BC hydro

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31 March 2004

Mr. Robert J. Pellatt
Commission Secretary
British Columbia Utilities Commission
PO Box 250
600 – 900 Howe Street
Vancouver, BC V6Z 2N3

Dear Mr. Pellatt:

RE: British Columbia Hydro and Power Authority ("BC Hydro")
2004 Integrated Electricity Plan ("IEP")

BC Hydro encloses its 2004 IEP. This document has been prepared in accordance with the British Columbia Utilities Commission's Resource Planning Guidelines.

The 2004 IEP presents BC Hydro's plan for acquiring the demand-side and supply-side electricity resources necessary to ensure BC Hydro can meet its obligation as a public utility to provide reliable, least cost electricity supply in an environmentally and socially responsible manner, sufficient to meet anticipated customer demand. The 2004 IEP has nine components:

- Summary
- Part 1 Introduction and Planning Objectives
- Part 2 Demand-Supply Outlook
- Part 3 Resource Options
- Part 4 First Nations and Stakeholder Engagement
- Part 5 Portfolio Evaluation Process
- Part 6 Portfolio Evaluation Results
- Part 7 Action Plan
- Glossary

The 2004 IEP is publicly available through BC Hydro's website at www.bchydro.com.

Yours sincerely,

Richard Stout
Chief Regulatory Officer

Enclosure

2004
Integrated Electricity Plan

Summary

BC hydro

National Library of Canada Cataloguing in Publication Data
B.C. Hydro.
2004 integrated electricity plan. Summary

ISBN 0-7726-5092-6

1. B.C. Hydro. 2. Electric power systems - British Columbia - Planning. 3. Electric utilities - British Columbia - Planning. I. Title. II. Title: Integrated electricity plan.

HD9685.C33B32 2003 333.79'32'09711 C2003-960253-2

Contents

Highlights

The 2004 Integrated Electricity Plan (IEP) presents BC Hydro's long-term plan for acquiring demand-side and supply-side electricity resources needed to meet anticipated customer demands. It includes:

- Reviewing the economic and regulatory context in which BC Hydro conducts its electricity planning;
- Considering the demand-supply outlook;
- Compiling an inventory of resource options; and
- Building and comparing alternative resource portfolios to meet electricity requirements.

Key findings from the IEP provide direction to electricity planning, including:

- Pursuing energy self-sufficiency; and
- Managing uncertainty and retaining flexibility for future options through a balanced portfolio to acquiring resources.

The IEP Action Plan identifies initiatives that BC Hydro plans to undertake over the next four years so as to be able to provide reliable, least cost electricity supply in an environmentally responsible manner over the next 20 years. It also includes a contingency plan which outlines the steps BC Hydro will take to manage risks and uncertainties. The main actions BC Hydro plans to take in the next four years are:

- Continuation of Current Programs

  Results of the IEP process confirm the value of the current supply-side and demand-side programs (i.e., Power Smart, Resource Smart and Vancouver Island call for tenders), and set out plans for continuing them.

- New Projects and Initiatives

  BC Hydro will further study Resource Smart options at Revelstoke and Mica, work with British Columbia Transmission Corporation (BCTC) to maintain key transmission project in-service dates for the Vancouver Island and Interior-to-Lower Mainland corridors, and initiate a call for energy from independent power producers (IPPs) in fall 2004.

- Future Resource Additions Requiring Near-Term Evaluation

  BC Hydro will undertake actions to address items that need further research and consideration, including: IPP network integration, Power Smart capacity based programs, rate programs, and the Peace River Site C hydroelectric project.

- Electricity Planning and Portfolio Management

  BC Hydro will improve its electricity planning and portfolio management processes, including improving forecasts and modelling tools and reviewing planning criteria.

The IEP also includes a contingency plan to respond to uncertainties, such as:

- Changes in forecast customer demand;
- Uncertainty regarding the future of existing supply (e.g., Burrard Thermal Generating Station);
- Gas and electricity market conditions;
- Technology innovation; and
- New information regarding resource options.

1 Introduction and Objectives

BC Hydro has completed an IEP that provides strategic direction to meet future electricity needs through the management of BC Hydro's owned and contracted energy resources, as well as future acquisition processes.

BC Hydro is a commercial Crown Corporation owned by the Province of British Columbia and regulated by the B.C. Utilities Commission (BCUC). As one of the largest electric utilities in Canada, BC Hydro serves more than 1.6 million customers in an area containing over 94 per cent of British Columbia's population.

The BC Hydro integrated electric system includes:

- Hydroelectric generation resources, which supply more than 10,000 megawatts of generating **capacity** and approximately 47,000 GWh of **energy** per year, on average, from 29 hydroelectric facilities;
- Two BC Hydro-owned gas-fired thermal power plants, the 913 MW Burrard generating station, and the 46 MW Prince Rupert generating station;
- A number of privately developed projects, which by 2007 will contribute some 800 MW of dependable capacity and approximately 8,000 GWh of energy per year; and
- Over 72,000 kilometres of transmission and distribution lines.

energy The amount of electricity produced or used over a period of time, usually measured in kilowatt-hours, megawatt-hours, gigawatt-hours.

installed capacity Also referred to as nameplate or rated capacity. The maximum instantaneous generator power output, or transmission facility ability to transmit power under specific conditions.

As a public utility, BC Hydro is obliged to meet customer demand. Thus, BC Hydro's first and foremost responsibility is to ensure that it is able to reliably supply electricity to its customers.

Approach to the IEP

The process for developing this plan involves a series of steps. The major steps are each presented in separate parts of the IEP. They are:

- **Part 1 – Introduction and Planning Objectives**. Develop clear objectives for the IEP.
- **Part 2 – Demand-Supply Outlook.** Develop a 20-year **load forecast** and assess how existing and committed resources compare to it, as well as assess the nature and magnitude of gaps in the resulting demand-supply balance.

dependable capacity The amount of megawatts a plant can reliably produce when required. External factors can affect its dependable capacity, such as streamflow conditions and fuel supply.

load forecast The expected amount of electricity required to meet customer needs in future years.

- **Part 3 – Resource Options**. Determine and characterize the supply-side and demand-side resource options available to fill the gaps.
- **Part 4 – First Nations and Stakeholder Engagement**. Engage interested parties at key points in the process to inform them, obtain and

document their feedback, and considered how to incorporate that feedback into the IEP.

- **Part 5 – Portfolio Evaluation Process**. Explains the evaluation approach and methodology.
- **Part 6 - Portfolio Evaluation Results**. Evaluates and compares portfolios against established criteria, and considers key risks and uncertainties.
- **Part 7 – Action Plan**. Sets out short term steps to develop projects and programs, and keep options open.

Utility planning is subject to risks and uncertainties related to supply, demand, cost, price, and other considerations. BC Hydro evaluated risk using sensitivity and scenario analysis to assess the trade-offs between minimizing costs and risk.

BC Hydro's preference for reliable and secure electricity supply drives electricity plans to ensure domestic loads are served even under low water conditions.

