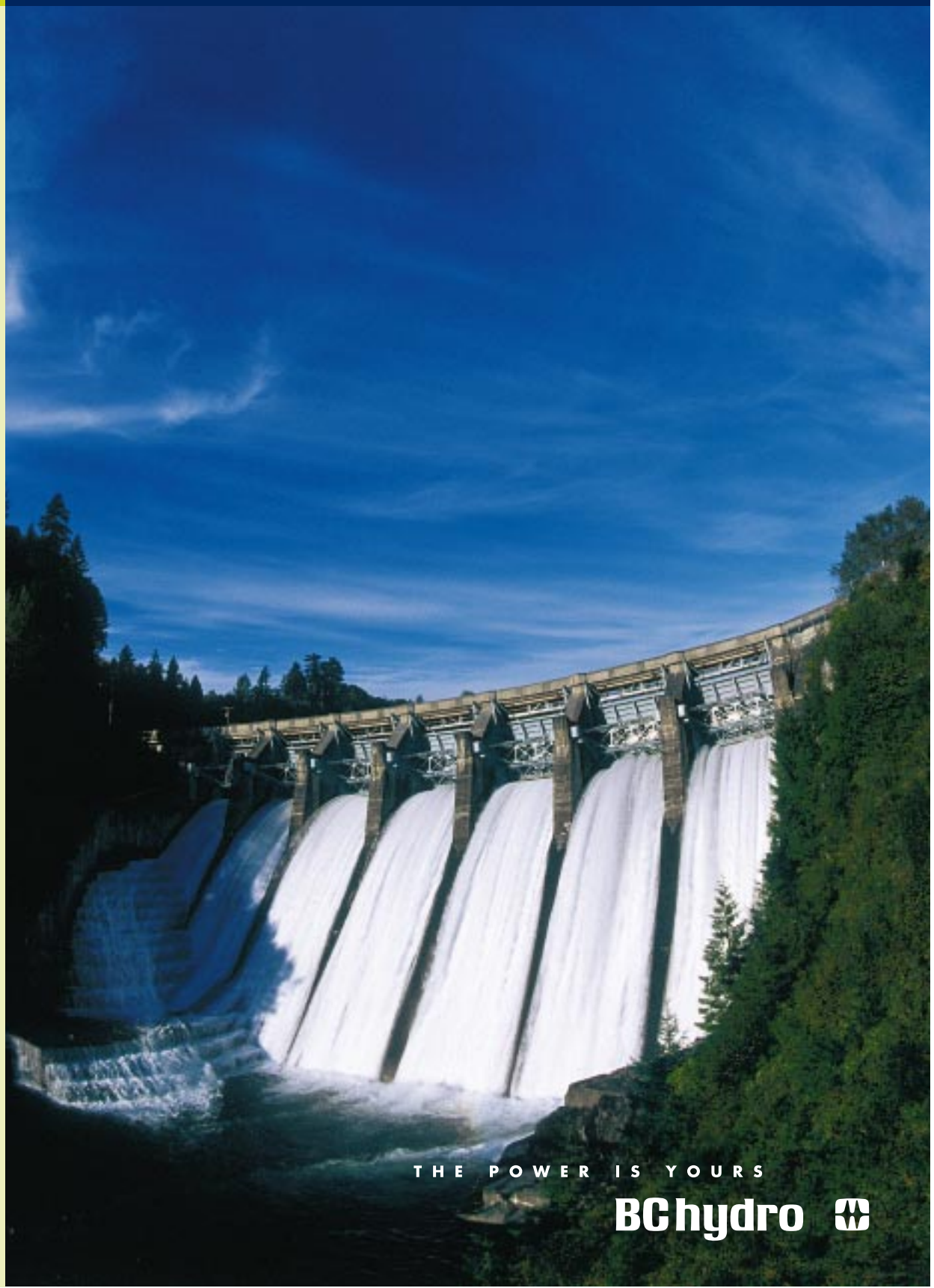
INTEGRATED ELECTRICITY PLAN

An Update to the 1995 IEP



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Integrated Electricity Plan

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The Integrated Electricity Plan (IEP) presents BC Hydro's plan for major generation and transmission reinforcements required to meet the forecasted demand for electricity. This is an update to the 1995 IEP. The focus of the IEP is on meeting BC Hydro's obligation to serve integrated system load. The IEP's Ten-Year Outlook is BC Hydro's resource plan to provide reliable and cost effective electricity service in an environmentally and socially responsible manner.

1.1 Scope

The 1995 Integrated Electricity Plan recommended a resource plan based on comprehensive evaluation of resource options and portfolios, and set out an Action Plan. BC Hydro has proceeded with the action items contained in the 1995 IEP, taking into consideration new IPP resources, changes in demand forecast and changes to BC Hydro's existing system.

This IEP has examined a number of resource portfolio alternatives, recognizing that many of the conclusions from the 1995 IEP are still valid and that the need for major resource additions is not imminent.

Similar to the 1995 IEP, this IEP provides recommendations with respect to the timing and location of new resources. It does not provide detailed, specific action plans for individual projects. This will be addressed as part of further, more detailed, planning investigations and in the approval process associated with implementation of each project.

The IEP is available to the public for information.

1.2 Planning Context and Recent Developments

Since the 1995 IEP was completed, a number of developments have occurred that need to be considered in the planning process.

1.2.1 Electricity Markets

Electricity and gas markets in North America continue to undergo changes. The gas market has been deregulated for some time. The electricity market is deregulating and subject to competition at the wholesale level. There is no retail competition in BC Hydro's service area at this time. However, the move toward competition emphasizes the need for continued efficiency improvements, and the need for BC Hydro to provide its customers with market-driven products and services.

BC Hydro provides non-discriminatory wholesale transmission access. With the increase in market access, there is increased opportunity for all market players to develop and market resources in the wholesale market. This increased wholesale market activity provides market price signals for investment decisions. Domestic wholesale customers can purchase some or all of their needs from the market. The load forecast used in this IEP assumes BC Hydro would continue to serve these customers.

BC Hydro's wholly owned marketing subsidiary, Powerex, buys and sells electricity in the extra-provincial markets on behalf of BC Hydro. This includes selling of any domestic surplus and , if economic, purchases for domestic use.

BC Hydro also conducts transactions, through Powerex, using the BC Hydro storage reservoir system to buy energy when prices are low and sell energy when prices are high. With continued deregulation, electricity trading activities have increased and are expected to continue to grow. These activities maximize values by efficient utilization of the BC Hydro system.

1.2.2 Water Use Planning

In 1998, the Province announced the policy on the Water Use Planning (WUP) process. This multi-stakeholder review process is designed to address the competing interests for water use (e.g. fish, recreation, and habitat management) associated with existing and new electricity generation facilities. Water Use Plans are to be drafted for facilities on a priority basis. Each Water Use Plan, once authorized under the B.C. Water Act, will define the operating boundaries of each licensed facility. Water Use Plans will be developed through a collaborative process designed to consider economic, environmental and social values. Participants can include government agencies, First Nations, local citizens and other interested parties. The likely outcome of the Water Use Planning process is some reallocation of water from power production to non-power values. BC Hydro will be compensated for any lost power value through a reduction in water rental fees collected by government. The IEP recognizes outcomes from the WUP as a resource planning issue but considering the status, the IEP does not propose advancing resources at this time.

1.2.3 Energy Futures

BC Hydro has established the Energy Futures Program to foster innovative development, implementation and marketing of new green resources. This initiative focuses on technologies and services that are not currently commercially viable but where British Columbia could have a comparative advantage. Examples include micro-hydro and emerging technologies for electricity generation with woodwaste.

1.2.4 Greenhouse Gas Strategy

Over the past decade, emissions of greenhouse gas (GHG) and their link to global climate change have emerged as a significant international environmental issue. In 1997, Canada became a signatore to the Kyoto Protocol on climate change. If implemented, the Protocol would require Canada to reduce its GHG emissions to six per cent below 1990 levels before 2012. There are many challenges associated with meeting this reduction commitment, including identifying and implementing measures that foster economically efficient means of achieving reductions while ensuring a fair distribution of the burden across sectors and regions. As well, the U.S. response to this issue could have significant implications for Canada.

The BC Hydro system is predominantly hydroelectric, and its 1990 GHG emissions were very low. As electricity demand grows in the province, GHG emissions will increase as BC Hydro uses more existing and new natural gas-fired generation to meet demand.

BC Hydro is actively engaged in national and provincial policy discussions, which will determine how Canada will meet its Kyoto commitments. BC Hydro is also developing strategies to mitigate GHG emissions while remaining cost competitive.

1.2.5 Role of Demand-Side Management

BC Hydro introduced the Power Smart demand-side management program in the mid-1980s with the primary goal of encouraging cost-effective conservation. Utility involvement was seen to be needed in order to encourage energy efficiency.

Over the past 10 years, substantial progress has been made in changing customer attitudes toward electricity use and in stimulating the development and consumer demand for more efficient appliances and equipment. A more competitive market for energy-efficient products has now been achieved.

Today, the private sector is producing energy-efficient products and providing energy management services at competitive prices. Customers are able to choose between investment in energy efficiency and purchasing supply.

The load forecast considers cumulative and future demand reductions attributable to BC Hydro's existing Power Smart programs. BC Hydro will continue to encourage energy efficiency by supporting energy-efficient standards and regulations and by providing energy management services.

BC Hydro will also continue its community energy planning activities which encourage energy awareness in community and land use planning.

1.2.6 Alcan Agreement

As part of the 1997 B.C./Alcan Agreement, BC Hydro and Alcan confirmed that their Long Term Energy Purchase Agreement (LTEPA) was still in effect and established Alcan's continuing supply obligations. Subsequently, BC Hydro agreed that a portion of the remaining obligation could be assigned to other suppliers including the Columbia Power Corporation (CPC). This delivery would be supplied from the 170 MW Keenleyside project.

Also under the Agreement, the Province, through BC Hydro, has committed to supply Alcan up to 175 average MW if Alcan decides to expand its smelter facilities at Kitimat. Alcan may also recall the 147 MW (1225 GWh/yr) currently supplied to BC Hydro under the LTEPA for the purpose of serving a new smelter.

If new electricity resources were required to serve a new smelter, these resources could be acquired on a timeline equal to or less than that required for the smelter.

1.2.7 Columbia Power Corporation and Columbia Basin Trust

In a joint venture initiative, the Columbia Power Corporation and the Columbia Basin Trust are pursuing the development of power projects in the Kootenay region. These include the Keenleyside powerplant which is currently under construction. Keenleyside is a Columbia River Treaty storage dam. BC Hydro has agreed to take delivery of the output of the Keenleyside project under the Alcan Long Term Energy Purchase Agreement.

2 Status of 1995 IEP Action Plan

The 1995 IEP identified a Four-Year Action Plan to acquire or maintain the availability of new projects and programs identified in the 20-Year Outlook. The status of initiatives identified in the 1995 IEP Four-Year Action Plan is summarized in Table 2-1.

