Appendix F – Large Hydro and Resource Smart

F.1 Project and Program Database – Table of Contents

No Preamble for this Appendix.

PROJECT: **Elaho River**

Resource Category: Hydro - Large Hydro Level of Study: Pre-feasibility Region: Lower Mainland

PROJECT DESCRIPTION

Strong concerns have been expressed over the development of a large hydro project on the Elaho River, particularly because of the old growth trees. The Squamish Nation have strong concerns and consider the Elaho Valley a sacred place. They would likely oppose the development of this project. This project was not included in any portfolios but was included in the database to demonstrate the range and limitations of large hydro projects in B.C.

Two alternatives for power generation have been studied by BC Hydro for the Elaho River, located near Squamish, BC. The Deserted Bay alternative consist of a 145 m high earthfill dam and 14.5 km power tunnel to divert water from the Elaho River to a powerhouse discharging into Deserted Bay on Jervis Inlet. The Elaho River alternative consists of a similar dam, but the powerhouse would be on the Elaho River. The Elaho River alternative is desribed here and has been included in the 2004 IEP Resource Options.

Although, the Deserted Bay alternative was recommended in the 1983 Elaho River Development Study due to its lower cost of energy, it was not been included in the 2004 IEP Resource Options since it was deemed infeasible to divert water between different watersheds.

The Elaho River large hydro project is mutually exclusive with the small hydro Elaho River project that is described in a separate project.

FINANCIAL INFORMATION

Total Capital Cost ($1000s of 2003$)	$738,000
Fixed Operating And Maintenance Cost ($1000s/year)	$3,540
Variable Operating And Maintenance Cost ($/MWh)	$0
Project Life (Years)	70
Project Lead Time (Years)	10
Unit Energy Cost ($/MWh)	$94

Costs from the 1983 Elaho Overview Study and escalated using Statistics Canada inflation rates. Total Capital Cost does not include Interest During Construction (IDC), Inflation, and Corporate Overhead. Unit energy costs were estimated using the spreadsheet-based model developed for the 2004 IEP as outlined in the Resource Options report. Financial assumptions are described in the report. Fixed Annual Operating and Maintenance Costs were estimated at 0.48% of Total Capital Cost and include variable O&M (0.45%) and insurance (0.03%). Grants and Taxes are not included in Fixed Annual O&M costs but are estimated at 1.33% of Total Capital Cost.

Project lead time is estimated to be comprised of 6 years to license, and 4 years for construction based on a lead time estimate provided for the Deserted Bay alternative in the Project Summaries completed by Woodley, 1987.

It is important to emphasize that, with the exception of Peace Site C, financial information contained in 2004 IEP large hydro resource options was referenced to studies that were conducted a minimum of 10 years ago, and in some cases up to 20 years ago. Values contained in the 2004 IEP information sheets were escalated from past estimates, and thus reflect the technical, regulatory and market assumptions and methodologies of those times. It is expected that the large hydro project financial estimates used in the 2004 IEP were valid within an order of magnitude, and can be used for broad trade-off and evaluation purposes.

The unit energy cost for this project is estimated to range from $85/MWh to $130/MWh, based on the price uncertainty ranking. Previous studies have estimated as low as $70/MWh, however this estimates has not been confirmed and may be for the Deserted Bay Alternative.

The unit energy cost estimate of $94/MWh was estimated using the spreadsheet-based model for private sector cost estimates, with specific financial assumptions for a large project. Companies or corporations financing such a project would likely be able to use 100% debt during construction, and only need to book in their equity when the project is nearing completion and the term debt is put in place. The assumption in the model, only activated for Large Hydro projects, was that Debt and Equity will be funded pro-rata during construction, at the D/E ratio. The notable exception is that the initial Development Capital (4% for large projects) will still be funded by 100% Equity.

PROJECT: **Elaho River**

Resource Category: Hydro - Large Hydro | Level of Study: Pre-feasibility | Region: Lower Mainland

TECHNICAL INFORMATION

Installed Capacity (MW)	200
Average Annual Energy (GWh/year)	945
Dependable Capacity (MW)	200
Firm Energy (GWh/year)	81

It is assumed that the capacity provided by large hydro electric projects with storage is 100% dependable for meeting winter peak. Energy and capacity data was quoted from the Elaho River Hydroelectric Overview Study, 1983.

SOCIAL AND ENVIRONMENTAL INFORMATION

Meets BC Hydro Clean Criteria	No
Greenhouse Gas Emission Factor (Tonnes CO2 equivalent/GWh)	0

Atmospheric Emissions (Metric Tonnes/GWh)	SOx	NOx	CO	VOC	PM 10	PM 2.5	Hg
	0	0	0	0	0	0	0

Project Footprint (Hectares)	3,200

Note: Some footprint aspects have not been estimated specifically.

Construction of a reservoir on the Elaho River would provide a measure of flood control in the lower reaches of the Squamish River.

Job Creation

Construction Jobs Created (Person-years)	3000
Permanent Jobs Created (Full time equivalents)	12

Employment information has been estimated based on results for the Murphy Creek large hydro resource option.

PRIVATE SECTOR INVOLVEMENT

Estimated Level of Private Sector Involvement	Primary: 50% to 99%

Large hydro projects would fall on the high end of Primary private sector involvement (i.e. 80-99% private sector involvement) or Private Sector Ownership (i.e. 100% private sector ownership). Large hydro projects may be developed using a variety of development and financing arrangements. In all cases the selected development approach would require a policy decision outside the bounds of BC Hydro's decision making authority. To be conservative, the lower expectation for private sector involvement (primary) was selected, although the project could be 100% private sector owned.

UNCERTAINTY

Development Uncertainty	High

Design at initial stages. Potential environmental challenges and public opposition.

Price Uncertainty	High

Pre-feasibility level design completed more than 10 years ago. However, the project is straightforward using common large hydro electric techniques so uncertainty could be low as medium.

REFERENCES

BC Hydro Development Engineering, Elaho River Hydroelectric Overview Study, Report No. H1595, 1983.

Woodley M., Project Summaries, BC Hydro inter-office memo, File # 527.1.17, July 1987.

PROJECT: **Peace River Site C**

Resource Category: Hydro - Large Hydro | Level of Study: Design | Region: Peace River

PROJECT DESCRIPTION

Site C is a proposed hydroelectric generating station on the Peace River. The project is located 7km southwest of Fort St. John. The project, as currently proposed, comprises of an earthfill dam across the river with a spillway, power intake structure, powerhouse and switchgear facilities on the right bank. The powerhouse would contain six units with a total rated capacity of 900 MW, which would supply approximately 4,800 GWh per year to B.C Hydro's system. The project would include a new 500 kV transmission line to an existing switchyard at Peace Canyon.

BC Hydro currently owns a significant portion, but not all, of the lands required to develop Site C. A local land manager manages the lease of these properties to allow economic use of the properties in the interim.

In early 1990, the project was put on hold due a change in the load forecasts.

FINANCIAL INFORMATION

Total Capital Cost ($1000s of 2003$)	$2,138,000
Fixed Operating And Maintenance Cost ($1000s/year)	$11,100
Variable Operating And Maintenance Cost ($/MWh)	$0
Project Life (Years)	70
Project Lead Time (Years)	9
Unit Energy Cost ($/MWh)	$54

Unit energy costs above were estimated using conservative financing assumptions including a short amortization period. This approach is consistent with other projects in the database. MAPA and portfolio evaluation financing assumptions, including a 70 year amortization period, lead to a unit energy cost estimate of $36/MWh.

Total Capital Cost was based on a hypothetical commitment to proceed by 1 January 2003, the award of first contracts by 01 January 2005 and in-service date of units 1 and 2 by 01 December 2010. Total capital cost is escalated to 2003 $ from 2001$ using Statistics Canada inflation rates (2003$=118.1/113.2 x 2001$) and includes $66,120,000 (Oct 2001 $) for stations and transmission.

