IRP Portfolio Analysis

PURPOSE

To describe how inputs are analyzed to inform the Integrated Resource Plan actions.

OVERVIEW

For the 2011 Integrated Resource Plan (IRP), BC Hydro will develop 20-year Base and Contingency Resource Plans (similar to previous Long-Term Acquisition Plans) that address levels of demand-side management to pursue, volumes of supply-side resources to acquire and transmission to build. In addition, over a 30-year period the IRP will evaluate sensitivities on electrification of energy and incremental export potential together with an assessment of transmission requirements.

This brief provides a high level description of the proposed analysis that will inform the plans, and is laid out as follows.

- Portfolio Analysis
- 20-Year Analysis
- 30-Year Sensitivity Analysis
- Other Analysis
- Portfolio Analysis Mechanics

PORTFOLIO ANALYSIS

A portfolio is a sequence of existing, committed and new demand-side and supply-side resources scheduled over the planning period to meet the energy and capacity needs of BC Hydro's customers. As the existing and committed resources are common between portfolios, portfolios are often referred to as potential combinations of different new resource options.

Portfolio analysis is the process of developing resource portfolios which meet customers' electricity needs and evaluating these portfolios by comparing their costs of acquisition and operation over the planning period and their environmental and economic attributes.

BC Hydro, in its IRP, plans at the portfolio level to set direction for the company and set the context for company actions/expenditures (e.g., future acquisition programs).

20-YEAR ANALYSIS

The base set of analyses in the IRP will be designed to meet BC Hydro's 20-year load forecast. As part of these analyses, uncertainties identified within the risk framework such as size of gap, market conditions (such as gas price, electricity price, greenhouse gas (GHG) price, renewable energy credit (REC) prices, renewable portfolio standard (RPS) eligibility) will be tested. A 20-year analysis to determine utilities choices is good utility practice.

DEMAND-SIDE MANAGEMENT (DSM) TARGETS

To meet customers' energy requirements (fill the energy supply demand gap), BC Hydro firsts considers reliance on DSM. BC Hydro's current DSM target of ~9,600 GWh by F2020 is ~74% of incremental need as compared to the 66% target level specified in the Clean Energy Act (CEA). DSM is a low cost, minimal environmental impact resource, but one with significant deliverability risk. BC Hydro will test cost effectiveness of DSM options by developing and evaluating portfolios with different expected levels of DSM savings and different levels of certainty around these expected savings. BC Hydro will also undertake a jurisdictional review to seek evidence that the current DSM target can be achieved. These analyses will inform what level of DSM savings BC Hydro should target in the 2011 IRP (2020 target).

Resource Acquisition

Once the level of DSM acquisition is determined, BC Hydro will fill the remaining gap using the following supply-side options:

1. Resource Smart,
2. Site C, and
3. future calls.

(1) Resource Smart

Resource Smart refers to generation improvement options on existing BC Hydro facilities. They are selected if they have a lower cost and less environmental impact than other generation options. The energy potential from Resource Smart is relatively small. BC Hydro routinely considers opportunities to do upgrades when resources are being refurbished for other reasons (e.g., safety, economic etc). Revelstoke Unit 6 is an upgrade that is available when the system requires additional capacity.

(2) Site C

BC Hydro believes that Site C is a cost effective generation option. In the IRP, BC Hydro will continue to evaluate the benefits and costs of Site C in portfolios through a range of costs and discount rates.

(3) Future Calls

For future call requirements, the IRP will assess volume, timing and resource type. BC Hydro proposes to analyze resource type through consideration of system integration limits, specific resource benefits (e.g., market conditions, RPS eligibility), geographical preference due to resource diversity, and geographic preference due to cluster economics (cluster economics will be tested in the 30-year analysis). Findings from these analyzes will inform future acquisition strategy.

Role of Gas Generation

The "role of gas generation" is discussed in another briefing note included in the material for the Technical Advisory Committee (TAC).

In the IRP analysis, BC Hydro proposes to compare the cost of gas projects against clean and renewable options, and demonstrate portfolio effects of allowing gas projects while respecting the 93% clean legislated target.

In addition, gas will be considered as an option to be available if plans do not all materialize as expected (e.g., as contingency option) and/or capacity is needed.