Table 2-1. 1995 IEP Action Plan - Current Status

Resources	Action	Current Status
Generation		
Alternative Technologies		
(solar, wind, fuel cells, tidal)	Continue to collect information, provide quarterly reports and annual updates of resource summaries. Support information exchange, research and demonstration projects if cost-effective.	Energy Futures Program established to foster development of alternative energy resources.
Hydroelectric		
Stave Falls Power plant	Continue licensing requirements and proceed with construction.	In-service fall 1999
Revelstoke Unit 5	Continue the Environmental Assessment Act licensing process.	No significant work undertaken on the Environmental Assessment process, but keep project in "shelf ready" status.
Seven Mile Unit 4	Continue the Environmental Assessment Act licensing process.	Environmental permits received; examining advancement of Seven Mile 4
Resource Smart	Continue cost-effective efficiency improvements at existing facilities.	Ongoing
Purchases		
Alberta and U.S. Imports	Purchase when cost-effective and/or needed.	Economic short-term market purchases and sales from US and Alberta are ongoing.
Alcan	Continue purchases.	Purchases from Alcan under the Long Term Energy Purchase Agreement are continuing.
Downstream Benefits	Continue discussions with the provincial government. Purchase when cost-effective and/or needed.	DSBs are being marketed by Powerex on behalf of the province but available to BC Hydro at market prices
Thermal		
Burrard G.S.	Install second selective catalytic reduction and associated upgrade work.	Installation of the 6th and final SCR will be complete by 2000.
	Continue investigation of repowering two modules and continue full repowering investigations.	Decisions on repowering deferred.
	Continue investigation of fuel supply.	Agreement with BC Gas in place for firm gas transport commencing November 1999.
Private Sector		
December 1994 Request for Proposals	Negotiate with proponents for possible purchase of up to 300 MW if contract terms and pricing are satisfactory.	Island Cogen – in service mid-late 2000 Purcell W/W – in service fall 2000 Intercon W/W – deferred by Proponent Pt. Alberni Cogen – commercial negotiations in progress

Table 2-1. 1995 IEP Action Plan - Current Status (continued)

Resources	Action	Current Status
Demand-side		
Community Energy Planning	Involve municipal governments, planners, businesses and residents in energy aware, community and land use planning.	Ongoing
Demand-side Management	Continue current plans in the short term, recognizing that changes in the electricity market structure toward more competition may require a transition from rebates to fee for service and cost recovery.	Transition is under way
Rates		
Wholesale Wheeling Rate	File wholesale wheeling rate.	Wholesale Wheeling Tariff Approved.
Industrial Service Options	Revise following consultation with industrial customers.	RTP Rate in place.
Power Exchange Operation	Review other alternatives.	Curtailable Load Program in place.
Other Options	Continue to develop rate options and consult with customers on their rate options needs.	Discussions with customers on rate options is in progress with products under development.
Transmission		
Interior to Lower Mainland		
American Creek Capacitor Station	Proceed with planning activities to uprate .	Planning activities have concluded due to project deferral
Second Nicola to Meridian 500 kV Transmission Line	Continue planning activities to ensure the availability of right-of-way to build a line, if required, in the future.	Planning activities have concluded due to project deferral
Supply to Vancouver Island		
Malaspina to Dunsmuir Seventh 500kV cable	Continue investigation of seventh 500 kV cable.	HVDC Replacement Project was determined to be a better transmission option. Georgia Strait Crossing Pipeline announced. New CCGT generation now the preferred option to serve Vancouver Island; further investigations to address reliability requirements are required
Dunsmuir to Sahtlam Upgrade	Continue investigation to upgrade from 230 kV to 500 kV operation.	Project deferred.

3 Demand-Supply Outlook

3.1 Introduction

The demand-supply outlook refers to the balance between the demand for electricity on the BC Hydro system and BC Hydro's ability to serve that demand using the existing system and committed new resources. The net requirement for new electricity supply is based on the difference between the forecast demand and the available supply of existing and committed resources, taking into consideration reserve margins.

A discussion of the demand-supply outlook is presented in four sections. Section 3.2 outlines the current load forecast. Section 3.3 provides an overview of the existing BC Hydro system. Section 3.4 discusses planning criteria and Section 3.5 identifies the need for additional electricity supply to be addressed in this plan.

3.2 BC Hydro Load Forecast

The IEP is based on BC Hydro's December 1998 Electric Load Forecast. This includes BC Hydro's domestic wholesale and retail sales on the provincial interconnected grid and ongoing firm sales commitments to the United States (i.e. Seattle City Light as a result of the Skagit River Treaty, and Hyder Alaska). In order to assess supply requirements, the forecast of electricity sales is adjusted upward to include estimated transmission losses.

The electricity demand outlook is based on modeling of electricity usage of major customer sectors. These models use population and economic forecasts and sectoral outlooks to project the growth in electricity demand.

The load forecast process generates a range of demand forecasts to reflect the outcome of various economic outlooks and uncertainties, as well as trends and changes pertaining to technology, fuel choice and related factors.

Figures 3-1 and 3-2 show the probable load forecasts for energy and peak capacity requirements, respectively. A comparison is provided of the forecast used in the 1995 IEP to the forecast used in this IEP. The IEP forecast indicates that by 2007/08, annual energy requirements will have increased by 13,500 GWh/yr and capacity

Figure 3-1. Probable Forecast of Energy Requirements for the BC Hydro Integrated System

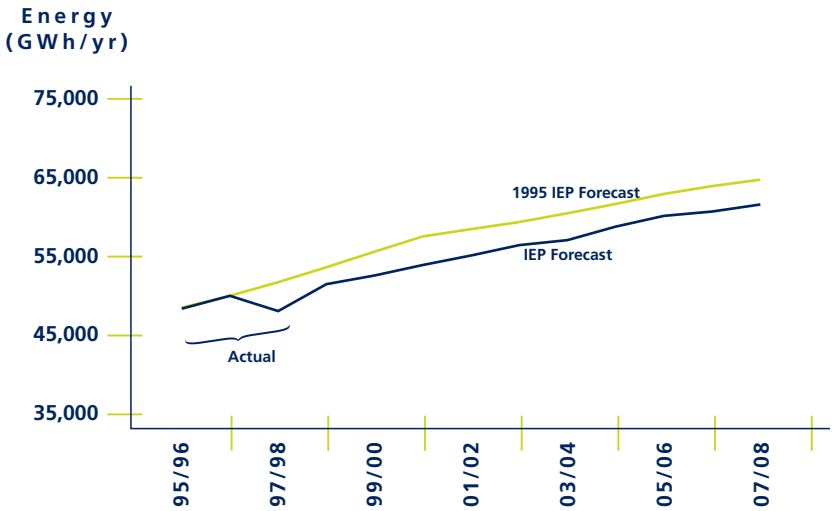
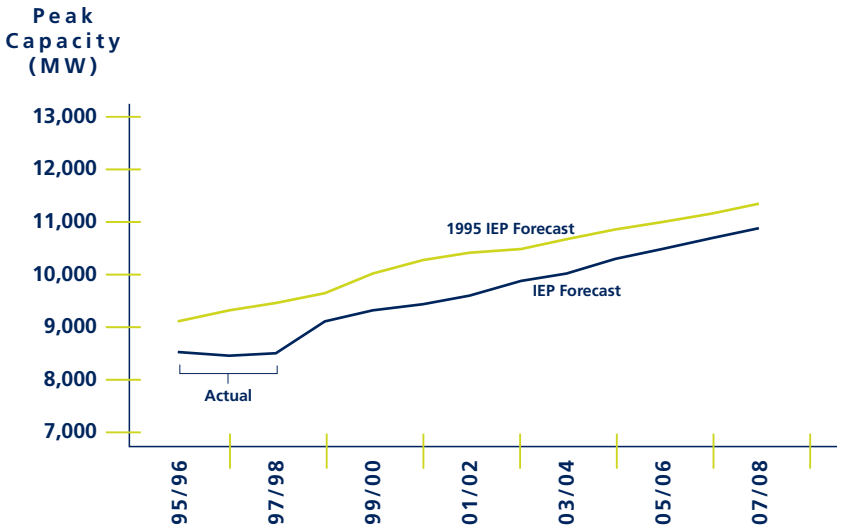


Figure 3-2. Probable Forecast of Peak Capacity Requirements for the BC Hydro Integrated System



requirements by 2,370 MW over demand in 1997/98. This is a reduction of about 2,000 GWh/yr compared to the forecast for 2007/08 used in the 1995 IEP.

The load forecast includes the cumulative and future demand reductions attributable to BC Hydro's existing Power Smart programs. It also includes anticipated ongoing improvements in energy-use efficiency.

3.3 Overview of the BC Hydro System

The majority of energy generated by BC Hydro continues to come from its hydroelectric resources. Figure 3-3 shows BC Hydro's generating stations, major substations and the major transmission system. Table 3-1 shows the energy and capacity of BC Hydro's portfolio of resources by the year 2003/04 when all committed new resources are expected to be in service.

3.3.1 Update on BC Hydro's Hydroelectric System

Since the 1995 IEP was issued, the capability of BC Hydro's hydroelectric system has increased:

- *The Stave Falls Redevelopment Project provides an additional 40 MW of capacity and 70 GWh/year of firm energy;*
- *The ability to achieve an additional 310 MW of peaking capacity by "overgating" the existing units at Mica and Revelstoke has been implemented and confirmed;*
- *Resource Smart projects (efficiency improvements at existing plants) have contributed an additional 56 GWh/year.*

3.3.2 Update on BC Hydro's Thermal System

The Burrard Generating Station consists of six natural-gas-fired steam units. BC Hydro has been installing selective catalytic reduction (SCR) equipment in order to reduce nitrogen oxide emissions. Currently, five of the six units have been retrofitted with SCR equipment. The