Fixed and Variable Operating and Maintenance costs have been extracted from the 1995 IEP and escalated to 2003$ from 1994$ (2003$=118.1/93.3 x 1994$). In the 1995 IEP document, Average O&M costs are estimated as 0.5% of Total Capital Cost. The estimate for total construction cost includes the generating station, Peace Canyon substation upgrade and transmission lines from Site C to Peace Canyon.

Project lead time is estimated at 9 years, with 2 years for approvals and 7 years from approval to full power. Note that the first power (in-service date) is 6 years from the implementation decision with one more year to bring the remainder of the units into service (7 years of construction). The two year lead time to commence implementation is dependent on a strong commitment to the project and to a well co-ordinated and co-operative review and resolution of issues outstanding prior to commencement of construction.

The unit energy cost for this project is estimated to range from $48/MWh to $64/MWh, based on the price uncertainty ranking. The unit energy cost estimate of $54/MWh was estimated using the spreadsheet-based model for resource options, with specific financial assumptions for a large project. Companies or corporations financing such a project would likely be able to use 100% debt during construction, and only need to book in their equity when the project is nearing completion and the term debt is put in place. The assumption in the model, only activated for Large Hydro projects, was that Debt and Equity will be funded pro-rata during construction, at the D/E ratio. The notable exception is that the initial Development Capital (4% for large projects) will still be funded by 100% Equity.

TECHNICAL INFORMATION

Installed Capacity (MW)	900
Average Annual Energy (GWh/year)	4780
Dependable Capacity (MW)	900
Firm Energy (GWh/year)	4570

Dependable Capacity and annual firm energy figures extracted from 1995 IEP. It is assumed that the capacity provided by large hydro electric projects with storage is 100% dependable for meeting winter peak.

PROJECT: **Peace River Site C**

Resource Category: Hydro - Large Hydro | Level of Study: Design | Region: Peace River

SOCIAL AND ENVIRONMENTAL INFORMATION

Meets BC Hydro Clean Criteria	Unknown
Greenhouse Gas Emission Factor (Tonnes CO2 equivalent/GWh)	0

Atmospheric Emissions (Metric Tonnes/GWh)	SOx	NOx	CO	VOC	PM 10	PM 2.5	Hg
	0	0	0	0	0	0	0

Project Footprint (Hectares)	5,125

Note: Some footprint aspects have not been estimated specifically.

The BCUC in their May 1983 Site C Report recognized that significant but acceptable impacts would result from Site C. The information on the environmental impacts was taken from reports compiled during the period of 1978-1980 and was expanded and updated in 1989-1991. Contemporary information would be required for analysis of the potential impacts of this project if it was proposed to proceed. Studies conducted as part of the Water Use Planning may be useful in this regard.

First Nations concerns are expected to be a significant consideration for project success. Two specific concerns raised by First Nations representatives from the region during previous work in the early 1990s include: the impacts of habitat loss and resulting decrease in moose population which is a staple of their diet, and the increased recreational hunting pressure if a road was built across the dam.

There has been a significant change in the recognition of the rights of Aboriginal peoples as a result of rulings of the Supreme Court of Canada. Both First Nation's and Metis expectations are high for support of their economic interests in exchange for agreement to allow development of the Peace Site C project.

Based on this earlier work, the project is expected to have an impact on local levels of mule deer, moose populations, and ruffled grouse with potential impacts on white-tailed deer and elk. None of these species are currently red or blue-listed. A variety of furbearers, carnivores and migratory waterfowl are present in the study area. Impacts would need to be evaluated in detail should the project proceed.

Impact assessments on fish populations are incomplete and would be examined more fully should the project proceed. The major species present in the study area are: mountain whitefish, arctic grayling, rainbow trout, lake whitefish and walleye. Rainbow trout populations are expected to be low. Losses to spawning habitats in the Moberly river and Lynx Creek are anticipated.

Water temperature is expected to increase by approximately 2-3 degrees Celsius in summer.

Roughly 120 ha of Terrestrial ecosystems will be lost ('95 IEP). The impact studies undertaken to date may not provide accurate information of the potential impacts within the study area due to likely changes in population densities, land use, community infrastructure and services etc. within the past decade. However, there are some likely impacts identified in earlier impact assessments.

Approximately 10 owners will require relocation as a result of the creation of the reservoir. Known heritage sites which exist in the study area, would be directly impacted when the reservoir is created. The realignment of sections of Highway 29 (approximately 23 km will be inundated) will be required. It is estimated that approximately 4400 hectares will be flooded. The effects of inundation on water supply use should be beneficial due to a reduction in seasonal suspended sediment. There is a potential for a slight increase in microclimate (fog), but would be geographically limited.

It is anticipated that 76 km for transmission lines from Peace Site C to Peace Canyon would be required. This will follow an existing right-of-way (the existing 138 kV line will be replaced), with an additional 75 metres of right-of-way required (approximately 560 hectares).

No present mineral, natural gas or gravel extraction would be affected.

Proceeding with this project may require an increase in community and social service employees during peak years of construction. The community resources of Fort St. John could be impacted by a change in the community composition due to non-resident workers and transients (primarily during construction period).

No loss in regional tourism is expected, the project may attract tourists.

Job Creation

Construction Jobs Created (Person-years)	8000
Permanent Jobs Created (Full time equivalents)	25

The construction phase of the Peace Site C project will require approximately 8000 person-years of employment over the 7 year construction period. It is expected that the Peace Site C plant will be operated remotely but that 25 new operations and maintenance jobs will be created.

There may also be some decreases in resource related economic activity. This will occur due to the loss of approximately 950 hectares of merchantable timber with a corresponding loss of average annual increment approximately equal to one weeks worth of timber supply for an average sawmill in the region. All merchantable timber will be harvested prior to flooding so the short-term influence on economic activity will be minimized. Some agricultural land in the area will be alienated by the increased footprint of the river.

PRIVATE SECTOR INVOLVEMENT

Estimated Level of Private Sector Involvement	Primary: 50% to 99%

Ownership and development decisions have not been made. However, Site C like other large hydro projects would fall on the high end of Primary private sector involvement (i.e. 80-99% private sector involvement). Large hydro projects may be developed using a variety of development and financing arrangements. In all cases the selected development approach would require a policy decision outside the bounds of BC Hydro's decision making authority.

UNCERTAINTY

Development Uncertainty	Low

This project is technically sound with significant investigation and design. General public acceptance, but impacts would need to be investigated and justified appropriately. Lead time contains uncertainty which is discussed under financial information.

Price Uncertainty	Low

Detailed cost estimates have been prepared at preliminary design level.

REFERENCES

Woodley M., Project Summaries, BC Hydro inter-office memo, File # 527.1.17, July 1987.

Peace River Site C Development, Estimate Update 2002. BC Hydro Report No. PSE421.

BC Hydro 1995 Integrated Electricity Plan, Appendix E, ISSN 1180-2561, October 1995.

PROJECT: **Border Dam**

Resource Category: Hydro - Large Hydro | Level of Study: Feasibility | Region: Selkirk Area

PROJECT DESCRIPTION

This project has been included to demonstrate an example of a large hydro option in B.C. that has been studied in the past. However, concerns around environmental, social and economic issues make the development uncertainty for this project high (see rating below).

The proposed Border Dam project is a low head run-of-river hydroplant on the Columbia River near the US Border at Waneta. Identified sites include upstream of the confluence of the Pende d'Oreille River to across the US border which backs up to the Waneta Powerplant. The head of the reservoir would extend back to the tailrace of the proposed Murphy Dam and have some limited inundation of the Trail area.

Three project arrangements (Alternatives 1-3) were studied at the axis upstream of the confluence of the Columbia and Pend d'Oreille Rivers. Alternative Two is the most attractive, comprising of a powerhouse on the left bank of the Columbia River and a spillway on the right abutment, connected by a long upstream and downstream spillway channel.

This project is essentially a run-of-river project on an already regulated river system.