2004 IEP Objectives

Electricity planning objectives provide the basis on which to identify and compare resource portfolios. Table 1.1 summarizes the 2004 IEP objectives and relates them to the four cornerstones of the B.C. Energy Plan.

Table 1.1. B.C. Energy Plan and Integrated Electricity Plan Objectives

B.C. Energy Plan Cornerstones	2004 Integrated Electricity Plan Objectives
Low electricity rates and public ownership of BC Hydro	Minimize long-term ratepayer costs by establishing the least cost sequence of resources on a risk-adjusted basis that meets customers' needs as well as other BC Hydro and provincial government policy objectives.
Secure, reliable supply	Maintain adequate dependable capacity and energy capability to meet customer needs through the application of relevant electricity industry and BC Hydro reliability planning criteria.
Private sector development of new electricity generation	Seek proposals from the private sector to supply power to BC Hydro.
Environmental responsibility and no nuclear power sources	Enhance environmental and social responsibility with a voluntary 50 per cent Clean Energy[1] target through **Customer-Based Generation**, **Green Energy**, **Resource Smart Programs** and project proposals that meet or exceed environmental and social requirements. Achieving the Clean Energy target may raise electricity rates by 0.1% to 0.2% per year over the next decade[2].

[1] As outlined in the Energy Plan, BC Clean electricity refers to alternative energy technologies that result in a net environmental improvement relative to existing energy production (e.g., small hydro, wind, solar, geothermal, tidal current, wave and biomass energy, cogeneration of heat and power, fuel cells and efficiency improvements). The scope of the "BC Clean" definition is subject to refinement and approval by the Minister of Energy and Mines.
[2] BC Hydro interprets this as a cap on the maximum rate impact of the Clean Energy target.

Customer-Based Generation A BC Hydro initiative to buy electricity from large customers through a competitive bidding process.

Green Energy Power produced from a green energy project. As defined by BC Hydro, green power projects are renewable, environmentally and socially responsible and licensable.

Resource Smart BC Hydro's program of improvements to existing power generation facilities to increase supply-side efficiency through physical and operational modifications.

BC Hydro's Business Environment

BC Hydro developed the 2004 IEP while the electric utility industry in B.C. and across North America was in a period of transition. Decisions and evaluation were made in view of these business considerations:

- The electricity and gas market faces substantial risks and uncertainties, as exemplified by price volatility and electricity supply shortages in 2000.
- Ongoing, albeit slow and uncertain, development of **regional transmission organizations (RTOs)** to promote efficient wholesale electricity trading.
- Increased uncertainty regarding future sources and prices of natural gas.
- Outcomes of the investigation in the August 2003 power blackout in eastern Canada and the northeastern U.S.

regional transmission organization An organization of transmission owners, operators and users to facilitate wholesale transmission access.

In addition to these considerations, the provincial government is implementing the B.C. Energy Plan, which includes the following key elements that BC Hydro takes into account when making planning decisions:

- Establishment of cornerstone policies guiding electricity rates and sources of supply;
- Creation of a separate corporation, the BCTC, to plan, operate and manage the bulk transmission system in B.C.;
- Direction regarding BC Hydro's existing generation resources ("The **Heritage Contract**"), stepped rates, and retail access for transmission-voltage customers;
- Direction for BC Hydro to acquire new sources of electricity from the private sector;
- Development of a voluntary Clean Energy target for electricity distributors, (50% of new supply over the next ten years, and may raise electricity rates by 0.1% to 0.2% per year);

Heritage Contract A ten-year, 49,000 gigawatt hour per year contract between BC Hydro's Generation and Distribution Lines of Business to ensure BC Hydro customers benefit from BC Hydro's existing low-cost hydroelectric and thermal resources.

- Amendments to the *Utilities Commission Act* dealing with the review and treatment of expenditures relating to the acquisition of **demand-side** and supply-side resources; and
- Direction regarding regulatory review of the proposed Vancouver Island Generation Project.

demand-side resources
Actions that modify customer demand for electricity, helping to defer the need for new energy and capacity supply additions.

Other government policy and legislative developments, relating to Burrard Thermal Generating Station, water use planning, greenhouse gas emissions controls and First Nations issues are also underway. BC Hydro also faces a variety of related planning considerations, such as the replacement of aging resources, evolution of new technology, and management of risk in a volatile business environment.

Status of the 2000 Action Plan and Resource Acquisition Initiatives

In 2000, BC Hydro updated its 1995 IEP. That update identified a four-year action plan to acquire or maintain new projects and programs identified in the 20-year outlook. In particular, Power Smart was renewed and energy calls from the private sector were added to complement and defer the need for future larger gas-fired generators identified in the IEP.

Key resource acquisition programs initiated since the 2000 IEP Update include:

- 10-Year Power Smart program to improve customer efficiency and encourage load displacement;
- 2001 Green Energy Call;
- 2002 Green Energy Call; and
- 2002 Customer-Based Generation Call.

Energy savings and supply resources achieved and expected from these programs form part of the resources described in the demand-supply balance.

2 Demand-Supply Outlook

After developing objectives for the IEP, the next step in the planning process is to assess the adequacy of supply of energy and dependable capacity to meet customer requirements.

BC Hydro has updated its demand-supply outlook, which compares the current forecast of energy and peak demand requirements of BC Hydro's customers to the capability of the existing supply. A demand-supply comparison is conducted to determine the extent of new resources needed, and when they will be required to reliably meet customer demands.

Load Forecast

The demand expected on BC Hydro's system was taken from BC Hydro's load forecast for customers connected to the integrated system. Load forecasts were developed showing both before and after the expected energy and demand savings from the current **Power Smart** program (**Power Smart 2**).

Power Smart 2 was initiated in 2002 and savings already achieved prior to F2004[3] are included in all IEP portfolios and forecasts.

The reference forecast before Power Smart 2[4] indicates that, over the 20-year period starting in F2003, annual energy and peak demand for the integrated system are expected to increase by 18,755 GWh and 4,092 MW, respectively. The reference forecast after Power Smart 2 indicates that, over the same period, annual energy and peak demand for the integrated system are expected to increase by 15,239 GWh and 3,577 MW, respectively.

Portfolio analysis includes both forecasts in order to evaluate the merits of continuing with the current Power Smart 2 program. Figures 2.1 and 2.2 show the energy and peak supply demand outlook before and after Power Smart 2.

Power Smart BC Hydro's demand-side management initiative to encourage energy efficiency by its customers, originally launched in 1989.

Power Smart 2 The current Power Smart program covering the period from F2003 to F2012. Its expected savings are in addition to BC Hydro's first Power Smart initiative launched in 1989.

[3] Dates marked with an F refer to BC Hydro's fiscal year ending March 31.
[4] Forecast before Power Smart 2 does not include expected Power Smart 2 future savings from 2005 to 2012.