Figure 3-3. BC Hydro's Major Electrical System

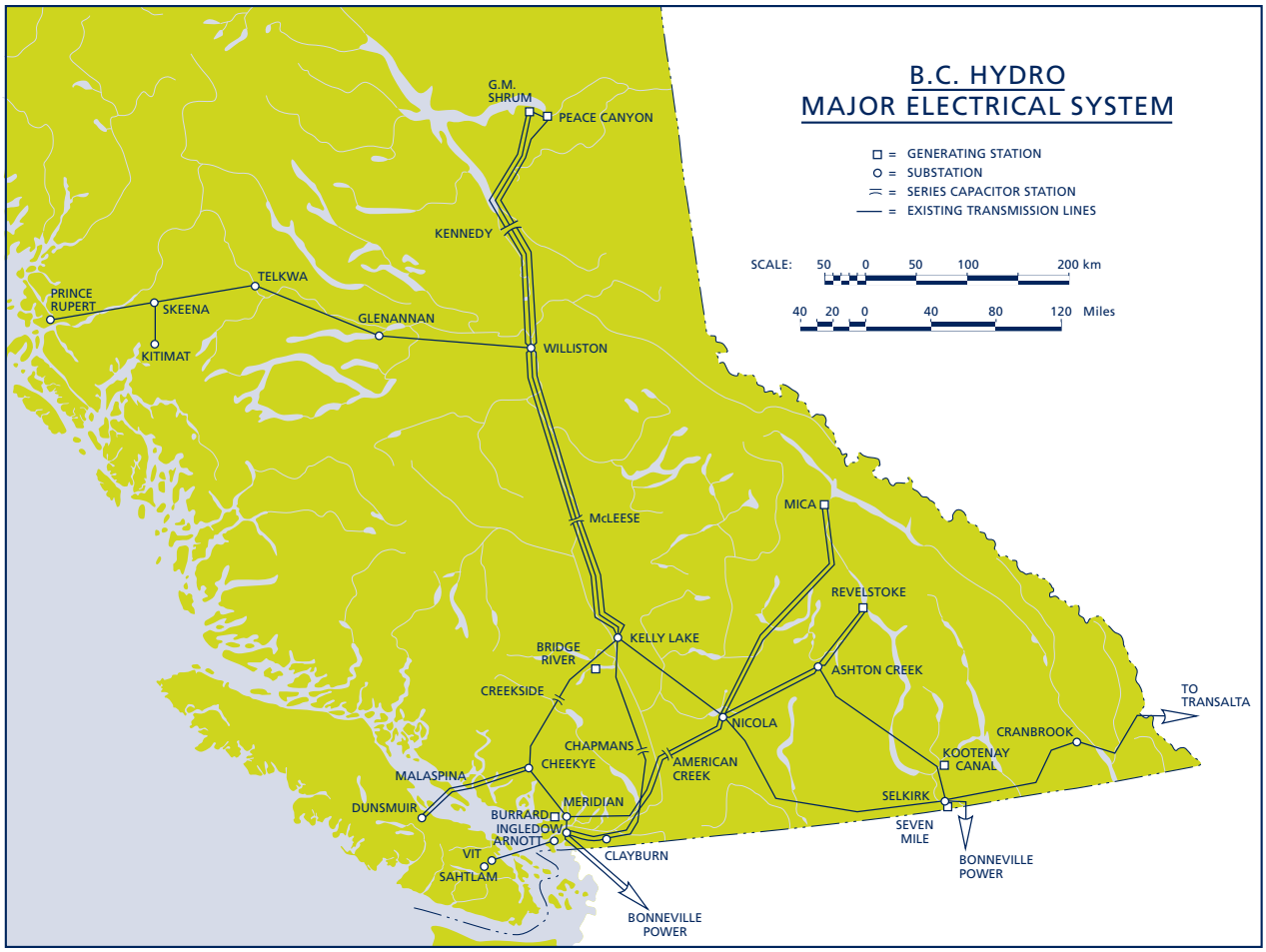


Table 3-1. Capability of Existing and Committed Resources by 2003/04

Resources	Capacity (MW)	Energy Capability (GWh)
	Dependable *	Firm*
Existing Hydroelectric[1]		
Peace System	3280	15790
Columbia System	3710	14490
Others	2659	12800
Subtotal	**9649**	**43080**
Existing Thermal		
Burrard[2]	950	7050
Rupert	46	180
Subtotal	**996**	**7230**
Existing Purchases[3]		
Alcan LTEPA	147	1225
IPPs	212	1820
Subtotal	**359**	**3045**
New Purchases		
Island Cogeneration Project[3]	240	2140
Port Alberni Cogeneration Project[4]	240	1995
Keenleyside (under Alcan LTEPA)[3]	170	750
Purcell Woodwaste[3]	14	90
Subtotal	**664**	**4975**
TOTAL	**11668**	**58330**

[1] *Potential losses in plant capability due to Water Use Planning outcomes or increased plant capability due to future Resource Smart projects are not incorporated. Firm hydro energy capability is annual energy capability under period of lowest historical stream flow conditions. Dependable winter capacity is based on 85% confidence level based on range of historical streamflow conditions.*

[2] *Includes firm gas transport and six upgraded SCR units at Burrard*

[3] *Binding Electricity Purchase Agreements in place.*

[4] *Negotiations in progress*

** Some numbers have been rounded*

sixth unit is to be completed by the summer of 2000.Burrard is an important energy and capacity resource in the BC Hydro system. It is equivalent to 12 per cent of BC Hydro's firm energy capability. Burrard is a displaceable resource and serves many roles. It is used for transmission support and to optimize the value of the electric system. It is also close to BC Hydro's major load centre enhancing security of supply. The December 1998 agreement with BC Gas to supply firm gas transportation to Burrard allows BC Hydro to rely on Burrard to meet system peak winter loads.

The Keogh generating station is a two-unit, 90 MW oil-fired plant near Port Hardy on Vancouver Island built in the early 1970s. The plant is no longer reliable and has high operating costs. Fuel storage capacity is limited. Decommissioning of the plant is planned.

3.3.3 Update on Purchase Agreements

BC Hydro has entered into Electricity Purchase Agreements with the IPP developers of the Island Cogeneration Project (ICP) at Elk Falls near Campbell River and Purcell Woodwaste Project at Skookumchuck. BC Hydro has also concluded a Key Principles Agreement to purchase the output from the proposed Port Alberni Cogeneration Project. Electricity Purchase Agreement negotiations with the Port Alberni project proponents are continuing. Both ICP and Purcell are expected to be in service by the fall of 2000. The Port Alberni project is currently expected to be in service no earlier than the fall of 2002.

BC Hydro has contracted to take delivery of the output of the Keenleyside Powerplant starting in January 2003 as part of its Long Term Energy Purchase Agreement with Alcan.

3.3.4 Major Transmission System Update

Since the 1995 IEP, the plan for the bulk transmission system has been impacted both by the change in regional load forecasts and by several new generation projects:

- *The trend in deterioration of the HVDC terminal station equipment confirms that both HVDC Pole 1 and Pole 2 are expected to retire in stages by the year 2007.*
- *HVDC Pole 1 transfer capability has already been reduced for planning purposes. However, operationally it is available in standby mode. Its transfer capability is replaced by Island Cogen and Port Alberni Cogen. The replacement of HVDC Pole 2 transfer capability will need to be addressed, including the unique reliability requirements of the Vancouver Island system. Options under consideration include the replacement of the HVDC or additional generation capacity on the Island.*
- *Refurbishment of the Creekside Capacitor Station to maintain the transfer capability from B.C.'s interior to the load center is proceeding;*
- *Installation of a new transformer at Selkirk Substation is proceeding. This will provide increased firm transfer capability for local generation in that area.*

3.4 Planning Criteria

BC Hydro develops electricity plans for new resource acquisitions to supply BC Hydro's existing and new domestic electricity requirements consistent with established energy and capacity reserve criteria. Electricity plans also

examine the opportunities to advance acquisition of new resources ahead of reserve requirements if there are economic benefits or opportunities to meet other planning objectives.

3.4.1 Energy Reserve Criterion

As a predominantly hydroelectric system, BC Hydro plans resources to ensure that adequate energy is available to meet customer needs even during low streamflow conditions. The "firm" annual energy capability of the hydroelectric system is based on what it can reliably produce during an extended period of low streamflows. Under better streamflow conditions, the hydroelectric system produces additional energy, referred to as "secondary" or "non-firm" hydro, averaging about 4000 GWh/yr.

BC Hydro currently applies an energy reserve criterion that allows for up to 2,500 GWh/yr of resources, based on secondary hydro and market purchases, in the scheduling of new energy resource requirements. This allowance is consistent with the energy reserve criteria that has been used by BC Hydro since the mid 1980's.

The energy reserve criterion serves several purposes:

- *It reduces the risk of unserved load, excessive drafting of hydro reservoirs during periods of low streamflow conditions, or periods of transmission constraints affecting BC Hydro's ability to import energy from the U.S. or Alberta; and*
- *It reduces the exposure to high costs during periods of high market prices.*

3.4.2 Capacity Reserve Criterion

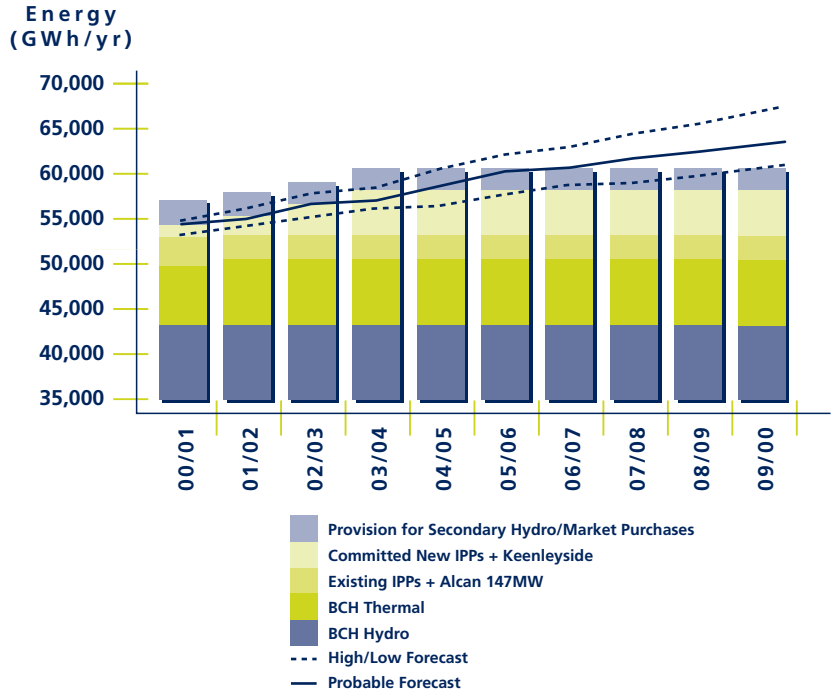
For BC Hydro, peak loads occur during the winter. The dependable peak capacity of the BC Hydro system is the amount of capacity available on a reliable basis to meet winter peak demands. For hydro resources, this is based on streamflow conditions that have a high probability of occurring. For thermal resources, it is based on the availability of fuel supply determined by the availability of firm gas transportation from a major gas supply hub to the generating plant.

BC Hydro plans new resources based on guidelines set by the Western System Coordination Council (WSCC). These guidelines recommend that the expectation of having insufficient resources available to meet the forecast daily peak load not exceed one day in 10 years. BC Hydro meets this criteria by maintaining capacity reserves of approximately eight per cent of its dependable generating capacity.