FINANCIAL INFORMATION

Total Capital Cost ($1000s of 2003$)	$1,270,000
Fixed Operating And Maintenance Cost ($1000s/year)	$6,100
Variable Operating And Maintenance Cost ($/MWh)	$0
Project Life (Years)	70
Project Lead Time (Years)	9
Unit Energy Cost ($/MWh)	$110

Project costs have been extracted from the Border Project Overview Study and escalated to 2003$ from 1989$ using Statistics Canada inflation rates (2003$=118.1/88.8 x 1989$). With an annualized cost of about $155 million at 8% discount rate, the project unit energy costs would be about 11 cents/kWh. This unit energy cost was estimated using the method described in the Value of Electricity Report. Included are:

* Fixed annual charges (operation and maintenance, grants and taxes)
* Variable annual charges (water rental fees for energy and capacity)
* Transmission system energy loss (between Southern Interior and Kelly-Nicola region)
* Transmission system capacity costs (between Selkirk and Nicola)

Fixed and Variable Annual Operating and Maintenance Costs were estimated at 0.48% of Total Capital Cost and include Operating and Maintenance at 0.45% and Insurance at 0.03%. Grants and Taxes are not included in the O&M costs but are estimated at 1.33% of Total Capital Cost. This methodology is referenced to BC Hydro Interoffice memo (File # 527.1.17).

The unit energy cost estimate of $110/MWh was estimated using the spreadsheet-based model for private sector cost estimates, with specific financial assumptions for a large project. Companies or corporations financing such a project would likely be able to use 100% debt during construction, and only need to book in their equity when the project is nearing completion and the term debt is put in place. The assumption in the model, only activated for Large Hydro projects, was that Debt and Equity will be funded pro-rata during construction, at the D/E ratio. The notable exception is that the initial Development Capital (4% for large projects) will still be funded by 100% Equity.

It is important to emphasize that, with the exception of Peace Site C, financial information contained in 2004 IEP Large Hydro resource options was referenced to studies that were conducted a minimum of 10 years ago, and in some cases up to 20 years ago. Values contained in the 2004 IEP information sheets were escalated from past estimates, and thus reflect the technical, regulatory and market assumptions and methodologies of those times. It is expected that the large hydro project financial estimates used in the 2004 IEP were valid within an order of magnitude, and can be used for broad trade-off and evaluation purposes.

The unit energy cost for this project is estimated to range from $99/MWh to $154/MWh, based on the price uncertainty ranking. Previous studies have estimated as low as $70/MWh, however this estimates has not been confirmed.

PROJECT: **Border Dam**

Resource Category: Hydro - Large Hydro | Level of Study: Feasibility | Region: Selkirk Area

TECHNICAL INFORMATION

Installed Capacity (MW)	275
Average Annual Energy (GWh/year)	1418
Dependable Capacity (MW)	275
Firm Energy (GWh/year)	1336

It is assumed that the capacity provided by large hydro electric projects with storage is 100% dependable for meeting winter peak.

SOCIAL AND ENVIRONMENTAL INFORMATION

Meets BC Hydro Clean Criteria	No
Greenhouse Gas Emission Factor (Tonnes CO2 equivalent/GWh)	0

Atmospheric Emissions (Metric Tonnes/GWh)	SOx	NOx	CO	VOC	PM 10	PM 2.5	Hg
	0	0	0	0	0	0	0

Project Footprint (Hectares)	260

Note: Some footprint aspects have not been estimated specifically.

This project is essentially a run-of-river project on a regulated river system, however, there will be some limited inundation in the Trail area.

There are potentially significant environmental impacts associated with the Border and Murphy Dam projects, most notably on the sturgeon. There is little to no local support for these projects as this is one of the last undammed sections of the Columbia River. There is significant intrinsic value to keeping it in its natural state.

Job Creation

Construction Jobs Created (Person-years)	3500
Permanent Jobs Created (Full time equivalents)	15

Employment information has been estimated based on results for the Murphy Creek large hydro resource option.

PRIVATE SECTOR INVOLVEMENT

Estimated Level of Private Sector Involvement	Primary: 50% to 99%

Large hydro projects would fall on the high end of Primary private sector involvement (i.e. 80-99% private sector involvement) or Private Sector Ownership (i.e. 100% private sector ownership). Large hydro projects may be developed using a variety of development and financing arrangements. In all cases the selected development approach would require a policy decision outside the bounds of BC Hydro's decision making authority. To be conservative, the lower expectation for private sector involvement (primary) was selected, although the project could be 100% private sector owned.

UNCERTAINTY

Development Uncertainty	High

Design well established but potential impact on sturgeon habitat. Public opposition possible.

Price Uncertainty	Medium

Preliminary design study (dated) with project optimized.

REFERENCES

BC Hydro, Value of Electricity, Resource Planning, Corporate and Environmental Affairs, August 1989.

BC Hydro, Lower Columbia Development - Border Project Overview study, Report No. H2258, 1990.

Woodley M., Project Summaries, BC Hydro inter-office memo, File # 527.1.17, July 1987.

PROJECT: **Murphy Creek**

Resource Category: Hydro - Large Hydro | Level of Study: Feasibility | Region: Selkirk Area

PROJECT DESCRIPTION

This project has been included to demonstrate an example of a large hydro option in B.C. that has been studied in the past. However, concerns around environmental, social and economic issues make the development uncertainty for this project high (see rating below).

The proposed Murphy Creek Project would be located about 3 km upstream of the City of Trail on the Columbia River and would develop an average gross head of about 15 m between the project site and the Hugh Keenleyside Dam, some 34 km upstream. The Murphy Creek project would consist of a 27 m high earth-rockfill dam across the river with a powerhouse containing five 55 MW Kaplan units located on the right bank of the river.

The reservoir may cause limited flooding of the Town of Castlegar, and would impact the tailrace of Arrow Lakes Powerplant.

FINANCIAL INFORMATION

Total Capital Cost ($1000s of 2003$)	$982,000
Fixed Operating And Maintenance Cost ($1000s/year)	$4,710
Variable Operating And Maintenance Cost ($/MWh)	$0
Project Life (Years)	70
Project Lead Time (Years)	9
Unit Energy Cost ($/MWh)	$80

Costs from 1986 have been extracted from BC Hydro Interoffice memo (File # 527.1.17) and escalated using Statistics Canada inflation rates (2003$=118.1/76.5 x 1986$). Total Capital Cost does not include Interest During Construction (IDC), Inflation, and Corporate Overhead. Unit energy costs were evaluated as outlined in the Resource Options report. Fixed and Variable Annual Operating and Maintenance Costs were estimated at 0.48% of Total Capital Cost and include Operating and Maintenance at 0.45% and Insurance at 0.03%. Grants and Taxes are not included in O&M costs but are estimated at 1.33% of Total Capital Cost.

Project lead time is estimated to be comprised of 2 years to license, and 7 years for construction.

It is important to emphasize that, with the exception of Peace Site C, financial information contained in 2004 IEP large hydro resource options was referenced to studies that were conducted a minimum of 10 years ago, and in some cases up to 20 years ago. Values contained in the 2004 IEP information sheets were escalated from past estimates, and thus reflect the technical, regulatory and market assumptions and methodologies of those times. It is expected that the large hydro project financial estimates used in the 2004 IEP were valid within an order of magnitude, and can be used for broad trade-off and evaluation purposes.

The unit energy cost for this project is estimated to range from $70/MWh to $110/MWh, based on the price uncertainty ranking. The unit energy cost estimate of $80/MWh was estimated using the spreadsheet-based model for private sector cost estimates, with specific financial assumptions for a large project. Companies or corporations financing such a project would likely be able to use 100% debt during construction, and only need to book in their equity when the project is nearing completion and the term debt is put in place. The assumption in the model, only activated for Large Hydro projects, was that Debt and Equity will be funded pro-rata during construction, at the D/E ratio. The notable exception is that the initial Development Capital (4% for large projects) will still be funded by 100% Equity.

