

- the cost of the land on which it is built;
- the cost of inputs (lumber, shingles, cement, carpets, paint, hardware, plumbing fixtures, architectural services and so on) purchased and used by the builder; and
- the value of the work done by the construction company.

An *output-based impact measure* would include the entire selling price of the house (including all these imbedded costs) in the direct output of the construction industry. The value of architectural services included in the cost of the house would also be counted as an indirect output impact on the architectural services industry. The value of the lumber used would be counted as an indirect output impact on the wood industry, and going further back in the supply chain, the value of the logs used by the sawmill would be counted in the indirect output impact on the logging industry. In this example, the value of the logs used to produce the building materials is counted at least three times: once in the direct output impact, and twice in the indirect output impacts on the sawmill and logging industries. In other words, the indirect output impact could be quite high simply because goods (or services) used in production have changed hands many times.

Indirect output impacts provide useful information about the total amount of money that has changed hands as goods and services are transformed into final products. GDP is a better measure of the overall economic impact since the value of the work done by each industry is attributed only to the producing industry, and is counted only once.

GDP is calculated by subtracting the cost of purchased goods, services and energy from the total value of an industry's output. As a result, the value of the work done by a producing industry is only counted once. In the construction example, the direct GDP impact would only include the value of the work done by the construction firm. The indirect impact on the sawmill industry would only include the value of the work done to transform the logs into lumber, and the indirect impact on the logging industry would be a measure of the value of the work done by the loggers. There is no double counting in GDP measures.

It should be noted that the relationship between GDP and output is a useful analytical measure since it shows the extent to which industries rely on labour and capital as opposed to material and service inputs in production. The analysis of economic impacts relies on this relationship, since output is more easily and directly measured than GDP. In fact, the starting point for most input-output analyses is a measure of the direct output associated with a project. From this, known relationships between output and other indicators such as GDP and employment can be used to estimate the economic impact associated with a specific project.

Appendix

Some background on input-output models and analysis

Input-output models are based on information about the flow of goods and services among various sectors of the economy. This information provides a comprehensive and detailed representation of the economy for a given year. The relationships between commodity usage and industry output are summarized in three tables or matrices: the input matrix, the output matrix, and the final demand matrix.

The *input matrix* shows which commodities–both goods and services–are consumed by each industry in the process of production. The following table, which is extracted from the input matrix, summarizes the inputs used by the forestry and logging industry in 2007 (one of 303 industries for which this type of information is available).

Forestry and logging industry uses:	Purchaser price ($M)	Producer price ($M)
Goods		
Other agricultural products	416.0	416.0
Petroleum and coal products	315.0	235.1
Forestry products	252.8	252.8
Machinery	103.6	50.6
Operating, office, cafeteria and laboratory supplies	773.6	760.1
Other goods	197.5	162.9
Services		
Business and computer services	265.2	262.0
Finance, insurance, and real estate services	235.0	235.0
Transportation and storage	131.2	133.7
Other services	142.8	138.0
Margins		
Wholesaling margins	-	92.9
Retailing margins and services	-	9.3
Transportation margins	-	13.9
Indirect taxes on products	-	70.6
Value added (GDP)		
Wages and salaries	1165.3	1165.3
Supplementary labour income	335.0	335.0
Other operating surplus	741.2	741.2
Mixed income	235.2	235.2
Indirect taxes on production (net of subsidies)	68.2	68.2
Total inputs	**5377.7**	**5377.7**

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Forestry and logging industry makes:	Producer price ($M)
Forestry products	4835.9
Business and computer services	268.0
Other agricultural products	133.5
Lumber and wood products	98.6
Wholesaling margins	14.2
Other products	27.5
Total output	**5377.7**

The table on the previous page includes information from both the *purchaser and producer* (basic) price versions of the input matrix. The information was included to illustrate the differences between purchaser and producer prices. For example, while the forestry industry spent $315 million on petroleum and coal products, only $235 million of that amount actually represented the value of the petroleum and coal products. The remaining $80 million went to pay for taxes and other embedded costs such as retail, wholesale and transportation margins.

The *output matrix* shows which commodities are produced by each industry. For example, the outputs of the forestry and logging industry include forest products as well as other goods and services, such as business and computer services and agricultural products.

The *final demand matrix* shows which goods and services are purchased for consumption by consumers, governments, businesses and non-residents. It includes consumer and government spending on goods and services, investment by government and businesses in plant and equipment, the value of physical change in inventories, and exports and imports of goods and services by commodity. Information in the final demand matrix is used to calculate import ratios and other leakages, as well as impacts associated with re-spending by workers (the induced impact).