3.4.3 Economic Advancement

To optimize the timing of resource acquisitions, BC Hydro assesses the merits of acquiring resources in advance of reserve requirements if there is an opportunity to reduce the long-term cost of supply. Advancing the acquisition of a new resource will advance capital and other fixed cost commitments. However, these expenditures could be offset by a combination of reduced annual system production costs and increased electricity trade revenues. The net result of these tradeoffs including due consideration of market price risk determines the net economic benefit of advancement of the resource under consideration.

Figure 3-4. Energy Balance with Existing & Committed Resources



3.4.4 Transmission Planning Criteria

The key considerations in transmission planning are to maintain system reliability and quality of power supply. The need for future reinforcements of the bulk transmission system and the nature of these reinforcements are influenced by several factors such as:

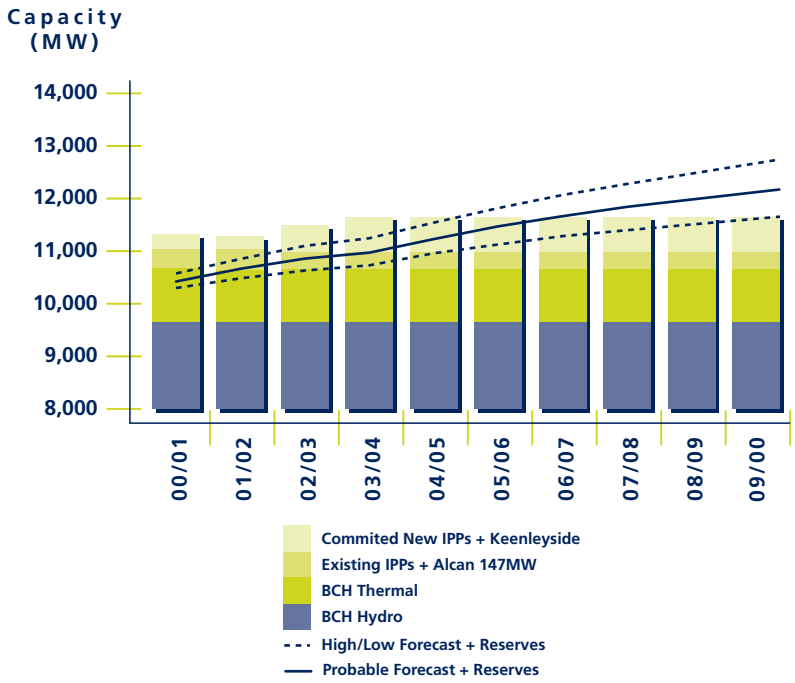
- *Power transfer capacity requirements;*
- *Location and size of new generation resources;*
- *Expected retirement of existing transmission elements;*
- *Demand for wholesale transmission access; and*
- *Economic benefits of reducing transmission capacity and energy losses.*

The electrical system is planned and designed to meet an appropriate level of system reliability. This includes certain standards of steady-state and dynamic performance under a variety of single or multiple contingencies, such as the loss of a major system component. This also includes compliance with the mandatory North American Electrical Reliability Council (NERC) and the Western Systems Coordinating Council (WSCC) reliability standards.

3.5 Need for New Resources

The need for new resources is determined in the context of overall integrated system load requirements with consideration of transmission impacts and regional requirements.

Figure 3-5. Dependable Capacity Balance with Existing & Committed Resources



3.5.1 System Requirements

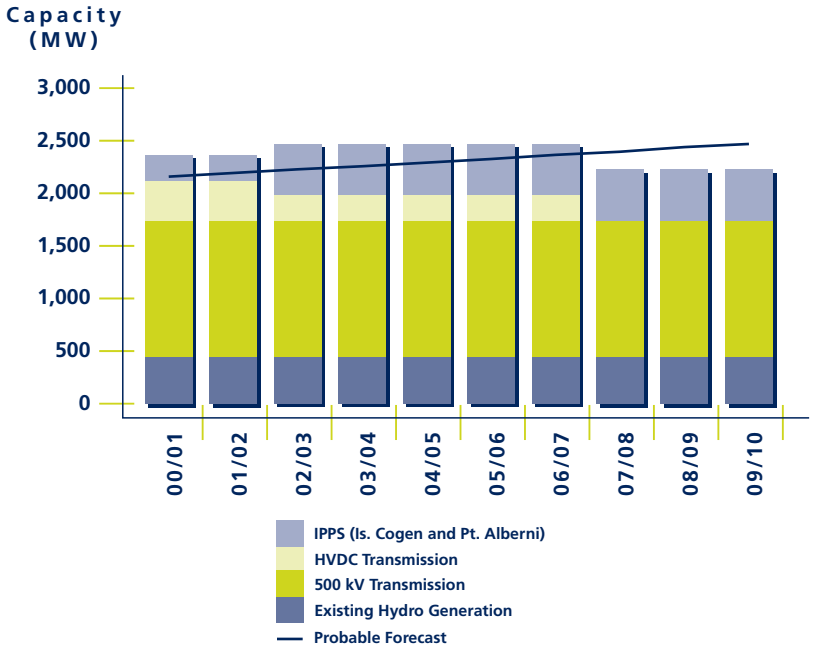
Figures 3-4 and 3-5 respectively show updated energy and capacity requirements for the BC Hydro integrated system. These figures reflect the load forecast and existing and committed new resources discussed in the previous sections. Figure 3-4 includes the 2,500 GWh provision for secondary hydro and market resources. The peak demand forecasts shown in Figure 3-5 include an allowance of eight per cent for capacity planning reserve. As shown in Figures 3-4 and 3-5, and based on the probable load forecast, no significant new resources are required until 2007.

Depending on the characteristics of the new generation to be added and the regional growth in demand, transmission reinforcements may need to be advanced or deferred. The North Coast region, the Lower Mainland to Vancouver Island and, to a lesser extent, the Southern Interior to the Lower Mainland are areas in which reinforcements may be required.

3.5.2 North Coast Requirements

The North Coast region continues to be served by a highly reliable single 500 kV transmission line, capable of supplying 900 MW, and 207 MW of local generation including the purchase from Alcan under the LTEPA. The current peak demand for this region is approximately 400 MW. In the event of an outage on the 500 kV line, service to industrial customers may be interrupted.

Figure 3-6. Vancouver Island Capacity Balance



BC Hydro will continue to monitor the reliability of supply to the North Coast and to assess opportunities to improve the reliability of the supply to the area.

If there were a significant increase in electricity demand due to a new large load, additional generation would be required in the region. However, a new load greater than 600 MW could shift the economics in favour of a second 500 kV transmission line.

BC Hydro is aware of Alcan's pending decision regarding expansion of its aluminum smelter capability at Kitimat. As noted in sub-section 1.2.6, the terms of the 1997 B.C./Alcan Settlement Agreement require BC Hydro to provide a portion of the supply needed by a new smelter. BC Hydro may also need to replace the 147 MW it currently receives from Alcan. Should the Alcan smelter expansion proceed, BC Hydro anticipates that local generation would likely provide the most cost-effective supply and could be brought into service in parallel with the smelter construction.

3.5.3 Vancouver Island Requirements

The future supply requirements for Vancouver Island are driven by regional load growth and the expected staged retirement of the existing high voltage direct current (HVDC) transmission link to the Island. As previously noted, the Island Cogeneration Project is under construction and the Port Alberni Cogeneration Project is planned. These new plants will require a second marine gas pipeline crossing to Vancouver Island. This pipeline project has been

announced (Georgia Strait Crossing Pipeline) and is expected to be in-service by 2002. This pipeline could support additional gas-fired generation on Vancouver Island, and would also meet growth in other gas demands on the Island.

Figure 3-6 shows the capacity balance for Vancouver Island including the expected retirement of the existing HVDC transmission and the addition of the committed new cogeneration resources. This shows that new supply for Vancouver Island will be required in 2007. The IEP portfolio analysis examines whether the need is best served by further gas-fired generation on Vancouver Island or by the installation of replacement electrical transmission from the Mainland.

3.6 Summary

The demand-supply outlook shows that BC Hydro requires additional resources by 2007 to meet the forecast increases in system load. This also coincides with the timing for new capacity for Vancouver Island. Capacity requirements for the North Coast region may influence the location and timing of resource additions if a smelter or other large load were to proceed in that region.

4 Planning Objectives

4.1 Introduction

The planning objectives help to guide the evaluation and selection of resource options, and to set criteria for identifying and comparing portfolios. The objectives focus the discussion about selection of options on the "ends" to be achieved, rather than on the "strategies" or the "means" to achieve a particular outcome.

4.2 IEP Objectives

The objectives established in the 1995 IEP were derived from BC Hydro's corporate policy with input from the Consultative Committee. The objectives were translated into measurable attributes that were then used to describe and compare resource options.

Since the 1995 IEP was completed, there have not been significant changes to the resource options available for consideration or to BC Hydro's obligation to provide its domestic customers with low-cost, reliable service in an environmentally and socially responsible manner.

Increasing competition in all aspects of the electricity marketplace means that BC Hydro must continue to respond to customer needs in a low-cost and efficient manner while realizing gains from the competitive market through profitable trading activities. This ability to participate and achieve trading gains provides revenues that contribute to low customer costs.

The objectives established in 1995 continue to be relevant. They reflect the range of values and interests that need to be considered when making planning decisions about future resource options, consistent with BC Hydro's overall business objectives. The IEP objectives are presented in Table 4.1.

4.3 Linking Objectives and Attributes

In order to determine the suitability of individual resources for inclusion in the IEP, a list of attributes was developed based on the 1995 IEP. These attributes are grouped into the "accounts" of a multi-attribute tradeoff analysis (MATA) framework that links the tradeoff attributes to the planning objectives.

Five main accounts were used in the 1995 IEP– financial, technical, environmental, social/community and economic development. The IEP incorporates all but the technical account. The technical account is not revisited as the resource options considered are all proven technologies. As well, BC Hydro's Energy Futures Program, which complements the IEP, addresses BC Hydro's initiatives related to emerging technologies which may not yet be fully technically proven.

The tradeoff attributes for each account and their links to the IEP objectives are summarized in Table 4-2. The attributes have been revised and reduced in number based on implementation experience during the 1995 IEP, and because this IEP deals with resource options that are not site-specific.

Table 4-1. IEP Planning Objectives

To provide the best electricity solutions for current and future generations of British Columbians in an environmentally and socially responsible manner.
• Minimize the cost of electricity services to customers • Provide reliable supply that meets customer needs and expectations. • Minimize adverse and promote positive environmental impacts • Provide positive socio-economic benefits in B.C. • Promote implementation of appropriate new and existing technologies

4.3.1 Resource Characterization Tradeoff Attributes

Attribute 1: Financial Account–Corporate Cost

Corporate cost is the total cost from BC Hydro's business perspective. Depending on location, new resources may impact transmission costs and transmission losses, which are incorporated.

Attribute 2: Financial Account–Provincial Cost

Provincial cost is the cost from the provincial perspective. It reflects an adjustment from corporate cost to account for the transfer payment benefits to the Province, such as water rental fees.