TECHNICAL INFORMATION

Installed Capacity (MW)	275
Average Annual Energy (GWh/year)	1465
Dependable Capacity (MW)	275
Firm Energy (GWh/year)	1350

It is assumed that the capacity provided by large hydro electric projects with storage is 100% dependable for meeting winter peak. Energy and capacity data was quoted from Woodley, M., Project Summaries, 1987.

PROJECT: **Murphy Creek**

Resource Category: Hydro - Large Hydro | Level of Study: Feasibility | Region: Selkirk Area

SOCIAL AND ENVIRONMENTAL INFORMATION

Meets BC Hydro Clean Criteria	No
Greenhouse Gas Emission Factor (Tonnes CO2 equivalent/GWh)	0

Atmospheric Emissions (Metric Tonnes/GWh)	SOx	NOx	CO	VOC	PM 10	PM 2.5	Hg
	0	0	0	0	0	0	0

Project Footprint (Hectares)	190

Note: Some footprint aspects have not been estimated specifically.

The reservoir banks are relatively steep and thus the reservoir would not inundate large areas. However, there are several small areas that would be inundated which are developed and in some cases populated. The river channel is armoured for present river conditions. However, as the water levels rise, there would some some regression of the overburden banks as a result of exposure to wave and current action.

Total footprint figures are beyond the scope of the studies (phase 1 and phase 2) conducted so far for this project.

The most significant impact of this this project will be on the Town of Castlegar:
* There is a significant amount of of low level area subject to submergence.
* Celgar road in the vicinity of the Ferry Ramp will need to be upgraded and relocated.
* The North Castlegar wastewater treatment plant will need to be upgraded or relocated.

For the other communities in the area, the only significant impact is on Balfour and Robson. Broadwater Road requires raising and the Balfour groundwater wells require construction and/or replacement.

There are potentially significant environmental impacts associated with the Border and Murphy Dam projects, most notably on the sturgeon. There is little to no local suppost for these projects as this is one of the last undammed sections of the Columbia River. There is significant intrinsic value to keeping it in its natural state.

Job Creation

Construction Jobs Created (Person-years)	3500
Permanent Jobs Created (Full time equivalents)	15

The construction phase of the Murphy Creek project will require approximately 3500 person years of employment over the 5.5 year construction period. Construction labour force estimates are based on estimates of construction expenditures contained in the Murphy Creek Project, phase 2 report. Permanent employment estimates are extrapolated from similar project on a jobs/project size basis.

PRIVATE SECTOR INVOLVEMENT

Estimated Level of Private Sector Involvement	Primary: 50% to 99%

Large hydro projects would fall on the high end of Primary private sector involvement (i.e. 80-99% private sector involvement) or Private Sector Ownership (i.e. 100% private sector ownership). Large hydro projects may be developed using a variety of development and financing arrangements. In all cases the selected development approach would require a policy decision outside the bounds of BC Hydro's decision making authority. To be conservative, the lower expectation for private sector involvement (primary) was selected, although the project could be 100% private sector owned.

UNCERTAINTY

Development Uncertainty	High

Design well established and few impacts. However, public opposition may be high.

Price Uncertainty	Medium

Preliminary design study (dated) with project optimized.

REFERENCES

Woodley M., Project Summaries, BC Hydro inter-office memo, File # 527.1.17, July 1987.

BC Hydro, Murphy Creek Preliminary Design Study Phase 2, Report No. H1782, 1985.

BC Hydro, Impact of the Murphy Creek Hydroelectric Dam on Municipal Services in the Castlegar Region, Report no N1179, 1981.

PROJECT: **Pumped Storage Opportunities for Vancouver Island**

Resource Category: Hydro - Pumped Storage | Level of Study: Conceptual | Region: Vancouver Island

PROJECT DESCRIPTION

The following summary includes possible pumped storage projects previously identified on Vancouver Island. Pumped storage uses electricity generated during off-peak hours to pump water from a lower elevation reservoir to a higher elevation reservoir. The stored water is then released during peak demand periods and used to turn a reversible pump/turbine generator before returning to the lower reservoir. Approximately 75% of electricity used to pump water is recovered in the generation cycle.

Additional pumped storage schemes have been studied on Vancouver Island. In 1977, BC Hydro identified 43 sites on Vancouver Island. In 2001, these sites were reviewed to estimate which sites could contribute up to 200 MW of storage with the lowest environmental impact. The site options selected to achieve the target 200 MW were as follows:
Shawnigan Lake 200 MW
Comox Lake 200 MW
Strathcona 100 MW

FINANCIAL INFORMATION

Total Capital Cost ($1000s of 2003$)	$617,000
Fixed Operating And Maintenance Cost ($1000s/year)	$6,000
Variable Operating And Maintenance Cost ($/MWh)	Unknown
Project Life (Years)	50
Project Lead Time (Years)	3
Unit Energy Cost ($/MWh)	Unknown

Assumptions made for the calculation of unit energy costs and lake fluctuations are included in the references. Key assumptions are as follows: 95% capacity factor (although may be lower if only required in winter months). Variable Operation and Maintainence costs were not estimated as it would depend on the dispatch (use) of the plant and the cost of energy to pump water back to the storage reservoir. The cost of this energy could be as low as $30/MWh in low load hours.

TECHNICAL INFORMATION

Installed Capacity (MW)	500
Average Annual Energy (GWh/year)	Unknown
Dependable Capacity (MW)	500
Firm Energy (GWh/year)	Unknown

The capacities provided here are cumulated from three projects in the region. It is assumed that the capacity provided by pumped storage is 100% dependable for meeting winter peak.

A pumped storage facility does not create new energy. Pumped storage facilities achieve approximately 75% efficiency between pumping and generation cycles and are thus net energy consumers. The energy consumption would be dependent on the dispatch (usage) of the facility and has not been estimated here. Approximately, 25% of the energy used to pump the water is not regained during the generation cycle, due to equipment efficiencies and hydraulic losses during the pumping and generating cycles.

SOCIAL AND ENVIRONMENTAL INFORMATION

Meets BC Hydro Clean Criteria	Yes
Greenhouse Gas Emission Factor (Tonnes CO2 equivalent/GWh)	0

Atmospheric Emissions (Metric Tonnes/GWh)	SOx	NOx	CO	VOC	PM 10	PM 2.5	Hg
	0	0	0	0	0	0	0

Project Footprint (Hectares)	0

Note: Some footprint aspects have not been estimated specifically.

Job Creation

Construction Jobs Created (Person-years)	Unknown
Permanent Jobs Created (Full time equivalents)	28

PRIVATE SECTOR INVOLVEMENT

Estimated Level of Private Sector Involvement	Primary: 50% to 99%

Pumped storage can be developed using a variety of development and financing arrangements. To be conservative, the lower expectation for private sector involvement (primary, if pumped storage was implemented at a BC Hydro facility) was selected.

UNCERTAINTY

Development Uncertainty	Low

Many sites could be selected with minimum impact and general public acceptance.

Price Uncertainty	Medium

No site specific studies done, but pumped storage consists primarily of equipment and construction costs that are predictable for site parameters.

REFERENCES

BC Hydro 1995 Integrated Electricity Plan, Appendix E, ISSN 1180-2561, October 1995.

Klohn Crippen, Review of Pumped Storage and Sites and Tidal Barrage Development, Vancouver Island, Report No. KC-150 (PP1321), February 2001.

BC Hydro, Green Energy Study for British Columbia - Phase 1: Vancouver Island, September 2001, Report No PSE379.