Figure 2.1. Integrated System Energy Demand-Supply Balance (GWh)

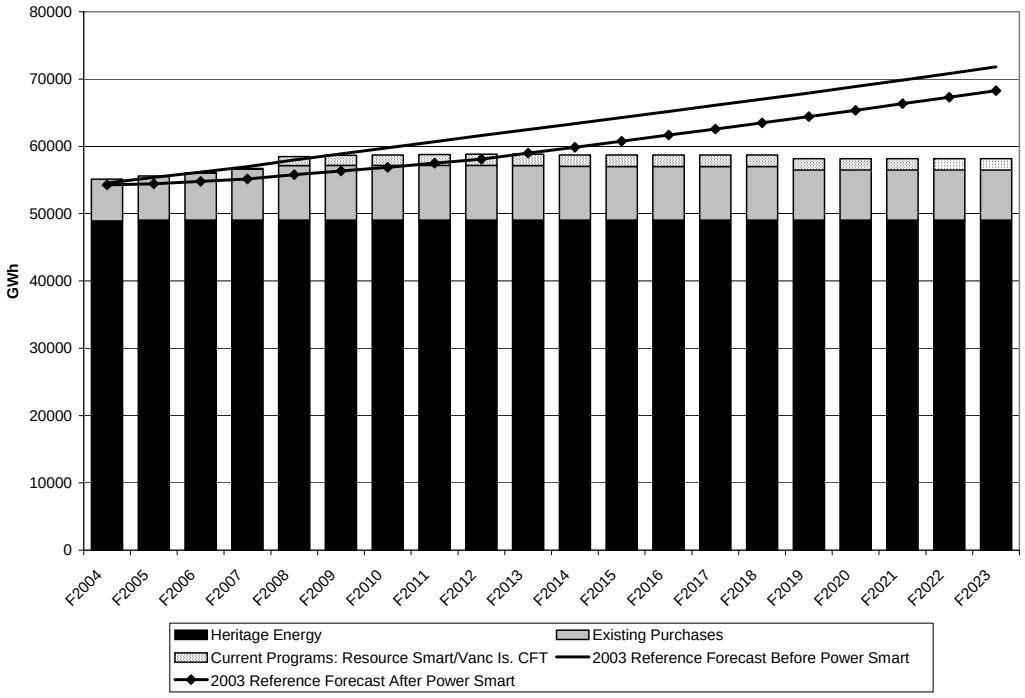
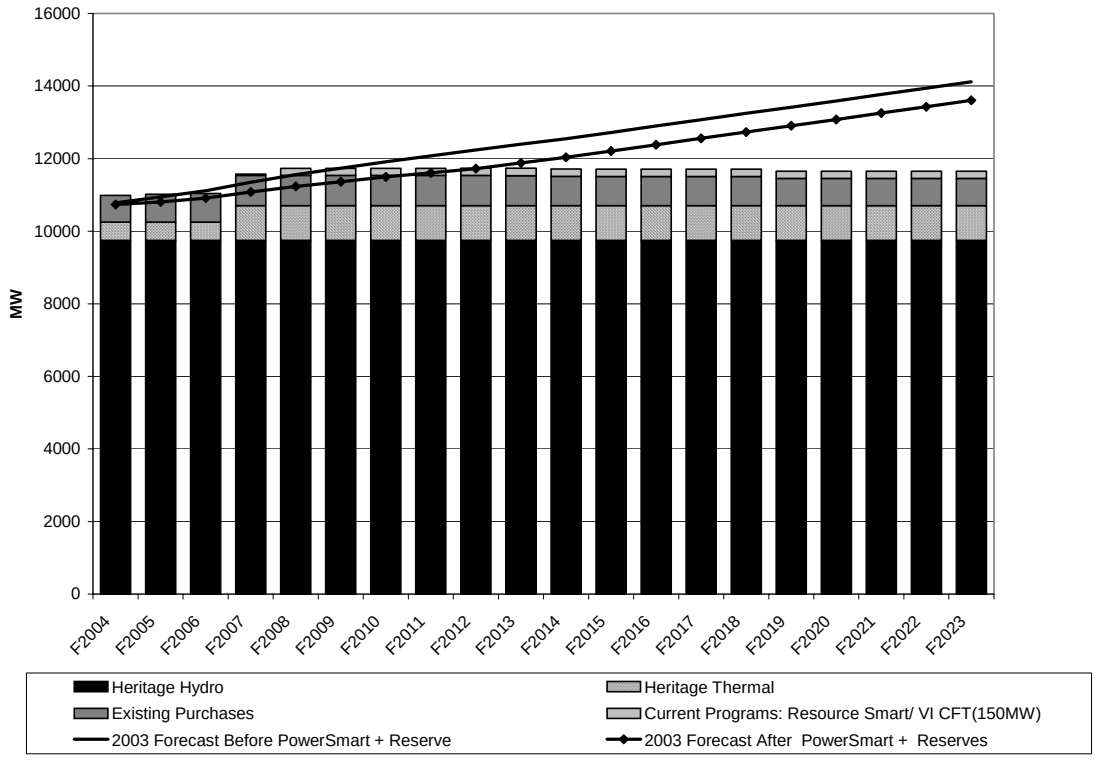


Figure 2.2. Integrated System Dependable Capacity Demand-Supply Balance (MW)



Supply Resources

Heritage Resources

In November 2003, through the *BC Hydro Public Power and Legacy and Heritage Contract Act*, the B.C. government created a "Heritage Contract" to preserve the benefits of the existing hydroelectric and thermal resources for BC Hydro's customers. The Heritage Contract requires BC Hydro Generation to provide 49,000 GWh per year[5] to BC Hydro Distribution for ten years. Of this, 48,845 GWh per year will be supplied to the integrated system.[6] The IEP is based on the assumption that the Heritage Contract would continue over the full 20-year planning horizon.

The dependable capacity available from the Heritage resources, including six units at Burrard Thermal Generating Station, is 10,708 MW. Currently, BC Hydro expects to need only three Burrard units for dependable capacity until F2007.

For portfolios where Burrard is phased out, BC Hydro has assumed that the Heritage Resources could provide approximately 47,000 GWh per year, based on average water conditions. The reliable energy supply under low water conditions from Heritage Resources (without Burrard) would be approximately 43,000 GWh per year.

Existing Purchase Contracts

As of F2007, BC Hydro expects that contracts with IPPs for projects that are in service or contracted but not yet in service will provide approximately 8,000 GWh per year of energy and 828 MW of dependable capacity. The contribution of projects not yet in service has been adjusted for anticipated attrition. Based on experience with previous calls for proposals, BC Hydro expects that some projects will not come into service for a variety of reasons.

Current Supply Programs and Initiatives

Resource Smart is an ongoing program to invest in improvements at BC Hydro's generating facilities. Resource Smart projects currently underway are expected to add 208 GWh per year of energy by F2006. Resource Smart is expected to provide an additional 488 GWh per year and 51 MW of dependable capacity by F2013.