Attributes 3, 4 and 5: Environmental Account–Local Air Emissions

Local air emissions include nitrogen oxides (NO_X), sulfur oxides (SO_X) and particulates. These emissions are of concern due to their impacts on local air quality. Since significant SO_X emissions are associated with the burning of coal and because the IEP does not include coal-fired generation in any of its portfolios, the focus is predominantly on NO_X and particulate emissions.

Attribute 6: Environmental Account–Greenhouse Gas Emissions

Greenhouse gas emissions have become an increasingly important consideration in the evaluation of resource options. The tradeoff attribute used to quantify greenhouse gases includes emissions of carbon dioxide and methane caused by the combustion of the fuel, (measured in tonnes of carbon dioxide equivalent).

Attribute 7: Social/Community Account–Land Use

Land used is qualitatively discussed for the alternative resource portfolios. Because resource options are not site specific and since no portfolios include new large hydro electric projects, or major new transmission projects, this attribute has to be used with care in the tradeoff analysis.

Attribute 8 and 9: Economic Development Account–Employment

The IEP differentiates between construction employment and permanent employment from operations. Construction jobs are measured in terms of full time equivalent (FTE) person-years and permanent jobs are measured in number of FTE jobs.

Table 4-2. Linkages between Planning Objectives and Tradeoff Attributes

	Financial Account		Environmental Account			Social/ Community Account	Economic Development Account	
Objective	BCH Corporate Cost	Provincial Cost	NO_X emissions	Particulate emissions	GHG emissions	land used	Construction Jobs	Permanent Jobs
Minimize the cost of electricity services to customers	X				X			
Provide reliable supply that meets customer needs and expectations	X							
Minimize adverse and promote positive environmental impacts			X	X	X	X		
Provide positive socio-economic benefits in BC		X					X	X
Promote implementation of appropriate new and existing technologies	X		X	X	X		X	X

5 Resource Options and Evaluation

5.1 Introduction

This chapter identifies and evaluates resource options to meet BC Hydro system requirements based on the demand-supply outlook and the planning objectives. Supply resources include gas-fired combined cycle, large and small hydroelectric, market purchases and wood-waste. Transmission resources required to integrate generation alternatives and to meet system or regional requirements are also identified.

The Energy Futures Program, discussed in section 1.2.3 addresses BC Hydro's initiatives related to alternative energy technologies.

BC Hydro's current Power Smart demand side management (DSM) programs are incorporated into the load forecast as discussed in section 3.2.

The development of new rate options could influence the future demand for electricity in B.C. However, their impact on the load forecast over the next ten years is not yet known. As more information becomes available, they will be incorporated into BC Hydro's ongoing planning process.

5.2 List of Resource Options

Information on the resource options is drawn from the following sources:

- *BC Hydro project studies and cost estimates;*
- *Small hydro and woodwaste project information from the 1994 RFP for New Electricity Supply as well as from unsolicited proposals;*
- *Alternative technologies based on literature and industry research; and*
- *BC Hydro research and forecasting of availability and pricing for electricity market purchases and sales.*

A general discussion of each type of option is outlined below. Table 5-1 summarizes the supply resource options, along with their attributes for cost, emissions, and employment impacts. Where applicable, other significant resource attributes are noted. The Corporate and Provincial costs are listed in the table simply as low, medium and high relative to market prices. This is done for commercial competitive reasons and also showing specific numbers would be misleading because many of the resources are generic, and also costs are dependent on current energy and gas forecasts. Therefore, resource costs are described only by a qualitative ranking. Table 5-2 summarizes the key transmission options, which are incorporated into the portfolio analysis presented in Chapter 6.

5.2.1 Combined Cycle Gas Turbines (CCGT)

A CCGT integrates the operation of one or more high efficiency gas turbines with a steam turbine. CCGT plants are available in several configurations. The most common are the "one-on-one" configuration in which the exhaust heat of one gas turbine is recovered for use in a steam turbine and the "two-on-one" configuration in which the exhaust heat of two gas turbines is used in a steam turbine.

The latest, commercially available, high efficiency gas turbines are commonly referred to as the F-series and the G-series. The G-series two-on-one, can produce about 640 MW whereas the F-series one-on-one, produces about 240 MW.

A CCGT can also be incorporated into a cogeneration configuration such that energy is extracted for process steam production. The window of opportunity for cogeneration projects tends to be when a steam host is either first being built or when existing steam facilities require major investment for upgrade or replacement.

5.2.2 Market Purchases and Downstream Benefits

In the long term, the annual average market price for wholesale electricity purchase is expected to converge to the cost of CCGTs. CCGTs are expected to represent the long run marginal cost of supply for most jurisdictions.

It can be expected that there will be cycles, lasting perhaps several years, in which market prices will be above or below the cost of a CCGT. Based on experience in other jurisdictions with electricity market restructuring, there is a reluctance to build generation because of the uncertain return on investment. The lack of new resources being built may drive market prices higher for a period of time until sustained high prices eventually attract new investment.

Monthly or daily prices will vary with demand and supply fluctuations. Market prices have typically been highest in the late summer due to peak electricity demands in California, and lowest in late spring during the freshet period in the U.S. Pacific Northwest. Daily demand variations are reflected in the spread between heavy load hour (HLH) and light load hour (LLH) prices. This spread may become more pronounced during periods when demand is high and transmission or generation constraints are evident.

Through its transmission interconnections, B.C. has access to wholesale electricity markets in Alberta and the U.S. The capacity of the transmission interconnections may limit the extent to which B.C. can import or export electricity.

The Canadian Entitlement to the Downstream Benefits (DSB) is owned by the Province and is managed by Powerex on the Province's behalf. Accordingly, they represent a source of supply, similar to other market purchases, that is available to BC Hydro to purchase for delivery in B.C.

5.2.3 Hydroelectric Projects (Small to Large)

The estimated potential for cost effective small hydro developments in B.C. is about 330 MW or 1,700 GWh/year. This is based on proposals submitted in the 1994 RFP, and on earlier site identification work conducted by BC Hydro. Previous estimates of small hydro potential in B.C. have ranged up to 7,000 GWh/year but this included many sites that are now in protected areas, have significant fish impacts, or are remote from the transmission grid.

BC Hydro's major hydroelectric resource options include 213 MW from Seven Mile Unit 4, two additional 500 MW units at Revelstoke, two 400 MW units at Mica and 900 MW from the Peace Site C project.

The Seven Mile Unit 4 project would generate 300 GWh/year under average water conditions and its firm energy capability is 135 GWh/year. Its dependable winter capacity is 90 MW.

Table 5-1. IEP Generation Resource Summary

Project	Capability		Cost		GHG Emissions tonnes/ GWh	Local Air Emissions kg/GWh		Employment		Other Comments
	Installed MW	Firm Energy GWh	Corporate Cost	Provincial Cost		NO_X	Particulates	Construction (prs-yrs)	Permanent (# jobs)	
Hydroelectric										
Seven Mile 4	213	135	Low/Med	Low	0	0	0	250	0	Addition to existing plant.
Revelstoke 5 (Similar units: REV6, Mica 5&6)	500	60	Low to Med	Low to Med	0	0	0	300	0	Addition to existing plant.
Small-Medium Hydro Estimated total developable potential: 330 MW	12–60	72–270	Med to High	Low to Med	0	0	0	23–310	1–6	Land use: varies from 1 to 215 hectares per site.
Peace Site C	900	4570	Med to High	Med to High	0	0	0	5700	25	Land use: 4,960 hectares.
Thermal										
CCGT G-series 2-on-1	640	5050	Low	Low	337	32	15	180–265	15–21	Cost based on Interior B.C. site.
CCGT F-series 1-on-1	225	1760	Low to Med	Low to Med	350	33	16	180–265	15–21	Cost based on Interior B.C. site.
Woodwaste Estimated total developable potential: 200-300 MW	12–53	100–420	Med to High	Med to High	0	varies	varies	150-300	8-20	Land use: varies, typically <15 hectares per site.

The Revelstoke and Mica projects would provide new generating capacity, but would not provide significant additional energy capability. The preferred sequence for adding these units would be to add the fifth unit at Revelstoke followed by the fifth unit at Mica to maintain hydraulic balance between the two plants.

Revelstoke Unit 5 would provide 60 GWh/year of additional energy because of improved efficiency compared to the existing Revelstoke units. Revelstoke Unit 5 would enhance BC Hydro's opportunities to shape energy output in peak demand hours.

The Peace Site C project is downstream of the Peace Canyon generating station. It would provide 900 MW of capacity and 4,570 GWh/year of firm energy.

On an ongoing basis, BC Hydro assesses opportunities for cost-effective efficiency and operational improvements at existing generation facilities. These initiatives are referred to as Resource Smart projects. This work is expected to continue and resulting increases in output will be incorporated into BC Hydro's ongoing planning process.

5.2.4 Woodwaste

Woodwaste projects include stand-alone electricity generation or cogeneration to produce steam and electricity, such as at a pulp mill. Woodwaste projects are assumed to cause no net increase in greenhouse gas. It is currently estimated that there is an additional 200 MW

to 300 MW of woodwaste potential in B.C. This incorporates the expectation that the emergence of other value-added uses for the whitewood component of woodwaste will affect the future amount of woodwaste available for electricity generation.

5.2.5 "New Green" Resources

Most of BC Hydro's energy supply comes from clean and renewable hydro. There is ongoing national and international debate with respect to what resources are considered to be "green." BC Hydro's current working definition is that new green resources include those which are clean, are renewable, have low net environmental impacts, are socially responsible and are licensable. In B.C., some small hydro and woodwaste projects are expected to fit the definition, and be available at reasonably economical prices.

5.2.6 Alternative Technologies

Alternative technologies are resource options which have costs that are currently significantly above the wholesale market price for electricity. These include solar, wind, geothermal, tidal, and fuel cells. It is recognized that the cost of some of these resources could decrease as the technology evolves and some may have specialty small scale applications. BC Hydro's Energy Futures Program monitors the development of these technologies and supports opportunities for their future application in B.C. For example, the Energy Futures Program includes "wind prospecting" to improve the estimated potential and the cost of this resource in B.C. As the economies of these technologies improve, BC Hydro will include these technologies into its ongoing planning process.

5.3 Supply Resource Ranking

The B.C. energy resources options that could provide major additions to meet future load growth are natural gas, coal and large hydro. The least cost of these is gas-fired combined cycle combustion turbine technology. Combined cycle combustion turbines have received broad acceptance in the industry as the preferred resource for new generation. This preference stems from the improvements in their fuel use efficiency, emission controls and abundance of natural gas. Combined cycle projects also have lower capital costs and short construction lead times relative to other major new resource options.

There are some small hydro and woodwaste projects close to being cost competitive with combined cycle and are considered to have no greenhouse gas emissions. However, the potential contribution from these resources is relatively small and insufficient to supply all of BC Hydro's new resource requirements. Alternative energy technologies are not currently cost effective for consideration as a significant supply option for the BC Hydro integrated system.