PROJECT: **Current Planned Resource Smart - Turbine Upgrades**

Resource Category: Resource Smart - Hydro Level of Study: Feasibility Region: All

PROJECT DESCRIPTION

The current Generation Capital Plan (See References below) identifies capital funding for several proposed hydraulic turbine upgrades at eight existing hydroelectric generating plants on the BC Hydro system. These planned turbine upgrades will improve overall generation efficiency resulting in more usable energy production. The turbine upgrade projects are listed as follows:

Ruskin, Units 1&2
Wahleach
GM Shrum, Units 1 to 5
Mica, Units 1&2
Seven Mile, Units 1, 2 and 3
Ash River
John Hart
Strathcona, Units 1and 2

In addition to the above turbine upgrades, an increase in rated capacity for GM Shrum Unit 8 is planned. This increase is made possible by a number of incremental improvements that have been made to this generating unit over the years.

For a description of each of the hydroelectric generating plants above, please refer to Making the Connection (see References below).

FINANCIAL INFORMATION

Total Capital Cost ($1000s of 2003$)	$112,000
Fixed Operating And Maintenance Cost ($1000s/year)	$0
Variable Operating And Maintenance Cost ($/MWh)	Unknown
Project Life (Years)	50
Project Lead Time (Years)	Unknown
Unit Energy Cost ($/MWh)	$22

Unit energy costs were not estimated with the spreadsheet model that was used to estimate other Resource Option unit energy costs. For each project, the Unit Energy Cost (UEC) is calculated as the present value (PV) of Water rentals, OMA and Capital (Loaded or Direct in Real 2003 dollars) divided by the PV of Energy. The unit energy costs for these projects range from $17/MWh to $26/MWh.

The above table provides aggregate data for the 9 projects described above. For individual project data, please see table below.

FACILITY	Capital Cost ($1000s)	Unit Cost of Incremental Energy ($/MWh)
1. Ruskin, Units 1&2	4,301	24.5
2. Wahleach	1,780	18.5
3. GMS, Units 1 to 5	41,371	28.6
4. GMS, Unit 8 Upgrade	3,900	n/a
5. Mica, Units 1&2	25,232	25.1
6. Seven Mile, Units 1, 2 and 3	16,500	18.7
7. Ash River	7,441	25.2
8. John Hart	7,998	21.1
9. Strathcona, Units 1and 2	3,346	27.0

Costs provided above are direct and indirect costs, unloaded.

In the March 2004 IEP portfolio analysis modelling, Resource Smart project costs were characterized using loaded costs that included interest during construction, corporate overhead and inflation. Loading these costs typically add 5 to 10% to the capital cost estimates. Future versions of portfolio modelling would likely use unloaded costs.

PROJECT: **Current Planned Resource Smart - Turbine Upgrades**

Resource Category: Resource Smart - Hydro Level of Study: Feasibility Region: All

TECHNICAL INFORMATION

Installed Capacity (MW)	51
Average Annual Energy (GWh/year)	398
Dependable Capacity (MW)	Unknown
Firm Energy (GWh/year)	Unknown

Dependable capacity and firm energy are unknown at this time and will be evaluated in future.

The above table provides aggregate technical data for the 9 projects described above. For individual project data, please see Table 1 below. The capacity increase identified above is associated with the GM Shrum Unit 8 project. The small increases in rated capacity associated with the turbine upgrade projects, where other components of the generating unit equipment has been or is planned to be uprated, are identified.

FACILITY	Incremental Capacity (MW)	Annual Average Energy (GWh/year)
1. Ruskin, Units 1&2	0	16
2. Wahleach	0	10
3. GMS, Units 1 to 5	0	125
4. GMS, Unit 8 Upgrade	30	0
5. Mica, Units 1&2	8	93
6. Seven Mile, Units 1, 2 and 3	0	81
7. Ash River	6	26
8. John Hart	7	36
9. Strathcona, Units 1and 2	0	11

SOCIAL AND ENVIRONMENTAL INFORMATION

Meets BC Hydro Clean Criteria	Yes
Greenhouse Gas Emission Factor (Tonnes CO2 equivalent/GWh)	0

Atmospheric Emissions (Metric Tonnes/GWh)	SOx	NOx	CO	VOC	PM 10	PM 2.5	Hg
	0	0	0	0	0	0	0

Project Footprint (Hectares)	0

Note: Some footprint aspects have not been estimated specifically.

No additional permanent land is required for these projects, therefore no land impacts are anticipated. Any temporary land requirements at each site during the construction period are ignored.

These projects all meet the definition of clean energy as described in the 2002 Energy Plan for BC.

Job Creation

Construction Jobs Created (Person-years)	Unknown
Permanent Jobs Created (Full time equivalents)	0

No current project-specific data is available on construction jobs. No permanent jobs will be created by these projects.

PRIVATE SECTOR INVOLVEMENT

Estimated Level of Private Sector Involvement	Primary: 50% to 99%

PROJECT: **Current Planned Resource Smart - Turbine Upgrades**

Resource Category: Resource Smart - Hydro Level of Study: Feasibility Region: All

UNCERTAINTY

Development Uncertainty	Low

Prior experience with turbine upgrades indicates low development risk.

Price Uncertainty	Medium

Most projects have been studied to the feasibility level and have low cost risk. Some projects have been studied to the pre-feasibility level and have medium cost risk.

REFERENCES

BC Hydro Resource Smart, Q3 Highlight Report, Period ending 31 January 2004, February 2004.

BC Hydro Resource Smart Inventory Update, Summary, BC Hydro Internal Spreadsheet, March 2001.

BC Hydro, Generation, Capital Plan F2005.

BC Hydro, Making the Connection, Second revision, ISBN 0-7726-4225-7, April 2000.

PROJECT: **Other Resource Smart Opportunities**

Resource Category: Resource Smart - Hydro Level of Study: Pre-feasibility Region: All

PROJECT DESCRIPTION

Additional Resource Smart opportunities may exist beyond those identified in the Generation Capital Plan. These will likely be more difficult to implement than currently planned projects because they have not been studied in much detail. Many involve unit outages at single unit plants, resulting in lost energy, and some require additional approvals from permitting agencies.

Over the next two years, Generation will initiate work to assess the resource inventory and identify new projects in addition to those already planned.

A summary of potential future Resource Smart projects is shown below. The projects are located in several regions, including Kelly/Nicola, Lower Mainland, Peace River, Selkrik and Vancouver Island.

Facility	Project Type
La Joie	Turbine Upgrade
Seton	Turbine Upgrade
Buntzen	Turbine Upgrade
Clowholm	Turbine Upgrade
Ladore	Turbine Upgrade
Puntledge	Turbine Upgrade
Whatshan	Turbine Upgrade
GMS	Tailrace Improvement
Whatshan	Barnes Creek Diversion
Kootenay Canal	Grohman Narrows Improvement
Strathcona	New Unit

An approximate estimate of the potential energy achievable is 168 GWh/year, at an estimated total capital cost of $67 million.

FINANCIAL INFORMATION

Total Capital Cost ($1000s of 2003$)	$67,000
Fixed Operating And Maintenance Cost ($1000s/year)	$0
Variable Operating And Maintenance Cost ($/MWh)	$0
Project Life (Years)	50
Project Lead Time (Years)	Unknown
Unit Energy Cost ($/MWh)	$30

The above values are aggregate information for the projects listed above. The unit energy cost ranges from $14/MWh to $78/MWh.

TECHNICAL INFORMATION

Installed Capacity (MW)	47
Average Annual Energy (GWh/year)	168
Dependable Capacity (MW)	Unknown
Firm Energy (GWh/year)	Unknown

PROJECT: **Other Resource Smart Opportunities**

Resource Category: Resource Smart - Hydro Level of Study: Pre-feasibility Region: All

SOCIAL AND ENVIRONMENTAL INFORMATION

Meets BC Hydro Clean Criteria	Yes
Greenhouse Gas Emission Factor (Tonnes CO2 equivalent/GWh)	0

Atmospheric Emissions (Metric Tonnes/GWh)	SOx	NOx	CO	VOC	PM 10	PM 2.5	Hg
	0	0	0	0	0	0	0

Project Footprint (Hectares)	0

Note: Some footprint aspects have not been estimated specifically.