In October 2003, BC Hydro announced a call for tenders for Vancouver Island to address the Island's need for new dependable capacity by F2008. This call is expected to contribute between 150 MW and 300 MW of dependable capacity and 1,200 to 2,100 GWh per year of new energy.

[5] Less Skagit River Treaty Obligations.
[6] The remaining 155 GWh per year is from the Fort Nelson Thermal Generating Station, which is in the non-integrated system.

Planning Criteria

Capacity

In assessing the reliability of supply consistent with Western Electricity Coordinating Council (WECC) guidelines, BC Hydro has adopted a maximum allowable risk of load loss due to insufficient generating resources of one day in 10 years. Loss-of-load analysis indicates that this is equivalent to maintaining capacity planning reserves equal to 14 per cent of total dependable capacity. However, BC Hydro is interconnected with other utilities in Alberta and the United States, and based on experience, the likelihood that capacity supplies on all systems would simultaneously be in short supply is low. Therefore, BC Hydro allows for up to 400 MW of capacity from neighbouring control areas when needed.

Energy

BC Hydro's energy planning reliability criterion is intended to ensure that sufficient generation resources are available to satisfy the system's annual energy requirements. For the IEP, BC Hydro has applied a 2,500 GWh per year reliance on non-firm imports. BC Hydro also applies economic planning criteria that examine the merits of advancing resources ahead of when they are needed for reliability. Part 6 of the IEP includes portfolios that evaluate the merits of acquiring energy resources with no allowance for market imports; that is, portfolios in which BC Hydro would be energy self-sufficient. The energy demand-supply balance is presented with no contribution from non-firm imports as this was shown to be economic.

System Demand-Supply Balance

In addition to forecast demand and existing supply, Figures 2.1 and 2.2 also show the impact on the demand-supply balance of BC Hydro's current programs.

Based on the reference forecast before Power Smart 2, the capacity demand-supply balance shows that new dependable capacity is required in F2009. When the contributions from Power Smart 2 and Resource Smart programs are included, and assuming BC Hydro acquires 150 MW from the Vancouver Island call for tenders, the need for new system capacity is deferred to F2013.

The demand-supply balance for energy indicates that demand exceeds supply in F2007. When the contributions from Power Smart 2 and Resource Smart programs are included and assuming BC Hydro acquires 1,200 GWh per year as a result of the Vancouver Island call for tenders, supply exceeds demand until F2013.

The regional disparity between sources of supply and centres of demand affects the investment in transmission infrastructure needed to ensure load is served reliably. The key transmission constraints to be addressed in the 2004 IEP are between Vancouver Island and the Lower Mainland and on the 500 kV transmission system between the Interior and the Lower Mainland. The timing and location of new generation will influence the need for new transmission.

3 Resource Options

The demand-supply balance identified a need for additional energy and dependable capacity. Part 3, Resource Options, outlines how BC Hydro identifies and describes the electricity resources available to meet future demand, including demand-side and supply-side resources.

Resource Option Inventory

As part of the IEP process, BC Hydro developed a resource option database, which lists and describes information on supply and demand-side resources. Options were included in the inventory if:

- They were available in B.C.;
- They were developed technologies or advanced developing technologies;
- Sufficient information was available to analyze the trade-offs involved with the resources; and
- Information sources were publicly available and reviewable.

The database includes resource options in the following categories:

- **Demand-side management:** energy conservation and load displacement programs;
- **Alternative and Clean Energy:** small and micro hydro (run-of-river up to 50 MW), biomass (woodwaste, municipal solid waste, biogas), geothermal, wind, wave, tidal current, solar (photovoltaic cells integrated into a building structure) and fuel cells;
- **Thermal generation:** natural gas, coal, oil and diesel;
- **Large hydro** (greater than 50 MW): New large hydro and pumped storage;
- **Resource Smart:** improvements to existing BC Hydro facilities; and
- **Transmission:** new resources that allow the transfer of electricity at times of peak demand.

Although not included in the database, the Canadian Entitlement to Downstream Benefits (DSBs) from the Columbia River Treaty were described as a resource option.

Resource Characterization

BC Hydro gathered available data for each resource option. Information on the resources was added to the database to track the financial, technical, environmental and social **attributes** of each resource, as well as the level of risk and uncertainty associated with their potential for development and estimated price. Resources were then scheduled and modelled in various portfolios for evaluation.

attribute A characteristic that describes a resource option or portfolio, used to assess its performance in meeting the planning objectives.

Summary of Available Resource Options

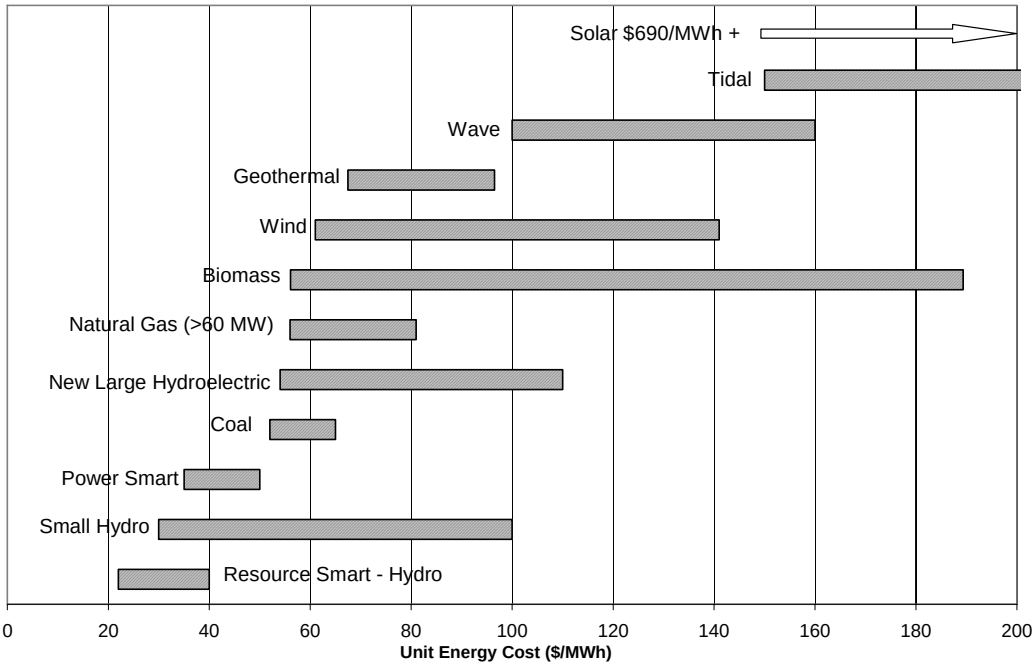
Sufficient information was available to characterize over 150 possible technologies, projects, project bundles and programs for evaluation. Included in these projects were approximately 800 small and micro hydro projects, bundled into price-range groups. The results of the resource characterization show that a wide variety of alternatives are available to BC Hydro, at varying costs, different levels of dependability and reliability, and with diverse environmental and social attributes, risks and uncertainties.