5.3.1 Resource Cost Uncertainties

Resource planning requires many assumptions that are subject to uncertainty. Several uncertainties related to future resource costs need to be considered. As noted, CCGTs have been identified as a preferred resource option. Accordingly, potential impacts of gas price uncertainty and future greenhouse gas policy measures need to be considered.

Greenhouse Gas Policy

One outcome of Canadian greenhouse gas policy development might be a future requirement to limit BC Hydro's greenhouse gas emissions through investment in greenhouse gas (GHG) offsets. Based on current estimates of GHG offset costs, CCGTs would continue to be lower cost than non-greenhouse gas emitting large hydro resources. There are small/medium hydro and woodwaste projects that could become economic but the potential contribution of these resources is limited. It is anticipated that offsets will be available at costs such that CCGTs would remain as a preferred major resource option.

Natural Gas Price Uncertainty

Natural gas price uncertainty is another factor affecting the future cost of CCGTs. Two key components of gas price uncertainty are short-term price volatility and the long-term cost of gas. Short-term price volatility, caused by relatively unpredictable phenomena such as weather, would be factored into operations. However, over the life of a long-term investment, such as a CCGT, the long-term cost of gas is the dominant concern. The long-term cost of gas is dependent on several factors such as cost of gas extraction and transportation infrastructure. While gas price volatility may cause swings in prices (i.e. daily), the long-term price of gas has a much narrower uncertainty band. Throughout this range of uncertainty, CCGTs remain a preferred resource. As well, high gas price risk is somewhat mitigated by the fact that electricity market prices are often affected by and therefore correlated to the price of gas.

5.4 Transmission Options

Several types of transmission resources can be used to reinforce the transmission system. These include new major transmission interconnections and also opportunities to improve the capacity of the existing transmission system with options such as series capacitors, station voltage support and control equipment, and remedial action schemes.

Table 5-2. Major Transmission Options Included in Portfolio Analysis

Reinforcement Project	FTE Construction Jobs person-years	Comments
Guichon Series Capacitor Station	75	The need for these series capacitors on the Nicola-Kelly Lake line is dictated by increased transfers from B.C. Interior to Lower Mainland.
HVDC Pole 3	200	Replaces existing HVDC and adds transfer capability between the Lower Mainland and Vancouver Island.

Some of these options are identified for reinforcement of the Interior to the Lower Mainland transmission system and others for the Lower Mainland to Vancouver Island transmission interconnection. The key transmission options identified for this Plan are listed in Table 5-2. The choice and mix of transmission options is dependent on the size and location of generation resources identified in the portfolios.

6 Portfolio Analysis

6.1 Introduction

In this chapter, the resources identified in Chapter 5 are used to develop alternative resource portfolios to meet the future requirements of the BC Hydro system. Each portfolio is evaluated using multi-attribute tradeoff analysis. This chapter describes the portfolios and the results of the tradeoff analysis.

6.2 Portfolio Development

In Chapter 3, it was determined that the next major resource is needed in 2007. Chapter 5 identified potential resource alternatives available to serve BC Hydro's system electricity requirements and characterized these resources according to the selected attributes. Some small hydroelectric and woodwaste resources are close to being cost competitive and are attractive based on a range of attributes. However, their potential energy contribution is insufficient to supply all of BC Hydro's new resource requirements. Of the resources that could provide a major economical addition to the BC Hydro system, CCGTs were chosen as the next major new resource. In the portfolio analysis this was assumed to be a 640 MW G-series two-on-one CCGT.

The portfolio analysis has been divided into two parts. Part 1 of the portfolio analysis examines alternative locations for the 2007 CCGT:

- *In the B.C. Interior with access to both gas and electric transmission;*
- *In the Lower Mainland represented by Burrard Repowering;*
- *On Vancouver Island which would defer the transmission reinforcements necessary to replace the aging existing HVDC system.*

Part 2 of the portfolio analysis examines the merits of deferring or advancing resources:

- *Defer the next major resource addition by purchasing from the wholesale electricity market;*
- *Advance Seven Mile Unit 4 to its earliest in-service date;*
- *Advance Revelstoke Unit 5 to its earliest in-service date;*
- *Advance "new green" resources (assumed to be 10 per cent of load growth).*

In structuring the portfolios in Part 1 and 2, the in-service dates for new resources are based on meeting system energy and capacity requirements except in portfolios where specific resources are advanced. Additional resources beyond the 2007 CCGT are assumed to be 640 MW CCGTs located in the B.C. Interior. Capacity requirements, over and above that provided by the CCGTs, are met with Seven Mile 4 and Revelstoke Unit 5.

6.3 Portfolio Modeling

New resources in each of the portfolios are scheduled based on the planning criteria discussed in section 3.4. This schedule determines the sequence of capital and fixed operating costs as well as the employment benefits associated with the generation and transmission elements of the portfolio.

Each portfolio is analyzed using a system simulation model to determine the energy dispatch. The system simulation model economically dispatches existing and new resources within the portfolio to meet domestic load requirements and for electricity trade transactions. Must-run resources such as IPP contracts and run-of-river hydro are dispatched first, followed

by the remaining hydro and thermal resources. This simulation includes operation of the hydro system over a range of historical stream flow conditions.

The variable costs are combined with the portfolio's capital and annual fixed operating cost. All costs are analyzed in real dollars (i.e. net of inflation). The net present value of future costs is calculated using an eight per cent real discount rate.

Based on the expected dispatch of resources in a portfolio, greenhouse gas and local air emissions are calculated based on the emission rate for each resource. Because greenhouse gas emissions are global, consideration is also given to each portfolio's impact on greenhouse gas emissions from a global perspective.

6.4 Portfolio Analysis Part I: Siting Alternatives for Next Major Resource Addition

The next major resource addition is needed in 2007 to meet system requirements. As discussed, the preferred major resource addition is a CCGT. This is represented as a 640 MW two-on-one G-series CCGT. The portfolios examined in Part I are named for the alternate locations of this CCGT addition in 2007. Table 6-1 summarizes the in-service dates of resources for these portfolios. Existing and committed resources listed in Table 3-1 are common to all portfolios.

6.4.1 Interior B.C. CCGT Portfolio

In this portfolio, the CCGT acquired in 2007 is located in the interior of the province nominally in the Kelly Lake/Nicola area. This area is considered to have favourable access to both gas supply and electrical transmission interconnection.

Seven Mile 4 and Revelstoke 5 are scheduled based on capacity requirements in 2010 and 2014, respectively. The next CCGT is required in 2012.

This portfolio includes the HVDC Pole 3 in 2007. The other major transmission element is the Guichon series capacitor station coincident with the in-service of Revelstoke Unit 5.

6.4.2 Burrard Repowering Portfolio

For this portfolio, the next major resource addition is assumed to be Burrard Repowering based on a 640 MW two-on-one CCGT. Because three existing steam units at Burrard would have to be retired at the start of the two-year repower construction period, there would be a reduction in system capability in 2005 and 2006. This is assumed to be covered by a market purchase for those two years. Seven Mile 4 and Revelstoke Unit 5 are scheduled in 2008 and 2012 respectively to meet system capacity requirements. Because of the loss of the capability of the three retired Burrard units, the next CCGT is required in 2009.

This portfolio includes the HVDC Pole 3 in 2007. The other major transmission element is the Guichon series capacitor station coincident with the in-service of Revelstoke Unit 5.

6.4.3 Vancouver Island CCGT Portfolio

In this portfolio, the 2007 CCGT is assumed to be located on Vancouver Island. The replacement HVDC Pole 3 is deferred beyond the end of the 20-year study period. The balance of the portfolio is the same as the Interior B.C. CCGT Portfolio.

6.4.4 Portfolio Evaluation and Multi-Attribute tradeoff Analysis (Part 1)

By locating the 2007 CCGT on Vancouver Island, BC Hydro avoids the cost of the HVDC Pole 3. Given the capability and cost of transportation using the Georgia Strait Crossing Pipeline, and accounting for electrical transmission losses, the Vancouver Island CCGT Portfolio is the least cost portfolio.

Table 6-2 shows the environmental and employment attributes of the three portfolios. The Interior B.C. CCGT portfolio performs better than the Vancouver Island CCGT portfolio from an employment perspective resulting from the advancement of jobs associated with the HVDC Pole 3. However, the Vancouver Island CCGT portfolio has lower cost and is preferred considering the small difference in jobs compared to the significant cost savings.

The expected retirement of the HVDC makes Vancouver Island a more economical site for the 2007 CCGT. Since advancing both the VI CCGT and Burrard Repower in 2007 would result in excess supply, it is recommended that Burrard Repowering be deferred. It will remain an option for future consideration.

Therefore, the result of the analysis is that the Vancouver Island CCGT is the preferred portfolio.

6.5 Portfolio Analysis Part 2: Resource Deferral/Advancement

Part 2 of the portfolio analysis examines the merits of deferring the 2007 CCGT in favour of market purchases, and advancement of several resource alternatives: Seven Mile Unit 4, Revelstoke Unit 5 and "new green" resources. These portfolios are compared to the Vancouver Island CCGT portfolio which was the recommended outcome of Part 1 of the portfolio analysis. Table 6-3 summarizes the in-service dates of resources for these portfolios.

6.5.1 Market Purchase Portfolio

This portfolio is intended to address the question of whether BC Hydro should invest in new resources or rely on wholesale electricity market purchases to meet system requirements. In this portfolio, the CCGT that has otherwise been scheduled in 2007 is deferred and BC Hydro relies on market purchase contracts. The deferral is assumed to extend until the next major resource is required in 2012. In 2012, the market purchases end and two CCGTs are scheduled. The HVDC Pole 3 is in-service in 2007 to meet Vancouver Island's supply requirements. The remainder of the portfolio elements are the same as the elements for the Vancouver Island CCGT Portfolio.

6.5.2 Early Seven Mile 4 Portfolio

This portfolio assumes that Seven Mile Unit 4 is advanced to its earliest in-service date of 2002. The remainder of the portfolio elements are the same as the elements for the Vancouver Island CCGT portfolio.

6.5.3 Early Revelstoke Unit 5 Portfolio

This portfolio assumes that Revelstoke Unit 5 is advanced to its earliest in-service date of 2002. This also requires advancement of the Guichon series capacitor station to increase the transfer capability from the Southern Interior to the Lower Mainland.