The land impact is limited to the increased human and equipment traffic in the area around the powerhouse during the upgrade construction period. Resource Smart projects are considered to be clean energy as laid out in the 2002 BC Energy Plan, but not considered to be green energy in the 2004 IEP study.

Job Creation

Construction Jobs Created (Person-years)	30
Permanent Jobs Created (Full time equivalents)	0

Employment data is cumulative and estimated based on results from the Ash Turbine Upgrade resource option.

PRIVATE SECTOR INVOLVEMENT

Estimated Level of Private Sector Involvement	Primary: 50% to 99%

UNCERTAINTY

Development Uncertainty	Medium

The majority of these projects are low cost turbine upgrades with a low to medium development risk.

Price Uncertainty	Medium

The level of study for these Resource Smart projects are at a pre-feasibily to feasibility level, so cost estimates are reasonable but may be outdated or at a high level.

REFERENCES

BC Hydro, Making the Connection, Second revision, ISBN 0-7726-4225-7, April 2000.

BC Hydro, GMS Tailwater Evaluation Study - Agenda for meeting 1 May 2003, May 2003.

Northcott, P., Resource Smart Program - Cost of energy and Financial Benefits, 2003.

BC Hydro, Condition Survey for Ladore Falls Generating Station and Area, Report No. MEP275, March 1997.

Julian Terpstra, Resource Smart Inventory Update - Summary, BC Hydro Internal Spreadsheet, October 2002.

BC Hydro, Kootenay Canal Groham Narrows Improvement Project, Report No. H1635, December 1984.

BC Hydro 1995 Integrated Electricity Plan, Appendix E, ISSN 1180-2561, October 1995.

BC Hydro, Seton Generating Station - Additional Energy Feasibility Study, Report No. MEP68, January 1997.

BC Hydro, Condition Survey for Whatshan Hydroelectric plant, Report No. MEP263, March 1997.

Northcott, P., Resource Smart Program 2003 to 2008, Internal BCH Spreadsheet, September 2003.

PROJECT: **Aberfeldie Redevelopment**

Resource Category: Resource Smart - Hydro Level of Study: Pre-feasibility Region: East Kootenays

PROJECT DESCRIPTION

The existing facilities were constructed in 1922. Components have aged and require repair or replacement. The redevelopment option envisages a larger powerhouse and larger diameter penstocks that would enable more diversion and higher energy generation by using water that is current spilt. The redevelopment will required water license approval. The current Generation Capital Plan (Reference 1 below) identifies capital funding for this project. A description of facilities is provided in Making the Connection (See References below).

FINANCIAL INFORMATION

Total Capital Cost ($1000s of 2003$)	$47,600
Fixed Operating And Maintenance Cost ($1000s/year)	Unknown
Variable Operating And Maintenance Cost ($/MWh)	Unknown
Project Life (Years)	50
Project Lead Time (Years)	3
Unit Energy Cost ($/MWh)	$40

The Unit Energy Cost (UEC) is calculated as the present value (PV) of water rentals, OMA and Capital (Loaded with IDC and OH) in Real 2003 dollars divided by the PV of the incremental energy. The planned in-service date is August 2007.

Portfolio evaluation used a previous cost estimate (loaded with Interest during Construction (IDC) and overhead) of $51,590,000.

In the March 2004 IEP portfolio analysis modelling, Resource Smart project costs were characterized using loaded costs that included interest during construction, corporate overhead and inflaction. Loading these costs typically add 5 to 10% to the capital cost estimates. Future versions of portfolio modelling would likely use unloaded costs.

TECHNICAL INFORMATION

Installed Capacity (MW)	30
Average Annual Energy (GWh/year)	90
Dependable Capacity (MW)	0
Firm Energy (GWh/year)	90

Aberfeldie Re-development is estimated to be a 120 GWh/yr project, with 90 GWh/yr being new energy.

SOCIAL AND ENVIRONMENTAL INFORMATION

Meets BC Hydro Clean Criteria	Yes
Greenhouse Gas Emission Factor (Tonnes CO2 equivalent/GWh)	0

Atmospheric Emissions (Metric Tonnes/GWh)	SOx	NOx	CO	VOC	PM 10	PM 2.5	Hg
	0	0	0	0	0	0	0

Project Footprint (Hectares)	0

Note: Some footprint aspects have not been estimated specifically.

There will be some footprint aspect during the relocation and construction of the new penstock and powerhouse. The final configuration for the option has not been made.

PROJECT: **Aberfeldie Redevelopment**

Resource Category: Resource Smart - Hydro Level of Study: Pre-feasibility Region: East Kootenays

Job Creation

Construction Jobs Created (Person-years)	Unknown
Permanent Jobs Created (Full time equivalents)	Unknown

No employment data was available.

PRIVATE SECTOR INVOLVEMENT

Estimated Level of Private Sector Involvement	Primary: 50% to 99%

UNCERTAINTY

Development Uncertainty	Medium

Price Uncertainty	Medium

The project is in the pre-definition phase. The scope of the project is under study and several options are being considered. The project will require regulatory approval that could impact the cost and the scope of the project.

REFERENCES

BC Hydro Resource Smart Inventory Update, Summary, BC Hydro Internal Spreadsheet, March 2001.

BC Hydro, Making the Connection, Second revision, ISBN 0-7726-4225-7, April 2000.

BC Hydro, Generation, Capital Plan F2005.

BC Hydro Resource Smart, Q3 Highlight Report, Period ending 31 January 2004, February 2004.

PROJECT: **Mica New Unit 5**

Resource Category: Resource Smart - Hydro Level of Study: Pre-feasibility Region: Selkirk Area

PROJECT DESCRIPTION

The project involves the installation of a generating unit at the existing powerhouse at the Mica generating facilities. The project also includes the construction of a capacitor station at the mid-point of 5L71/72 to reliably deliver the power to the grid.

The current Generation Capital Plan does not include capital funding for this project. The need and in-service date for the project are under review in the IEP. A description of Mica facilities is provided in Making the Connection (see References below).

In 2002 Comptroller of Water Rights (CWR) and Environmental Assessment Office (EAO) advised that Mica Units 5 and 6 have BCEAA and Water Act regulatory approvals

This summary assumes that the installation of Unit 5 at Revelstoke precedes installation of Mica Unit 5.

FINANCIAL INFORMATION

Total Capital Cost ($1000s of 2003$)	$120,250
Fixed Operating And Maintenance Cost ($1000s/year)	$1,150
Variable Operating And Maintenance Cost ($/MWh)	$0
Project Life (Years)	50
Project Lead Time (Years)	5
Unit Energy Cost ($/MWh)	Unknown

Costs have been extracted from Inter-office Memo, John Boots to Peter Northcott, March 2003 and escalated to 2003$ from 2002$ using Statistics Canada inflation rates (2003$=118.1/115.3 x 2002$) for hydro electric generating equipment. Capital costs do not include corporate overhead, escalation and interest during construction or cost of associated transmission equipment. Basic operating and maintenance costs were estimated based on 0.48% of non-discounted capital cost. Fixed operating and maintenance cost does not include water licence fees but does include grants in lieu of taxes valued at $244,000.

The unit cost of capacity is $28/kW/year and is calculated as the present value (PV) of water rentals, OMA and Capital (Loaded with IDC and OH) in Real 2003 dollars divided by the PV of the incremental capacity.

Project lead time provided above is years from project approval to in-service date. Timing and lead time for licensing and approval is uncertain. Transmission project lead times are provided in transmission project sheets (Appendix G)..

In the March 2004 IEP portfolio analysis modelling, Resource Smart project costs were characterized using loaded costs that included interest during construction, corporate overhead and inflaction. Loading these costs typically add 5 to 10% to the capital cost estimates. Future versions of portfolio modelling would likely use unloaded costs.

TECHNICAL INFORMATION

Installed Capacity (MW)	450
Average Annual Energy (GWh/year)	50
Dependable Capacity (MW)	400
Firm Energy (GWh/year)	50

Previous Resource Smart information had estimated Mica Unit 5 and Mica Unit 6 to have an installed capacity of 435 MW. Current information provided by Generation indicate an installed, nameplate capacity estimate of 450 MW as shown above.