Capacity and Shaping Need

After addressing customers' energy needs, BC Hydro will assess whether there is a need for additional dependable capacity resources to ensure reliability (resource adequacy). Dependable capacity refers to a resources capability of being turned on at a specific time when the customers need the electricity. Intermittent resources and potentially DSM may not always provide adequate supply when customers require it. Resources that have a high level of dependable capacity and possibly little energy may be required.

In addition to the resource adequacy perspective, BC Hydro will also assess need for resources that enhance energy shaping capability and enhance ability to integrate intermittent renewables.

Energy shaping capability is the ability to absorb energy (buy energy and save water in the reservoir) at lower electricity value period and release that energy (generate energy using water saved in the reservoir) at higher value period. Resource integration is the ability to increase or decrease output of one source of generation as intermittent generation output varies.

The proposed IRP analysis will compare the characteristics, cost effectiveness and deliverability uncertainties and risks of different capacity options that will inform IRP actions.

30-YEAR SENSITIVITY ANALYSIS

In addition to the base set of analyses, BC Hydro plans to do a set of load sensitivity analyses. BC Hydro proposes to analyze the generation and transmission requirements to meet these load sensitivity levels and plans to consider 30-year timeframe to meet the CEA requirements of determining 30-year transmission need.

The objective of performing the sensitivity analysis is to gain insights from "what ifs" to provide directional guidance and to inform the development of a more robust IRP. These sensitivities are higher level assessments of load than the typical load forecast and as a result will not be run against the uncertainties identified on the risk framework (for example, in most cases, only the most probable market condition will be tested).

The outcome of this assessment will be to determine what actions may be prudent (e.g., keeping some options open or doing pilot studies etc) to meet future load requirements.

Load Sensitivities

The load sensitivities (electrification and incremental/aggregated export) will be compared to a 30-year extension of the mid load forecast.

The electrification sensitivities is based upon the B.C. provincial GHG reduction target of 33% reduction from 2007 level by 2020, and 80% by 2050. Switching fuel to electricity is one of the obvious measures to achieve this target. Given a possible major electrification driven load, the planning environment is more uncertain than ever before. As such, BC Hydro plans to consider two electrification sensitivities over above its mid load forecast in its IRP analysis.

The incremental/aggregated export sensitivities would consider two levels of transmission capacity (one 500 kV transmission capacity and two 500 kV transmission capacity) worth of incremental export energy volume with two energy profiles as summarized in the table below.

Table 1: Export Level Sensitivities

	One 500 kV line	Two 500 kV lines
Flat profile	~10,500 GWh Max capacity: ~ 1200MW	~ 21,000 GWh Max capacity: ~ 2400MW
Shaped profile	~8000 GWh Max capacity: ~ 1500MW	~16,000 GWh Max capacity: ~ 3000MW

Issues to Address

The key issues to analyze in these sensitivity analyzes include:

1. future calls,
2. capacity need,
3. transmission requirements, and
4. Fort Nelson.

(1) Future Calls

In analyzing the different load levels, the IRP analysis will assess the volume and timing of future calls to meet these loads and to assess the benefits/sensitivities/need of considering resource options that are not normally considered for planning purpose.

(2) Capacity Need

Further need for capacity resources to meet load scenario requirements will be assessed for resource adequacy purpose only.

(3) Transmission Requirements

The CEA requires the 2011 IRP (and if ordered by the Minister in any subsequent IRP) to "include a description of the authority's infrastructure and capacity needs for electricity transmission for the period ending 30-years after the date the integrated resource plan is submitted". This description "must include an assessment of the potential for developing" in this 30-year period, "grouped by geographic area, electricity generation from clean or renewable resources in B.C."

In the IRP, BC Hydro proposes to analyze the economics and portfolio effects of clusters, as well to identify any future transmission bottlenecks on the bulk transmission system. Further background on clusters is provided in a separate briefing note.

(4) Fort Nelson

The biggest uncertainty for BC Hydro regarding Fort Nelson is the uncertainty of the load requirements from gas production customers. These requirements are, among other factors, a function of gas production level, degree of electrification, whether customers decide to self supply and the GHG reduction policies. Even if these requirements are known, BC Hydro is faced with a decision to integrate Fort Nelson with the rest of the system or try to supply using local generation (i.e., remain to be non integrated). The former means Fort Nelson will be served by clean renewable resources, the later means by gas projects.