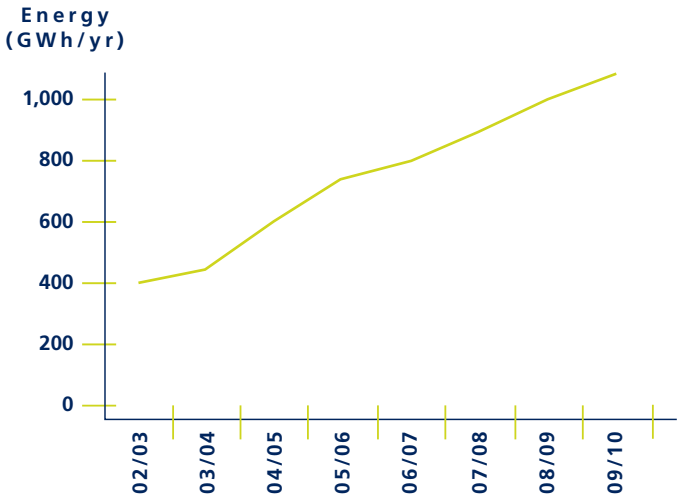
Table 6-1. Portfolio Analysis Part 1: Comparison of Project In-Service Dates

In-service Year	B.C. Interior CCGT	Burrard Repowering	Vancouver Island CCGT
00/01	Island Cogen Project Purcell Woodwaste Project	Island Cogen Project Purcell Woodwaste Project	Island Cogen Project Purcell Woodwaste Project
01/02			
02/03	Port Alberni Cogen Project Keenleyside	Port Alberni Cogen Project Keenleyside	Port Alberni Cogen Project Keenleyside
03/04			
04/05			
05/06			
06/07			
07/08	B.C. Interior CCGT HVDC Pole 3	Burrard Repowering CCGT HVDC Pole 3	Vanc. Is.CCGT
08/09		Seven Mile 4	
09/10		CCGT	
10/11	Seven Mile 4		Seven Mile 4
11/12			
12/13	CCGT	Revelstoke 5 Guichon Capacitor Station	CCGT
13/14			
14/15	Revelstoke 5 Guichon Capacitor Station	CCGT	Revelstoke 5 Guichon Capacitor Station
15/16			
16/17			
17/18	CCGT		CCGT

Table 6-2. Portfolio Analysis Part 1: Summary of Portfolio Environmental/Social Attributes

Portfolio	Greenhouse Gas Emissions (20-year total kilotonnes)	NO_X Emissions (20-year total kilotonnes)	Particulate Emissions (20-year total kilotonnes)	Employment (20-year total person years)
Interior BC CCGT	128,270	23.5	1.2	4350
Burrard Repower CCGT Portfolio	125,010	21.3	0.7	4225
Vancouver Island CCGT	127,490	23.4	1.2	4140

Figure 6-1. New Green Energy Corresponding to 10 Per Cent of Load Growth



Revelstoke Unit 5 provides sufficient capacity such that Seven Mile 4 can be deferred beyond the end of the 20-year study period. The remainder of the portfolio elements are the same as the elements for the Vancouver Island CCGT Portfolio.

6.5.4 Ten Per Cent "New Green" Portfolio

In this portfolio, ten per cent of load growth is met with new green resources. The cumulative amounts of new green resources is shown in Figure 6-1. It was scheduled in 50 GWh increments for modelling purposes. Ten per cent was chosen as a reasonable amount to illustrate the potential impacts of introducing a new green energy portfolio. Consideration of the acquisition of this type of portfolio is in line with current industry trends.

At this time, the most likely candidates to meet this new green target are small hydro and woodwaste. The costs assumed for these resources are based on studies and project proposals received by BC Hydro. In future, other technologies such as solar and wind may become competitive.

6.5.5 Portfolio Evaluation and Multi-Attribute Tradeoff Analysis (Part 2)

Table 6-4 summarizes the environmental/and employment attributes of the Deferral/Advancement portfolios.

Market Purchase Portfolio

Based on the current outlook that long-term market prices will be comparable to the cost of CCGTs and the expectation that the HVDC transmission will need to be replaced, a market purchase to defer a Vancouver Island CCGT in 2007 is not economic. As well, the Market Purchase portfolio has higher GHG emissions based on the assumption that imports would

produce the average GHG emissions of existing resources in the western integrated electricity market which is approximately 500tonnes/GWh. Local air emissions are less for the Market Purchase portfolio only because local air emissions impacts in B.C. are not attributed to imports. The employment benefits are higher because of the construction employment associated with from the Pole 3 HVDC replacement project. Based on these tradeoffs, deferring the Vancouver Island CCGT in favour of market purchases is not preferred.

Table 6-3. Portfolio Analysis Part 2: Comparison of Project In-Service Dates

In Service Year	VI CCGT	Market Purchase to Defer CCGT	Early Seven Mile 4	Early Revelstoke 5	Ten Percent "New Green"
00/01	Island Cogen Project Purcell Woodwaste	Island Cogen Project Purcell Woodwaste	Island Cogen Project Purcell Woodwaste	Island Cogen Project Purcell Woodwaste	Island Cogen Project Purcell Woodwaste
01/02					
02/03	Port Alberni Cogen Keenleyside	Port Alberni Cogen Keenleyside	Port Alberni Cogen Keenleyside Seven Mile 4	Port Alberni Cogen Keenleyside Revelstoke 5 Guichon Capacitor Station	Port Alberni Cogen Keenleyside
03/04					
04/05					
05/06					
06/07					
07/08	Vancouver Island CCGT	HVDC Pole 3	Vancouver Island CCGT	Vancouver Island CCGT	Vancouver Island CCGT
08/09					
09/10					
10/11	Seven Mile 4	Seven Mile 4			
11/12					Seven Mile 4
12/13	CCGT	CCGT CCGT	CCGT	CCGT	
13/14					
14/15	Revelstoke 5 Guichon Capacitor Station	Revelstoke 5 Guichon Capacitor Station	Revelstoke 5 Guichon Capacitor Station		CCGT
15/16					Revelstoke 5 Guichon Capacitor Station
16/17					
17/18	CCGT	CCGT	CCGT	CCGT	CCGT

Table 6-4. Portfolio Analysis Part 2: Summary of Portfolio Environmental/Social Attributes

Portfolio	Greenhouse Gas Emissions (20-year total kilotonnes)	NO_x Emissions (20-year total kilotonnes)	Particulate Emissions (20-year total kilotonnes)	Employment (20-year total person years)
Vancouver Island CCGT (from Part 1)	127,490	23.4	1.2	4140
Market Purchase Portfolio (deferral of VI CCGT)	130,070	22.7	0.8	4245
Early Seven Mile 4 Portfolio	126,570	23.4	1.2	4140
Early Revelstoke 5 Portfolio	127,490	23.4	1.2	3896
Ten per cent New Green Portfolio	119,340	23.4	-7.5	6163

Advancement of Seven Mile Unit 4

Advancing Seven Mile 4 from 2010 to its earliest in-service date of 2002 is marginal from BC Hydro's corporate cost perspective. Over a range of sensitivities, advancement could be expected to produce either slightly positive or negative financial impacts. However, advancement of the project will provide significant social and economic benefits to the Province.

The Early Seven Mile Portfolio performs better than the Vancouver Island CCGT Portfolio with respect to GHG emissions. Advancing Seven Mile 4 by eight years from 2010 to 2002 means that the availability of its energy displaces some GHG emissions.

The 250 person-years of direct construction employment associated with Seven Mile 4 would be advanced by eight years but the 20-year total of direct employment benefits does not change. Seven Mile 4 is not expected to increase the number of permanent jobs at this existing hydro facility.

In summary, the tradeoff analysis indicates that advancement of Seven Mile Unit 4 merits further consideration.

Advancement of Revelstoke Unit 5

There is a significant corporate and provincial cost premium associated with advancing Revelstoke Unit 5 from 2014 to its earliest in-service date of 2002.

Revelstoke Unit 5 would advance 300 person-years of direct construction employment. However, the 20-year total of direct employment is lower than for the Vancouver Island CCGT portfolio because Seven-Mile 4 is deferred beyond the end of the 20 year study.

Since Revelstoke Unit 5 provides only 60 GWh/yr of additional energy, its impact on air emission is considered to be negligible.

Based on its expected benefits, the tradeoff analysis does not support Revelstoke Unit 5 advancement.

Advancement of Ten Per Cent New Green Resources

The Ten Per Cent New Green portfolio has higher costs than the Vancouver Island CCGT portfolio. However, the Ten Per Cent New Green portfolio has benefits associated with increased employment and reduced emissions.

The Ten Per Cent New Green portfolio results in reductions in greenhouse gas, and particulate emissions. The 20-year total greenhouse gas emissions are lower by about 8100 kilotonnes. The particulate emission reduction results from a credit given to woodwaste power projects for reducing the particulate emissions that would otherwise occur from the continued operation of existing wood-fired boilers or incinerators to dispose of woodwaste. The reduction is estimated at about 9 kilotonnes over the 20-year period. The Ten Per Cent New Green portfolio increases job creation benefits by 2,023 person-years.

This portfolio analysis is based on an assumption of ten per cent of new load to be met with new green resources. Acquisition of a higher percentage of new green resources would result in a proportional increase in emissions reduction benefits and employment benefits. However, because of the limited availability of relatively economic small hydro, woodwaste or other new green resources additional amounts will be more costly.

The proposal to voluntarily acquire new green resources provides an opportunity for BC Hydro to mitigate greenhouse gas emissions and the cost risks associated with potential future requirements to reduce greenhouse gas emissions. Together with the broad public support for the acquisition of new green resources, this will lay the foundation for the development of a new green energy sector in B.C. Accordingly, it is recommended that BC Hydro acquire new green resources as part of its supply portfolio. These resources should be acquired at their competitive commercial value to BC Hydro and its customers.

In practice, as individual projects are considered for the new green portfolio, there may be land use or other issues identified. However, these are not considered to be “show-stoppers” with respect to a recommendation that BC Hydro target the acquisition of new green resources.

6.6 Scenarios and Uncertainties

Resource cost uncertainties were discussed in section 5.3.1. Other issues that present uncertainties for BC Hydro include load forecast uncertainty and Water Use Planning.

6.6.1 Load Forecast Uncertainty

BC Hydro continues to monitor changes in load forecast and updates its plan as necessary. Figures 3-4 and 3-5 show the Probable Load Forecast as well as the Low and High Load Forecasts. Based on the Probable Forecast, the next major addition is needed in 2007. Under a high load growth scenario, BC Hydro would need new resources by 2005. The relatively short lead-time of CCGTs allows BC Hydro to be able to respond to this in-service date. As well, the advancement of Seven Mile Unit 4 and the proposed acquisition of new green resource would provide some flexibility to meet increases in the demand outlook. Conversely, should load growth be lower than currently forecast, new resource additions could be deferred.

BC Hydro continues to monitor the potential for a significant increment of new load such as a new smelter development. If new electricity resources were required to serve a new smelter, these resources could be acquired or constructed on a timeline equal to or less than that required for a smelter. Acquiring a portion of the DSBs is one such acquisition option.