Figure 3.1 compares the unit energy costs for selected resource options and displays their estimated range.

Figures 3.2 and 3.3 show the contribution of each resource type to the total estimated capability of the projects included in the database, in terms of their annual energy and dependable capacity. Roughly one quarter of the 68,000 GWh per year identified are represented in the database by projects have a good level of information detail from feasibility or design level studies. Forty per cent of the projects have a moderate level of study and information from site specific pre-feasibility studies, or appropriate industry standard information. Approximately, the remaining third of the projects have only high level information and estimates, from preliminary studies, or are future prospects.

Although the database is not exhaustive, and some private sector project information is confidential, BC Hydro believes that the data is suitable for current planning studies.

Figure 3.1. Illustrative Range of Unit Energy Costs



Notes. Estimated unit energy cost ranges are based on: (a) range of project prices for resource categories with more than one project; (b) "price uncertainty" ratings for options with only one project price (wave); and (c) a natural gas price range for natural gas projects. Thermal prices do not include a cost estimate for potential GHG costs.

Figure 3.2. Average Annual Energy Identified by Resource Type (GWh)

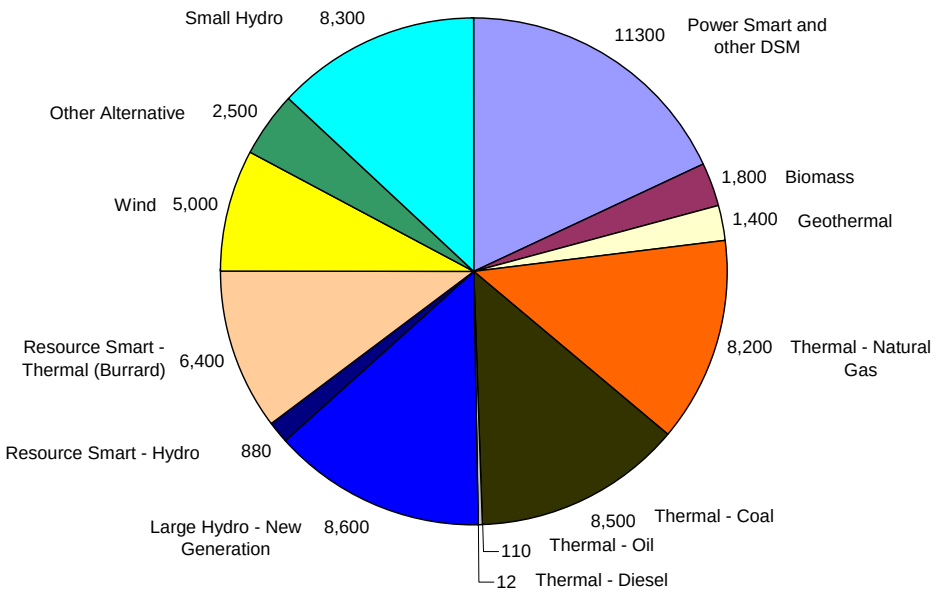
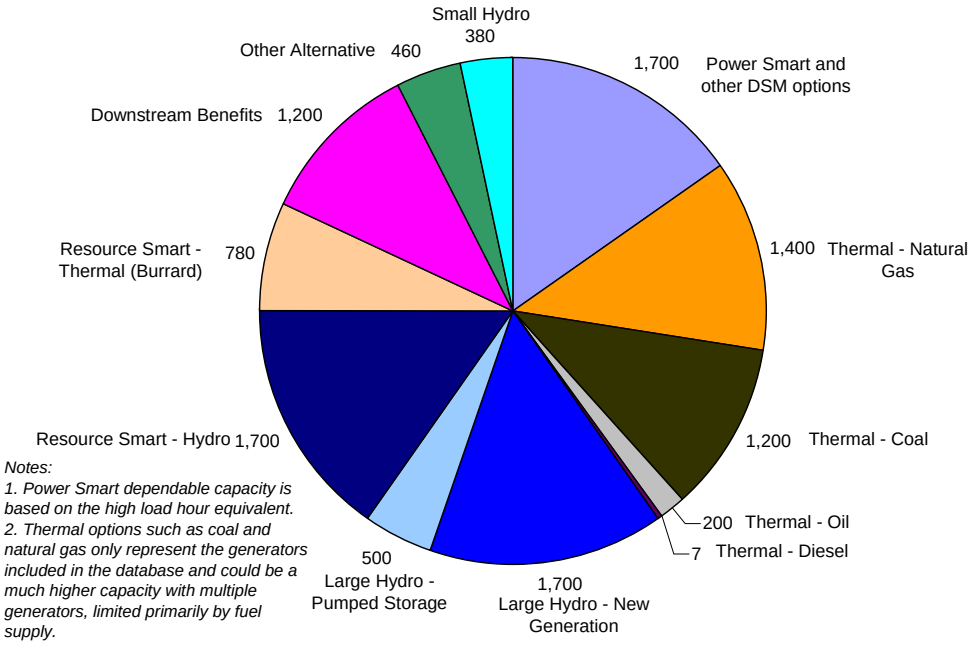


Figure 3.3. Dependable Capacity Identified by Resource Type (MW)



Notes:
1. Power Smart dependable capacity is based on the high load hour equivalent.
2. Thermal options such as coal and natural gas only represent the generators included in the database and could be a much higher capacity with multiple generators, limited primarily by fuel supply.

4 First Nations and Stakeholder Engagement

Another key input to decision making in the IEP is feedback from First Nations and stakeholders. BC Hydro developed the First Nations and stakeholder engagement processes for the IEP to inform **interested parties** and obtain their feedback about the IEP objectives, demand-supply outlook, and resource option considerations.

Interested parties
Individuals or representatives of groups on whom the 2004 IEP process has an impact or who are interested in being involved in the 2004 IEP process. Interested parties include, but are not limited to, the following groups: ratepayer organizations, broadly based environmental groups, BC Hydro customers, independent power producers, BC Hydro employees, First Nations, local governments, opinion leaders, BCUC, and the provincial government.

First Nations Engagement

BC Hydro worked with and included First Nations and aboriginal organizations in its information contacts, public meetings and other activities related to the IEP. On the advice of the First Nations Water Use Planning Committee, BC Hydro hired an independent First Nations facilitator to coordinate meetings with First Nations and aboriginal organizations.

Regional meetings with First Nations took place in nine communities during January and February 2004. Participants raised a variety of issues, including:

- Consultation and accommodation;
- Aboriginal rights and title;
- Unresolved grievances;
- IEP objectives, risks and uncertainty;
- Electrification of Aboriginal communities;
- Reliability of electrical supply;
- Relations with IPPs and the potential for obtaining benefits from IPP power development;
- Revenue sharing;
- Energy costs;
- Transmission lines;
- Large hydro and coal-fired projects;
- Environmental impacts; and
- Energy efficiency and Power Smart.

