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**

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.