6.6.2 Water Use Planning

Water Use Planning (WUP) is expected to result in reductions in generation capabilities and operational flexibility. Actual impacts will only be known once the WUP processes are complete. The time frame that has been established to complete the WUP process allows for flexibility in determining the requirements for replacement power, either through market supplies or by the advancement of new resource additions by approximately up to one year.

6.7 Summary of Risk Management Strategies

Because future resource additions are expected to be predominantly high efficiency gas-fired resources, BC Hydro faces increases in its greenhouse gas emissions over historical levels. The possibility of having to offset greenhouse gas emissions in the future is a significant business risk. This risk will be actively managed through activities such as participation in GHG policy discussions with the public and all levels of government and the acquisition of GHG offsets. The targeted acquisition of new green resources as recommended in this IEP also helps to address this business risk. As well, BC Hydro needs to maintain options such as Peace Site C.

To address gas price uncertainty, BC Hydro will continue to monitor the outlook for gas prices. The short-term outlook is used to develop fuel purchase contracting and gas price risk mitigation strategies. The long-term outlook is used to assess future resource options. BC Hydro will also continue to assess the correlation of gas prices with electricity market prices. The extent to which electricity prices are positively correlated with gas prices mitigates fuel price risk for new gas-fired resources.

Similar to gas prices, the market price of electricity also faces short term volatility and long-term price uncertainty. The long-term market price for electricity is expected to converge at the long run marginal cost of new resources, which is assumed to be based on the cost of CCGTs. However, it can be expected that there will be cycles lasting perhaps several years in which market prices will be above or below the cost of a CCGT. BC Hydro will continue to monitor the outlook for both short-term as well as long-term market prices to ensure support for its investment decisions.

7 Ten-year Outlook

The Ten-Year Outlook presents BC Hydro's current plans to meet its domestic customers' long-term electricity requirements and identifies resource advancement opportunities.

Based on the December 1998 Probable Demand Forecast and BC Hydro's supply of existing and committed resources, the next major resource addition is needed in 2007. The year 2007 is also when the HVDC transmission system to Vancouver Island is expected to be retired. Therefore, there are significant cost savings associated with additional CCGT generation on Vancouver Island in 2007 to meet system requirements and to avoid the cost of replacement transmission to Vancouver Island. In order to meet a 2007 in-service date, no immediate actions are required at this date beyond an investigation of potential CCGT sites.

Since Vancouver Island has emerged as a preferred site for the next major resource additions, BC Hydro is deferring Burrard Repowering at this time.

The multi-attribute tradeoff analysis indicates that there is merit in further examining advancement of Seven Mile Unit 4 but not Revelstoke Unit 5.

There is broad public support to develop new green resources in B.C. and a potential need to mitigate greenhouse gas emissions associated with gas fired generation. Therefore, it is recommended to acquire new green resources in the order of ten per cent of load growth. BC Hydro would acquire new green resources at their competitive commercial value to BC Hydro and its customers.

The major planned bulk transmission element of the Ten-Year Outlook is the retirement of the HVDC transmission link to Vancouver Island, BC Hydro will continue to monitor the reliability requirements for Vancouver Island and will continue to evaluate options to meet these requirements including the option to rebuild the HVDC. The timing of the Guichon series capacitor station depends on the future transfer capability required from the Southern Interior to the Lower Mainland. The current outlook is that Guichon will not be needed within the Ten-Year Outlook.

Figures 7-1 and 7-2 show the selected resources that make up the Ten-Year Outlook and their contributions to firm energy and dependable capacity respectively.

Figure 7-1. Energy Balance
Ten-Year Outlook for New Resources

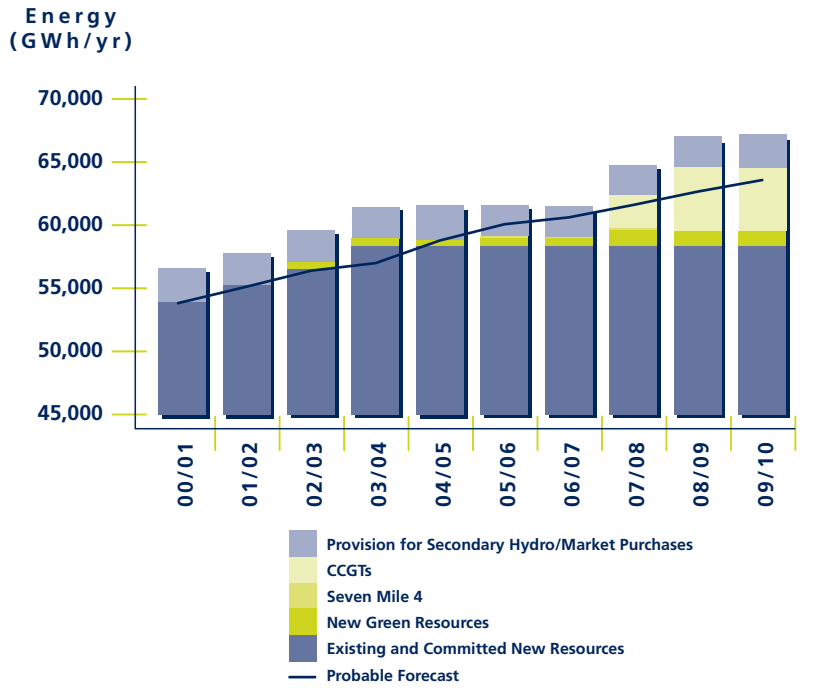
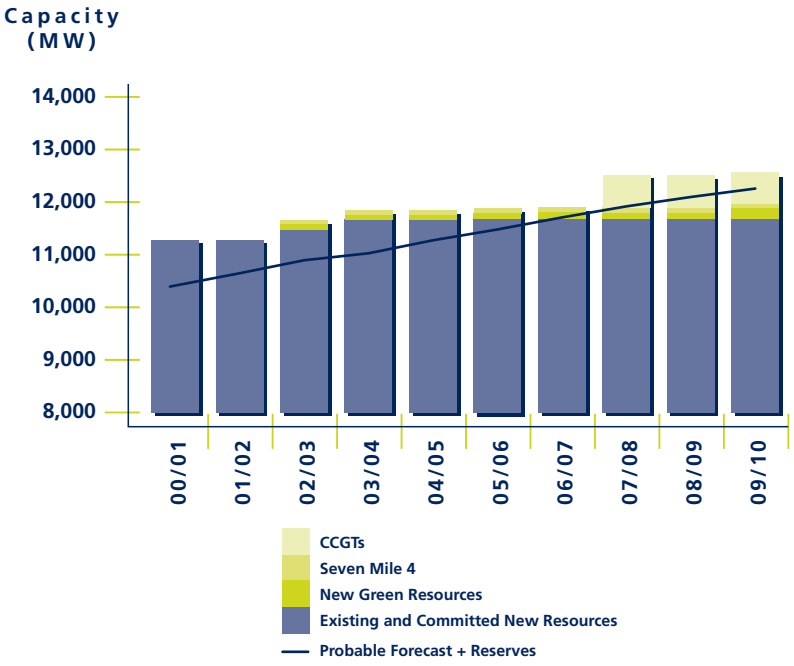


Figure 7-2. Capacity Balance
Ten Year Outlook for New Resources



8 Action Plan

8.1 Action Plan

The following Table 8-1 provides BC Hydro's Recommended Action Plan resulting from the IEP. This Action Plan is based on current information and is updated on an ongoing basis.

Table 8-1. Current Action Plan

ITEM	ACTION
Combined Cycle Gas Turbines	Identify and examine Vancouver Island and Mainland sites
New Green Resources	Acquire cost-effective new green resources
Seven Mile Unit 4	Examine merits of advancement
Revelstoke Unit 5	Maintain as an option for future consideration
Resource Smart	Continue with efficiency improvements and operational improvements at existing facilities
Burrard Thermal G.S.	Defer Burrard Repowering decision
HVDC Transmission to Vancouver Island	Continue to monitor performance and retirement schedule and evaluate Vancouver Island system reliability requirements .
Demand-side Management	Continue with current approach with respect to demand-side management activities
Community Energy Planning	Continue to work with community planners on energy related issues.
Planning Activities	Continue to monitor and develop strategies to meet changes from forecast load growth including potential large new loads. Continue to monitor the outlook for long term gas and electricity market prices. Retain future provincial resource options such as Peace Site C through continued support for the retention of flood reserves. Continue to monitor and incorporate the impacts of Water Use Planning Continue to monitor technological advancements in energy supply resources and incorporate into ongoing planning process
Greenhouse Gas Issue developments	Continue to develop and implement management plan and continue to monitor GHG policy developments provincially, nationally and internationally.
North Coast Supply	Continue to monitor reliability of service in the area
Keogh G.S.	Develop a decommissioning strategy

8.2 Review of the Ten-Year Outlook and Action Plan Against the Planning Objectives

Objective: *Minimize the cost of electricity services to customers.*

The resource strategy of the Ten-Year Plan identifies the cost advantages associated with locating additional generation on Vancouver Island. The advancement of resources proposed in the Ten-Year Outlook provides some hedge against higher-than-expected gas or electricity market prices, and the uncertainty of greenhouse gas policy. In addition, new green resources will be acquired at their competitive commercial value to BC Hydro and its customer.

Objective: *Provide reliable supply that meets customers' needs and expectations.*

The Ten-Year Outlook is based on meeting energy and capacity reserve criteria. The advancement of Seven Mile and "new green" resources provides some additional reserve capability. As noted in the Action Plan, BC Hydro will continue to monitor the adequacy and reliability of supply in the North Coast region and will continue to monitor the reliability of Vancouver Island supply.

Objective: *Minimize adverse and promote positive environmental impacts.*

The recommendations to advance Seven Mile Unit 4 and acquisition of a limited amount of new green resources result in greenhouse gas reductions. As well, particulate reduction benefits in Interior B.C. communities are expected since woodwaste projects are anticipated to be a component of the new green resources.

Objective: *Provide positive socio-economic benefits in B.C.*

The Ten-Year Outlook would advance job creation benefits. The 250 direct person-years of construction employment associated with advancing Seven Mile 4 benefit the Province. The acquisition of new green resources also provides job creation benefits.

The increased transfer payments to the Province associated with advancing Seven Mile 4 and small hydro projects would be of additional financial benefit to the Province.

Objective: *Promote implementation of appropriate new and existing technologies.*

The Ten-Year Outlook recognizes the merits of clean, efficient and cost effective CCGT technology as an appropriate resource for meeting the future growth in electricity demand in B.C. By recommending the acquisition of new green resources, BC Hydro is also promoting the development of new green resources in B.C.

8.3 Overall Assessment

The Ten-Year Outlook and the recommended Action Plan provide a reasonable balance among BC Hydro planning objectives associated with meeting the future demand for electricity of its customers. Appropriately, considerable weight is given to minimizing future costs. However, the Plan also considers other financial and non-financial benefits.

BC Hydro will continue to be responsive to the needs of its customers by prudent planning and acquisition decisions.