Examples of the types of goods and services purchased by consumers and included in investment spending are given in the table on the following page (valued at purchaser prices).

It should be noted that these tables are summarized extracts of the BCIOM database. The detailed input and output tables include information for 303 industries and 727 commodities. Similarly, the final demand matrix shows spending for 172 different final demand categories and 727 commodities.

Final demand (Purchaser prices, $M)	Consumer expenditures	Investment in structures, machinery and equipment
Food, beverages & tobacco	14,912	0
Petroleum & coal products	3,773	0
Vehicles	6,898	3,693
Electrical, electronic & communication	3,307	1,135
Other goods	20,281	5,494
Construction	0	29,973
Finance, insurance and real estate	35,821	3,482
Communications	3,017	0
Other services	17,423	2,292
Retail margins	883	0
Transportation	3,269	0
Utilities	1,818	0
Government services	323	0
Education services	1,810	0
Health services	3,573	0
Other	3,014	1,038
Total	120,123	47,106

The British Columbia Input-Output Model (BCIOM)

The BCIOM is a model that traces the relationships between commodity usage, industry output and final demand for goods and services. It is derived from inter-provincial tables developed by Statistics Canada. In addition to the input, output and final demand tables, the dataset includes estimates of retail, wholesale, transportation, gas, storage, pipeline and tax margins (for 18 different types of commodity taxes) for each of the 727 commodities, 303 industries and 172 final demand categories.

Other data used in the model include annual estimates of paid and self-employment and earnings by industry (used to estimate the employment impacts), corporate and personal income tax data (used to develop the equations for estimating personal and corporate income taxes), and other supplementary data such as information on tax rates (used in the calculation of tax impacts).

The data is combined with computer algorithms that can be used to predict how an increase or decrease in demand for the products of one industry will affect the rest of the economy. This is done by tracing through the relationships between producers and consumers of goods and services to determine how much additional production is generated by a change in the demand for one or more commodities or by a change in the output of an industry. Changing the usage or production of a commodity or group of commodities is often referred to as shocking the model.

Assumptions and Caveats

All economic modelling involves making assumptions about interactions in the economy. Input-output analysis relies on some key assumptions, which are listed below:

- Input-output models are linear. They assume that a given change in the demand for a commodity or for the outputs of a given industry will translate into a proportional change in production.
- Input-output models do not take into account the amount of time required for changes to happen. Economic adjustments resulting from a change in demand are assumed to happen immediately.
- It is assumed that there are no capacity constraints and that an increase in the demand for labour will result in an increase in employment (rather than simply re-deploying workers).
- It is assumed that relationships between industries are relatively stable over time, so that the structure of the economy represented by the input-output data is still representative and can be used as the basis for impact analysis.

Assumptions specific to the BCIOM

- When a change in demand is met by increasing or decreasing imports from other jurisdictions, there is no net effect on domestic production. All of the benefits or costs associated with employment generation or loss, and other economic effects, will occur outside the region. Therefore, it is important to identify whether or not a change in the demand for a good or service is met inside or outside a region. Unless information on the import component of expenditures has been provided by a client, commodity import leakages are calculated using ratios derived from the final demand matrix.
- Estimates of international and interprovincial imports are also based on model averages.
- Estimates of commodity taxes are generated using model information (updated to reflect the current tax regime). They are based on model information about taxes by commodity and industry or final demand category, extrapolated using information on changes in tax rates and coverage.
- Where appropriate, estimates of other margins embedded in the cost of goods and services (e.g., transportation and other margins) are also based on model averages for each commodity.
- Employment estimates reflect wage levels in 2009 (the latest year for which the information needed to calculate wage levels was available at the time the analysis was done).
- The induced impact is calculated using the assumption that consumers spend an average of 80% of their personal income on goods and services. The remaining 20% is consumed by taxes, or goes into savings.

Caveats

Input-output analysis is often used to assess the economic impact of projects that are under consideration. Actual expenditure data may not be available, and information provided by clients usually relies on a number of assumptions about the anticipated expenditures. In most cases, the analyst doing the input-output analysis must also make some judgements about the appropriate allocation of expenditures to BCIOM categories.

The precision of the figures in the report tables should not be taken as an indication of their accuracy. Since many assumptions are built into the model as well as the data used to shock it, a rule of thumb is that the results are probably reliable to within a margin of error of about +/- 10%.

It should also be noted that the BCIOM does not distinguish between regional effects. It will not, for example, differentiate between the economic impact of a plant located in one region of the province and a similar plant elsewhere in BC.

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