The independent facilitator wrote a final report that was presented to the First Nations Water Use Planning Committee. The report is appended to Part 4 of the IEP.

Stakeholder Engagement Process

BC Hydro's focus in conducting stakeholder engagement was to provide clear, factual information to interested parties.

The stakeholder engagement process involved:

- Focus groups in June 2003 to canvass opinions about the general direction, the context and the factual background for the planning process;
- A workshop facilitated by the Rocky Mountain Institute focusing on capacity options for Vancouver Island;
- Meetings with interested parties and website postings to share information and receive comments; and
- Information sessions in January and February 2004 to gather input from invited representatives from across the province on four key questions.

Each stage of the process was supported by communication activities such as:

- A Web page providing information resources related to the IEP;
- A toll-free project phone line;
- Information sheets; and
- Communications on related BC Hydro activities such as Power Smart, IPP announcements and Energy Plan Implementation activities.

Through the stakeholder engagement process, BC Hydro contacted or received input from more than 250 individuals or organizations, including contacts by telephone and email, informal discussions and information sessions.

Stakeholder comments informed the 2004 IEP, and assisted in focusing on aspects of the IEP that are important to British Columbians.

Stakeholder Engagement Outcomes

Many stakeholders, especially residential customers, want BC Hydro to consider economic, social and environmental factors (i.e., **triple bottom line**) in planning future electricity supply.

Triple bottom line
BC Hydro's process of balancing, tracking and measuring its performance against a mix of environmental, social and economic criteria, or "bottom lines," to measure progress towards sustainability.

While most stakeholders value environmental responsibility, they place a higher priority on reliability and low cost of electricity supply. This is particularly important to industrial, and to a lesser extent, commercial customers and reflects the high cost of outages to these customers. Opinion is more varied among residential customers. For example, many Vancouver Island and Fraser Valley stakeholders said that they value environmental responsibility over reliability and low cost.

Stakeholders hold diverse views about the most appropriate resource options for new electricity supply. Stakeholders generally agree that BC Hydro's existing resource acquisition program is appropriate. Most stakeholders strongly support making better use of existing resource options, such as:

- Demand-side management through incentives and education;
- Rate options including **time-of-use**, **interruptible load** (including for residential customers), and **green rate options**;
- Resource Smart; and
- Biomass (woodwaste and agricultural waste) and biogas.

Many stakeholders support increased generation from independent power producers, local and community-based sources, especially for remote communities (e.g. non-integrated or at the far end of distribution lines) and to support economic development.

In terms of electricity planning, stakeholders are interested in BC Hydro remaining a public entity and they recommend more integration between BC Hydro, gas utilities, municipalities, BCTC and others.

BC Hydro values the input from First Nations and stakeholders and has reflected the comments in the IEP where possible. BC Hydro will continue to engage First Nations and stakeholders integrated electricity planning.

Time-of-use rate Electricity rates that vary with the time of day to encourage customers to reduce consumption in peak times.

Interruptible load A supply of electricity that is subject to short- or long-term discontinuation with or without notice.

Green rate options Electricity from Green resources sold at a premium rate.

5 Portfolio Evaluation Process

Alternative resource **portfolios** that meet the future electricity requirements of BC Hydro's customers were developed, modelled and evaluated. BC Hydro assessed the performance of these portfolios against the planning objectives of the IEP and tested them against a number of future uncertainties.

portfolio A group of individual resource options acquired in a sequence that meets the 20-year load forecast and criteria for reliability and electricity planning.

Portfolio Modelling Process

BC Hydro constructed alternative 20-year portfolios by first adjusting the load forecast to account for the amount of demand-side resources (Power Smart) specified in the portfolio. Various combinations of generation resources were then added to the existing supply to serve the demand after Power Smart 2.

New resources were then scheduled based on the planning criteria discussed in Part 2 of the IEP. The schedule of resources, their costs and characteristics from the resource option database, are assembled and evaluated in the Multi-Attribute Portfolio Analysis model (MAPA), developed by BC Hydro.

Once the schedule of new resources is determined, the portfolios are analyzed with BC Hydro's hydrological system simulation model (HYSIM) to determine the expected annual generation from each resource. The expected generation determines the annual variable cost for each portfolio, including the cost of imports and the revenue from market exports. These annual variable costs are consolidated with the capital and fixed costs in MAPA.

MAPA uses the expected generation to calculate attributes that vary with the amount of electricity generated. Table 5.1 summarizes the attributes used to evaluate the performance of the portfolios. These include key performance attributes link to the objectives of the 2002 B.C. Energy Plan, and a number of supplementary attributes further examine the performance of the portfolios. For example, the greenhouse gas emissions and the local air emissions for a thermal resource are based on energy output and the associated emission rates[7].

MAPA calculates the present value of the annual costs net of export revenues over the 20-year study period for each portfolio in real dollars, i.e. net of inflation, using a range of discount rates (six, eight and 10 per cent). MAPA also calculates the annual revenue requirement per unit of energy sales as an estimate of the impact (net of inflation) each portfolio has on customer rates.

MAPA is used to conduct **scenario analysis** and **sensitivity analysis** with system simulation results provided by HYSIM.

sensitivity analysis An analysis of the effect on a project's costs if financial factors, such as discount rates and fuel costs.

scenario analysis A set of planning assumptions to test the long-term performance of a portfolio.

[7] For example, 2000 GWh/year x 500 tonne GHG/GWh = 1 million tonnes GHG.

Table 5.1. Summary of Portfolio Attributes

Four Key Performance Attributes		
Attribute	**Unit of Measure**	**Objective**
Net present value (NPV)	Discounted cash flow of total cost less export revenues in real F2003 dollars[1]	Minimize ratepayer costs
Reliability planning criteria	Meets Criteria Yes/No	Secure and reliable supply
Private sector involvement	Percentage of new energy provided by private sector Percentage of new energy owned by private sector	IPP involvement
Clean target	Percentage of newly acquired energy (GWh) that meets the definition of B.C. Clean Energy	50% Clean target
Supplementary Attributes		
Attribute	**Unit of Measure**	
Rate impact	20-year change in rates net of inflation relative to the first year	Minimize ratepayer costs
Dependable capacity	MW installed capacity MW dependable capacity	Secure and reliable supply
Diversity	Number of new resource types	Secure and reliable supply
Employment	Temporary/construction (person-years) Long-term (full-time equivalents)	Social responsibility
Greenhouse gases and Local emissions	Greenhouse Gases: tonnes of CO_2 equivalent Local Emissions: tonnes of nitrogen oxides (NOx), sulphur oxides (SOx), and particulate matter (PM)	Social and Environmental responsibility
Footprint	Hectares of total surface area affected by a portfolio	Social and Environmental responsibility
Communities	Qualitative comments with respect to affected communities, First Nations and stakeholder feedback	Social responsibility

Note:

1. Includes customer costs to implement demand side management programs.

Risk Assessment

Risk assessment examines portfolio performance over a range of uncertain future outcomes. Measuring the variability of attributes and evaluating the risk helps to discern portfolio preferences in the IEP. For example, portfolios that include gas-fired generation are subject to future gas price uncertainty. The analysis also evaluates portfolios under five scenarios for gas and electricity market prices. Discount rates are also evaluated because portfolios that include capital-intensive projects are more sensitive to the discount rate.