BC Hydro proposes to consider a load requirement for Fort Nelson based on its best estimate and a higher "what if" load level. BC Hydro proposes to analyze the infrastructure needed for both of these load levels under both the integrated and non integrated Fort Nelson options.

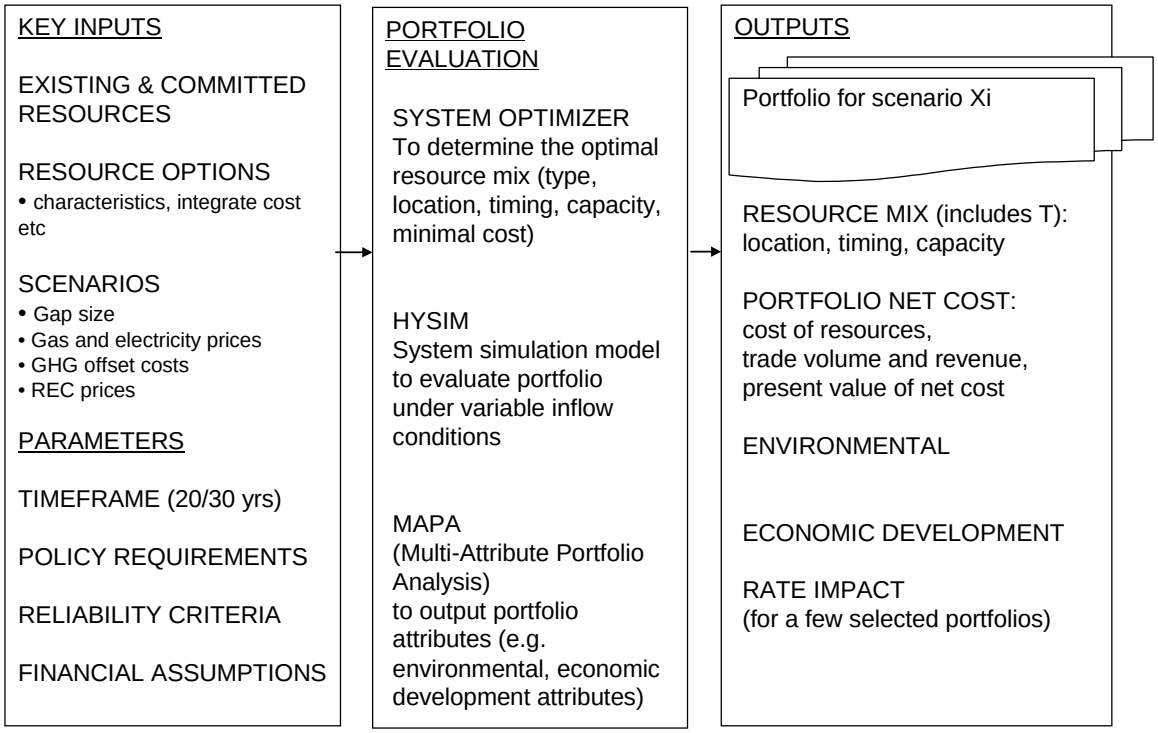
OTHER ANALYSIS: SELF-SUFFICIENCY SURPLUS (TRADITIONAL EXPORT)

Background and the need to optimize the value of self-sufficiency surplus is described in another brief included with the material for the TAC.

BC Hydro proposes to analyze in this IRP the benefits of additional generation capacity and transmission capacity access to market in terms of their value to optimize values of surplus energy by selling to higher value periods.

PORTFOLIO ANALYSIS MECHANICS

Figure 1 provides an overview of the process of portfolio analysis.



Inputs

The inputs into portfolio analysis are discussed in other briefing notes and meetings for the TAC. This briefing note only discusses how resource options are used in the portfolio analysis.

In developing portfolios, resource options identified in the 2010 Resource Options Update (ROU) are options considered to fill future supply demand gap. The ROU is described in the 2010 Resource Options Report available at:
www.bchydro.com/planning_regulatory/long_term_electricity_planning/irp/document_centre.html.

Inputs to the portfolio analysis on resource options include:

1. DSM options,
2. supply-side options, and
3. transmission options.

(1) DSM Options

As identified in the 2010 Resource Options Report and characterized by the Risk Framework, with different deliverability levels associated with different probabilities.