PROJECT: **Mica New Unit 5**

Resource Category: Resource Smart - Hydro Level of Study: Pre-feasibility Region: Selkirk Area

SOCIAL AND ENVIRONMENTAL INFORMATION

Meets BC Hydro Clean Criteria	Yes
Greenhouse Gas Emission Factor (Tonnes CO2 equivalent/GWh)	0

Atmospheric Emissions (Metric Tonnes/GWh)	SOx	NOx	CO	VOC	PM 10	PM 2.5	Hg
	0	0	0	0	0	0	0

Project Footprint (Hectares)	0

Note: Some footprint aspects have not been estimated specifically.

There will be some footprint impact on previously disturbed ground during construction both at the power facilities and at the capacitor station.

Job Creation

Construction Jobs Created (Person-years)	440
Permanent Jobs Created (Full time equivalents)	Unknown

PRIVATE SECTOR INVOLVEMENT

Estimated Level of Private Sector Involvement	Primary: 50% to 99%

UNCERTAINTY

Development Uncertainty	Low

Projects of this type have been developed by BC Hydro. The technology is well understood. Projects of this size type have recently been completed by BC Hydro.

Price Uncertainty	Medium

The estimate has been updated using indices. A detailed design has not been completed.

REFERENCES

BC Hydro, Making the Connection, Second revision, ISBN 0-7726-4225-7, April 2000.

BC Hydro, Inter-office Memo: John Boots to Peter Northcott, 12 March 2003.

PROJECT: **Mica New Unit 6**

Resource Category: Resource Smart - Hydro Level of Study: Pre-feasibility Region: Selkirk Area

PROJECT DESCRIPTION

The project involves the installation of a generating unit at the existing powerhouse at the Mica generating facilities. The project also includes the construction of a capacitor station at the mid-point of 5L71/72 to reliably deliver the power to the grid.

The current Generation Capital Plan does not include capital funding for this project. The need and in-service date for the project are under review in the IEP. A description of Mica facilities is provided in Making the Connection (Reference 1 below).

In 2002 Comptroller of Water Rights (CWR) and Environmental Assessment Office (EAO) advised that Mica Units 5 and 6 have BCEAA and Water Act regulatory approvals

FINANCIAL INFORMATION

Total Capital Cost ($1000s of 2003$)	$90,240
Fixed Operating And Maintenance Cost ($1000s/year)	$920
Variable Operating And Maintenance Cost ($/MWh)	$0
Project Life (Years)	50
Project Lead Time (Years)	5
Unit Energy Cost ($/MWh)	Unknown

Costs have been extracted from Inter-office Memo, John Boots to Peter Northcott, March 2003, and escalated to 2003$ from 2002$ using Statistics Canada inflation rates (2003$=118.1/115.3 x 2002$) for hydro electric generating equipment. Fixed operating and maintenance cost includes grants in lieu of taxes valued at $262,000.

The unit cost of capacity is $22/kW/year and is calculated as the present value (PV) of water rentals, OMA and Capital (Loaded with IDC and OH) in Real 2003 dollars divided by the PV of the incremental capacity.

Project lead time provided above is years from project approval to in-service date. Timing and lead time for licensing and approval is uncertain. Transmission project lead times are provided in transmission project sheets (Appendix G).

In the March 2004 IEP portfolio analysis modelling, Resource Smart project costs were characterized using loaded costs that included interest during construction, corporate overhead and inflaction. Loading these costs typically add 5 to 10% to the capital cost estimates. Future versions of portfolio modelling would likely use unloaded costs.

TECHNICAL INFORMATION

Installed Capacity (MW)	450
Average Annual Energy (GWh/year)	50
Dependable Capacity (MW)	400
Firm Energy (GWh/year)	50

Previous Resource Smart information had estimated Mica Unit 5 and Mica Unit 6 to have an installed capacity of 435 MW. Current information provided by Generation indicate an installed, nameplate capacity estimate of 450 MW as shown above.

PROJECT: **Mica New Unit 6**

Resource Category: Resource Smart - Hydro Level of Study: Pre-feasibility Region: Selkirk Area

SOCIAL AND ENVIRONMENTAL INFORMATION

Meets BC Hydro Clean Criteria	Yes
Greenhouse Gas Emission Factor (Tonnes CO2 equivalent/GWh)	0

Atmospheric Emissions (Metric Tonnes/GWh)	SOx	NOx	CO	VOC	PM 10	PM 2.5	Hg
	0	0	0	0	0	0	0

Project Footprint (Hectares)	1

Note: Some footprint aspects have not been estimated specifically.

There will be some footprint impact on previously disturbed ground during construction. After completion of construction there will be no footprint impact as the project is wholly bounded by the existing facilities.

Job Creation

Construction Jobs Created (Person-years)	440
Permanent Jobs Created (Full time equivalents)	Unknown

PRIVATE SECTOR INVOLVEMENT

Estimated Level of Private Sector Involvement	Primary: 50% to 99%

UNCERTAINTY

Development Uncertainty	Low

Projects of this type have been developed by BC Hydro. The technology is well understood. Projects of this size type have recently been completed by BC Hydro.

Price Uncertainty	Medium

The level of study is pre-definition and therefore the estimates reflect that level of study effort.

REFERENCES

BC Hydro, Inter-office Memo: John Boots to Peter Northcott, 12 March 2003.

BC Hydro, Making the Connection, Second revision, ISBN 0-7726-4225-7, April 2000.

PROJECT: **Revelstoke New Unit 5**

Resource Category: Resource Smart - Hydro | Level of Study: Design | Region: Selkirk Area

PROJECT DESCRIPTION

The project involves the installation of a generating unit and completion of the penstock at the existing powerhouse at the Revelstoke generating facilities.

The current Generation Capital Plan does not include capital funding for this project. The need and in-service date for the project are under review in the IEP. A description of Revelstoke facilities is provided in Making the Connection (see References below).

FINANCIAL INFORMATION

Total Capital Cost ($1000s of 2003$)	$105,400
Fixed Operating And Maintenance Cost ($1000s/year)	$960
Variable Operating And Maintenance Cost ($/MWh)	$0
Project Life (Years)	50
Project Lead Time (Years)	4
Unit Energy Cost ($/MWh)	Unknown

Costs have been extracted from Inter-office Memo, John Boots to Peter Northcott, March 2003 and escalated to 2003$ from 2002$ using Statistics Canada inflation rates (2003$=118.1/115.3 x 2002$) for hydro electric generating equipment. All costs are referenced from Revelstoke 5 Business Case and include grants in lieu of taxes valued at $305,000.

The unit cost of capacity is $20/kW/year and is calculated as the present value (PV) of water rentals, OMA and Capital (Loaded with IDC and OH) in Real 2003 dollars divided by the PV of the incremental capacity.

Project lead time provided above is years from project approval to in-service date. Timing and lead time for licensing and approval is uncertain. Transmission project lead times are provided in transmission project sheets (Appendix G).

In the March 2004 IEP portfolio analysis modelling, Resource Smart project costs were characterized using loaded costs that included interest during construction, corporate overhead and inflaction. Loading these costs typically add 5 to 10% to the capital cost estimates. Future versions of portfolio modelling would likely use unloaded costs.

TECHNICAL INFORMATION

Installed Capacity (MW)	500
Average Annual Energy (GWh/year)	60
Dependable Capacity (MW)	480
Firm Energy (GWh/year)	60

SOCIAL AND ENVIRONMENTAL INFORMATION

Meets BC Hydro Clean Criteria	Yes
Greenhouse Gas Emission Factor (Tonnes CO2 equivalent/GWh)	0

Atmospheric Emissions (Metric Tonnes/GWh)	SOx	NOx	CO	VOC	PM 10	PM 2.5	Hg
	0	0	0	0	0	0	0

Project Footprint (Hectares)	0

Note: Some footprint aspects have not been estimated specifically.