The discount rate used was six percent with sensitivities at eight and 10 per cent. The analysis also examines sensitivity to uncertainties in generation and transmission capital costs. The risk of a charge being imposed

on greenhouse gas emissions from thermal resources owned or contracted by BC Hydro was also analyzed. High and low load forecast scenarios focus on the impact of high and low electricity demand on resource timing.

BC Hydro uses several different types of analysis to examine risk. Table 5.2 summarizes the probabilistic variables analyzed, and the scenarios and sensitivity analysis performed as part of the risk evaluation process.

Table 5.2. Uncertainties Investigated in Risk Evaluation Process

	Reference case	Scenario/Sensitivities Tested
Probabilistic Variable		
Hydrological variability	60 years of monthly historical stream flows (1940-2000) in 20-year sequences	Variability of inflows intrinsically reflected in the analysis of each portfolio
Scenarios		
Gas and electricity market scenarios	No single market price forecast is assumed to be a base case	Confer Energy Information Administration National Energy Board Techno-Vert High Gas Alternative heat rate
Demand scenario	Reference forecast	Low forecast High forecast
Environmental – Regulatory costs associated with GHG	No cost	10$/tonne of GHG emissions from BC Hydro and IPP generation
Sensitivities		
Financial – Discount rate	6% real	8% and 10% real
Supply: project capital cost and fixed costs, and/or IPP contract fixed cost	Expected cost	Low: -10 to +20% of expected value Medium: -10 to +40% of expected value High: -10 to +60% of expected value

6 Portfolio Evaluation Results

Part 6 of the IEP describes the portfolios and summarizes the results of the portfolio evaluation. In addition, the portfolios are tested for a number of sensitivities and scenarios.

Focus of the Analysis

BC Hydro developed and compared portfolios encompassing a variety of resource options in order to evaluate the following key issues:

- **Currently planned acquisitions:** the first group of portfolios tests BC Hydro's currently planned acquisitions (Power Smart, Resource Smart projects and the VI CFT).
- **Vancouver Island Supply:** the second group of portfolios explores the Vancouver Island capacity constraint and compares the merits of on-Island generation with expanding the transmission system to address the Island's need for capacity.
- **Future Options for Burrard:** the third group of portfolios explores options regarding the future of the Burrard Thermal Generating Station.
- **Resource Deferral and Advancement:** the fourth group of portfolios examines the economics of deferring or advancing resources.
- **Future Options for New Resource Acquisitions:** the fifth group of portfolios examines future resource acquisitions and evaluates different resource types to identify the advantages and disadvantages of each.

The portfolios were evaluated based on the attributes discussed in Part 5, which in turn align with the 2004 IEP planning objectives described in Part 1 of the IEP. Table 6.1 provides the performance of portfolios for the key attributes.

Table 6.1. Illustrative Portfolio Performance.

		Portfolio[1, 2]						
		Cancel Planned Programs - Natural Gas (Remote Location)[3]	Natural Gas (Remote Location)	Power Smart 3	Green	Natural Gas (Load Centre)	Coal	Large Hydro
		P1a	P2	P3a[4]	P4a[5]	P5[5]	P6	P8[6]
Attributes	NPV of Costs ($ Billions)	3.5 to 4.7	3.1 to 3.8	3.1 to 3.5	3.5 to 3.8	3.1 to 3.7	3.3 to 3.5	3.2 to 3.6
	Rate Impact (%)[7]	-0.5 to 4.1	-0.2 to 2.6	0.3 to 2.5	0.9 to 2.5	-0.5 to 2.3	0.3 to 1.6	0 to 2
	Meets Relia-bility Criteria	No[8]	Yes	Yes	Yes	Yes	Yes	Yes
	Private Sector Involve-ment (%)	98%	86%	80%	86%	86%	86%	76%
	BC Clean Energy (%)	35%	64%	67%	69%	64%	64%	65%

Notes:

1. Portfolios include least-cost capacity additions at Revelstoke and Mica to meet future dependable capacity requirements.
2. Portfolios include planned programs of Power Smart 2, Resource Smart, and the Vancouver Island CFT, except Portfolio P1a "Reference Case" assumes discontinuation of current Power Smart, Resource Smart and VI CFT programs, and includes natural gas projects in the Central Interior.
3. Remote Location is assumed to be Kelly Lake in the Central Interior, 100 km west of Kamloops.
4. Power Smart 3 includes likely achievable demand-side management programs, as defined by the Conservation Potential Review.
5. Green portfolio is made up of 80% small hydroelectric resource options.
6. Large Hydro is based on Peace River Site C Hydroelectric Project.
7. Rate Impact is a measure that allows for comparison between portfolios, and does not represent comprehensive rate impacts from future programs or revenue requirements.
8. This portfolio does not meet the single contingency planning criterion for Vancouver Island.

Risk and Uncertainty

Risk and uncertainties related to demand-supply, development and lead time, and market price require BC Hydro to have a flexible portfolio that allows for response to the risks and uncertainties discussed below.

Demand-Supply

There are demand and supply uncertainties related to:

- Stream flow variation;
- Load forecast;
- Power Smart savings;
- IPP project attrition;
- Vancouver Island call for tenders; and
- Future role of Burrard.

Development and Lead Time

Many larger resource options have long lead times and significant development risk. These projects would need to be initiated in time to allow for uncertainty in project approval and development timelines. Conversely, Power Smart, private sector Clean and Green projects, and Resource Smart are more likely to achieve stakeholder and licensing acceptance.

The analysis conducted for the 2004 IEP shows that new dependable capacity and firm energy resources are required to meet system needs in about ten years. Some of the resource and transmission options considered have 10-year lead times, so they would need to be initiated now to be preserved as options.

Market Prices

BC Hydro considers a number of natural gas and electricity price forecasts. Given market fundamentals, it is likely that natural gas supply will be tight in North America, leading to high natural gas prices in the short and medium term. Significant new supplies of gas from offshore liquefied natural gas, coal bed methane, Arctic gas or other supply are required to relieve this pressure on gas prices. Only in a low gas price scenario would a high reliance on gas fired generation be cost-effective.

Concern about the risk of high natural gas prices was one of the reasons that BC Hydro developed a balanced resource acquisition strategy in 2001 that includes non-gas resources such as Power Smart, Resource Smart, Customer-Based Generation and Green Power Generation.