(2) Supply-Side Options

The supply-side resource options identified in the ROU are at various stages of technological maturity and face different development challenges. Some resource options are commercially proven technologies and others are still emerging or pre-commercial. Some resource options have been built and are in-service in British Columbia while others are not.

Due to the wide spectrum of uncertainties across the resource options, some options are more likely to be offered and built and will be considered in a base resource plan reflecting near term acquisitions. The key resource options that have participated in BC Hydro's recent Open Calls for power are hydro, wind, and biomass.

For the sensitivity analyses, a longer term view and near commercial resources will be added to the available supply. These resources include:

- emerging technologies such as wave, tidal, hydrokinetic, and coal-fired generation with carbon capture and sequestration,
- standing timber portion of the wood-based biomass potential, and
- geothermal.

Geothermal power is a technology that is commercially available; however, uncertainties regarding resource potential have restricted development of this resource and make it only a longer term resource option. There are operating facilities in a number of countries (U.S., Italy, New Zealand, Mexico, Iceland, Indonesia, Philippines, etc.), however, there are no commercial geothermal electricity projects in B.C. at this time.

Two factors are thought to pose significant hurdles to the development of geothermal potential in B.C.

- Geothermal resources are generally located in remote areas with challenging topography which pose access (roads, etc..) and exploration hurdles (physical and financial).

- Exploratory drilling is very cost intensive (3 – 10 slim holes may cost form $500k to $5M) and feasibility studies (may cost more than $10 M) provide no guarantee of identifying viable geothermal resources.

Given the complexity and the number of supply-side resources available for consideration at the portfolio level to meet future electricity needs, resources need to be aggregated into manageable but meaningful chunks. Aggregating resource options is appropriate given the planning level estimates (high level estimate) for these resources and that IRP plans at portfolio level.

For this IRP, BC Hydro aggregates resource options in two different ways: Bundles and Clusters. The key difference between a bundle and a cluster is that a bundle can be interconnected with the existing transmission system where as a bulk transmission line is required to interconnect a cluster. More details on Bundles and Clusters found in the Clusters briefing note.

(3) Transmission Options

Transmission options as identified in ROU. Additional transmission options identified to interconnect with clusters are also input to portfolio analysis.

Planning Tools

Resource portfolios for the IRP will be developed using a resource planning tool known as the System Optimizer (SO) model (same tool used in 2008 Long-Term Acquisition Plan). This model considers how the resource options with different characteristics and constraints can fit together and complement each other. It selects an optimal resource expansion sequence of generation and transmission additions for a given set of input assumptions (e.g., load, schedule of DSM savings, market conditions etc) and constraints (e.g., reliability criteria, legal requirements etc). The model minimizes the present value of net costs, including the incremental fixed capital and operating costs for new resources and total system production costs (inclusive of trade revenues) to meet a given load net of DSM savings.

System Optimizer is used in combination with BC Hydro's internally developed Hydrological System Simulation (HYSIM)/Multi Attribute Portfolio Analysis (MAPA) models to analyze portfolios (resource expansion sequences). HYSIM has the capability to model detailed operation of major hydroelectric reservoirs on the BC Hydro system under a range of stream flow conditions. MAPA takes the portfolio (resource expansion sequences) output from SO and HYSIM and tracks the various attributes (e.g., environmental, economic development) for the portfolios. For a few selected portfolios, portfolio analysis would also include a rate impact analysis.

Portfolio Evaluation and Risk Framework

The Risk Framework provides the method to guide the development and comparison of portfolios under conditions of uncertainty. The Risk Framework has reduced key market and net gap uncertainties into a fifteen branch probability tree. Each branch of this tree can be translated into a set of input conditions. Portfolios can then be developed to assess what would be an optimal set of resource decisions for a given set of input conditions. An optimal portfolio may be one that is a) best across all fifteen scenarios, or b) shows the best probability weighted outcome, or c) shows the best combination of risk and return across the fifteen scenarios.

In developing the portfolios, the planning tools made tradeoffs between resource options based on their technical (e.g., energy profile, energy and capacity availability etc) and financial attributes (e.g., cost), and reports out all attributes (including environmental and economic development attributes) at the portfolio level. Upon seeing the results from portfolio analysis, BC Hydro will consider how other attributes may inform the IRP. The way results are summarized and compared is discussed in a separate briefing note regarding making portfolio comparisons.