Energy Self-Sufficiency

Energy self-sufficiency means not having to rely on other jurisdictions to meet BC Hydro's domestic firm energy obligations. BC Hydro assessed the economic merits of acquiring resources in advance of reliability requirements.[8] The analyses carried out in Section 6 show it is economic to schedule new energy resources earlier. Under low water conditions, BC Hydro would rely on approximately 6,000 GWh per year of Burrard (subject to the market price of

[8] BC Hydro plans on the basis of 2,500 GWh per year of non-firm imports to meet reliability criteria.

gas) or market electricity (mainly light load hours). This mix of large hydro and discretionary, dispatchable thermal resources has historically provided low cost, reliable power for BC Hydro customers.

In general, the financial risks related to purchasing electricity during low water conditions and restricted supply are greater than the risk of selling during periods of high water conditions and surplus supply. Scheduling resources for energy self-sufficiency reduces financial risk during low water conditions. This strategy also provides flexibility to adjust to changes in demand, supply or an unexpected delay in planned acquisitions. Energy self-sufficiency can also provide opportunities for the private sector to meet BC Hydro's domestic energy needs, in accordance with the Energy Plan.

Retaining Flexibility through a Balanced Portfolio

The risks identified above demonstrate the need for flexibility to respond to changing market conditions and future uncertainties. Therefore, the IEP sets a strategy of retaining options that provide flexibility for BC Hydro to adapt to an uncertain future. The portfolio analysis and many stakeholders support BC Hydro's balanced portfolio approach.

Key Conclusions

Based on the analysis in the IEP, the key conclusions are:

- Power Smart 2 is economic and should be continued. BC Hydro will monitor and evaluate the success of the Power Smart 2 program to ensure that its goals are being achieved.
- Planned Resource Smart projects are economic and should be continued. BC Hydro should continue to evaluate options for future Resource Smart projects at its existing facilities.
- A modest energy acquisition program from the private sector is warranted to meet incremental requirements and to mitigate demand and supply risks. Private sector calls should be undertaken periodically to secure low cost power, maintain energy self-sufficiency, and meet the Clean energy target.
- The outcome of the VI CFT or a change in demand will influence the timing of 230 kV cables to Vancouver Island. BC Hydro has requested that BCTC maintain the earliest in-service date of F2009. Reliability criteria may not be met on Vancouver Island in F2008 if the call for tenders does not provide at least 150 MW of dependable capacity. BC Hydro is investigating alternatives to cover the possible reliability gap in F2008.
- There is uncertainty about Burrard's future role. Assumptions about the future role of Burrard have a significant impact on BC Hydro's resource portfolio.
- The DSBs should be considered as a potential option for meeting dependable capacity requirements in the near-term.
- Adding capacity at Revelstoke or Mica is the least cost approach to meeting capacity requirements. These additional units would be required

in all of the portfolios studied. Therefore, the necessary studies and approvals for the fifth unit at Revelstoke or Mica should be initiated.

- All portfolios require an Interior-to-Lower Mainland transmission reinforcement. The timing of this upgrade depends on whether future supply is from remote generation or load-centred generation. BC Hydro needs the flexibility to plan for the possibility that future supply will be located outside the load centre. For this reason, BC Hydro needs the Interior-to-Lower Mainland transmission reinforcement by F2016. Given the uncertainty around transmission lead times, future load growth and planned acquisitions, BC Hydro has asked BCTC to keep available the earliest possible in-service date (F2014).
- Maintain Peace River Site C as it is economic and the portfolio NPV results are relatively insensitive to different gas and electricity price scenarios. It has a long lead time, so discussions with First Nations and stakeholders need to be initiated and studies need to be completed to preserve Site C as a resource option for capacity and energy needs ten years from now.

Based on these conclusions, BC Hydro plans to undertake the actions described in the following section.

7 Action Plan

The IEP Action Plan identifies specific activities that BC Hydro will undertake in fiscal years 2005 to 2008 to provide reliable, least cost electricity supply in an environmentally responsible manner over the next 20 years. The Action Plan is divided into four categories. It also includes a contingency plan that outlines the steps BC Hydro will take to manage risks and uncertainties.

Continuation of Current Programs

This IEP results confirm the value of the current supply-side and demand-side programs and lays out plans for continuing them in the future. BC Hydro will undertake following actions:

- Continue to consult with First Nations and stakeholders on projects;
- Continue to engage First Nations and stakeholders in the electricity planning process;
- Continue the current Power Smart 10-Year Plan (Power Smart 2);
- Improve the process for IPPs to interconnect to BC Hydro's distribution system during F2005;
- Continue the current planned Resource Smart projects; and
- Complete the Vancouver Island call for tenders process by the third quarter of F2005.

New Projects and Initiatives

BC Hydro will undertake specific actions pertaining to new resource acquisitions:

- Determine the optimum sequence of capacity resource additions of Revelstoke 5 and Mica 5 by the third quarter of F2005;
- Work with BCTC to maintain the earliest in service date of the third quarter of F2009 for the 230 kV Mainland-to-Vancouver Island transmission project;
- Work with BCTC to maintain the earliest in service date of F2014 for the 500 kV Interior-to-Lower Mainland transmission project; and
- Initiate a call in the third quarter of F2005 for up to 400 GWh.

Future Resource Additions Requiring Near-Term Evaluation

BC Hydro will undertake the following actions to address issues that need further research and consideration:

- Complete the re-examination of the policies with respect to network upgrades for IPPs connecting to the distribution system by the third quarter of F2005;
- Investigate the feasibility of a capacity-based Power Smart program by the fourth quarter of F2005;

- Design stepped rates, time-of-use rates and other rate options by the fourth quarter of F2005; and
- Maintain the Peace River Site C project as an option for F2015 by, e.g., consulting First Nations, engaging stakeholders, and pursuing licensing and environmental assessment processes.

Electricity Planning and Portfolio Management

BC Hydro plans to make the following improvements to its electricity planning and portfolio management processes:

- Review dependable capacity and firm energy planning criteria;
- Refine the estimate of peak demand sensitivity to variations in temperature throughout the year;
- Continue to update planning and econometric models; and
- Update the IEP at intervals of approximately two years.

Contingency Plan

The contingency plan is needed to respond to uncertainties, such as:

- Changes in forecast customer demand;
- Uncertainty regarding the future of existing supply (e.g., Burrard);
- Gas and electricity market conditions;
- Technology innovation; and
- New information regarding resource options.

During the period covered by the Action Plan, most uncertainties can be accommodated through adjustments in project in-service dates.

The major exception is supply to Vancouver Island, where BC Hydro faces uncertainty from the amount and type of new energy supply that will be derived from the Vancouver Island call for tender process currently underway. To preserve the ability to meet the expected capacity shortfall on Vancouver Island, BC Hydro has maintained the following backup options:

- BC Hydro has requested BCTC to preserve the earliest in-service date of F2009 for the 230 kV AC submarine transmission link to Vancouver Island, and BCTC has agreed to BC Hydro's request; and
- BC Hydro continues to review the alternatives or supplements to the 230 kV transmission option, including BCTC review of the high voltage direct current (HVDC) life extension and conversion of the on-Island transmission between Qualicum and Duncan from 230 kV to 500 kV.