There will be some footprint impact on previously disturbed ground during construction. After completion of construction there will be no footprint impact as the project is wholly bounded by the existing facilities.

Job Creation

Construction Jobs Created (Person-years)	300
Permanent Jobs Created (Full time equivalents)	0

PRIVATE SECTOR INVOLVEMENT

Estimated Level of Private Sector Involvement	Primary: 50% to 99%

UNCERTAINTY

Development Uncertainty	Low

Projects of this type have been developed by BC Hydro. The technology is well understood. Projects of this size type have recently been completed by BC Hydro.

Price Uncertainty	Low

Considerable effort has been expended during the 1990's to advance the design and environmental review of this project. Pricing is based in part from competitive bids for the generating unit that makes up the largest portion of the project cost.

REFERENCES

BC Hydro, Making the Connection, Second revision, ISBN 0-7726-4225-7, April 2000.

BC Hydro, Inter-office Memo: John Boots to Peter Northcott, 12 March 2003.

PROJECT: **Revelstoke New Unit 6**

Resource Category: Resource Smart - Hydro | Level of Study: Design | Region: Selkirk Area

PROJECT DESCRIPTION

The project involves the installation of a generating unit and completion of the penstock at the existing powerhouse at the Revelstoke generating facilities.

The current Generation Capital Plan does not include capital funding for this project. The need and in-service date for the project are under review in the IEP. A description of Revelstoke facilities is provided in Making the Connection (see References below).

FINANCIAL INFORMATION

Total Capital Cost ($1000s of 2003$)	$103,450
Fixed Operating And Maintenance Cost ($1000s/year)	$900
Variable Operating And Maintenance Cost ($/MWh)	$0
Project Life (Years)	50
Project Lead Time (Years)	4
Unit Energy Cost ($/MWh)	Unknown

Costs have been extracted Inter-office Memo, John Boots to Peter Northcott, March 2003 and escalated to 2003$ from 2002$ using Statistics Canada inflation rates (2003$=118.1/115.3 x 2002$). Average operating and maintenance costs were estimated based on 0.48% of capital cost. Fixed operating and maintenance costs include grants in lieu of taxes valued at $264,000.

The unit cost of capacity is $18/kW/year and is calculated as the present value (PV) of water rentals, OMA and Capital (Loaded with IDC and OH) in Real 2003 dollars divided by the PV of the incremental capacity.

Project lead time provided above is years from project approval to in-service date. Timing and lead time for licensing and approval is uncertain. Transmission project lead times are provided in transmission project sheets (Appendix G).

In the March 2004 IEP portfolio analysis modelling, Resource Smart project costs were characterized using loaded costs that included interest during construction, corporate overhead and inflaction. Loading these costs typically add 5 to 10% to the capital cost estimates. Future versions of portfolio modelling would likely use unloaded costs.

TECHNICAL INFORMATION

Installed Capacity (MW)	500
Average Annual Energy (GWh/year)	60
Dependable Capacity (MW)	460
Firm Energy (GWh/year)	60

Previous Resource Smart information had estimated Revelstoke 6 to have a dependable capacity of 460 MW, as shown above and used in Portfolio Modelling. Current information from Generation indicates a dependable capacity estimate of 480 MW.

SOCIAL AND ENVIRONMENTAL INFORMATION

Meets BC Hydro Clean Criteria	Yes
Greenhouse Gas Emission Factor (Tonnes CO2 equivalent/GWh)	0

Atmospheric Emissions (Metric Tonnes/GWh)	SOx	NOx	CO	VOC	PM 10	PM 2.5	Hg
	0	0	0	0	0	0	0

Project Footprint (Hectares)	0

Note: Some footprint aspects have not been estimated specifically.

There will be some footprint impact on previously disturbed ground during construction. After completion of construction there will be no footprint impact as the project is wholly bounded by the existing facilities.

Job Creation

Construction Jobs Created (Person-years)	300
Permanent Jobs Created (Full time equivalents)	Unknown

PRIVATE SECTOR INVOLVEMENT

Estimated Level of Private Sector Involvement	Primary: 50% to 99%

UNCERTAINTY

Development Uncertainty	Low

Projects of this type have been developed by BC Hydro. The technology is well understood. Projects of this size type have recently been completed by BC Hydro.

Price Uncertainty	Low

Considerable effort has been expended during the 1990's to advance the design and environmental review of this project. Pricing is based in part from competitive bids for the generating unit that makes up the largest portion of the project cost.

REFERENCES

BC Hydro 1995 Integrated Electricity Plan, Appendix E, ISSN 1180-2561, October 1995.

BC Hydro, Inter-office Memo: John Boots to Peter Northcott, 12 March 2003.

BC Hydro, Revelstoke 5: Business Case, January 1995.

BC Hydro, Making the Connection, Second revision, ISBN 0-7726-4225-7, April 2000.

PROJECT: **Burrard Generating Station - Immediate Shutdown.**

Resource Category: Resource Smart - Natural Gas | Level of Study: Feasibility | Region: Lower Mainland

PROJECT DESCRIPTION

The Burrard Generating Station (BGS) is a 912.5 MW conventional natural gas fired generating facility located in the Lower Mainland. This resource option describes the permanent shutdown of the Burrard Generating Facility.

In November 2002 the BC Provincial Government announced a technical review of the future of BGS as part of its Energy Plan. This technical review is scheduled to complete at the end of 2003, and the findings of the Review Committee may affect the options for Burrard presented in the 2004 Integrated Electricity Plan.

Shutdown of Burrard is assumed to result in the removal of its generating capacity from the system, which would mean the loss of the Base Case included in the Demand Supply Balance portion of the IEP. Please refer to Part 2 of the IEP Report for a description of these Base Case assumptions.

Complete "immediate" shutdown of Burrard would take likely place over a four to five year time frame due of the necessity of Burrard to operate for VAR transmission support.

FINANCIAL INFORMATION

Total Capital Cost ($1000s of 2003$)	$15,000
Fixed Operating And Maintenance Cost ($1000s/year)	$2,250
Variable Operating And Maintenance Cost ($/MWh)	$7
Project Life (Years)	4
Project Lead Time (Years)	Unknown
Unit Energy Cost ($/MWh)	Unknown

The capital cost estimate of $15 million was provided by Compass Resource Management September 25, 2003 and was assumed to be 2003$. This capital cost includes building removal and disposal (note that existing buildings are suspected of contamination) and site capping (basic landscaping). Costs do not include substation removal or site remediation, if necessary.

Fixed and Variable Operating and Maintenance costs for the 4 to 5 years of operation after “shutdown” for VAR support purposes, have been extracted from the Compass Resource Management table provided to BCH Engineering September 8, 2003. These O&M costs have been included in the database but should be modelled over a limited time period only, until VAR support is replaced by alternate transmission or generation sources.

TECHNICAL INFORMATION

Installed Capacity (MW)	0
Average Annual Energy (GWh/year)	0
Dependable Capacity (MW)	0
Firm Energy (GWh/year)	0

Over the past 20 years, BGS has on average generated a maximum and minimum average annual energy of 3,740 GWh/yr and 2,421 GWh/yr respectively. The cumulative 20-year total for energy generated at Burrard Generating Station is 48,417 GWh.

PROJECT: **Burrard Generating Station - Immediate Shutdown.**

Resource Category: Resource Smart - Natural Gas | Level of Study: Feasibility | Region: Lower Mainland

SOCIAL AND ENVIRONMENTAL INFORMATION

Meets BC Hydro Clean Criteria	N/A
Greenhouse Gas Emission Factor (Tonnes CO2 equivalent/GWh)	0

Atmospheric Emissions (Metric Tonnes/GWh)	SOx	NOx	CO	VOC	PM 10	PM 2.5	Hg
	0	0	0	0	0	0	0

Project Footprint (Hectares)	0

Note: Some footprint aspects have not been estimated specifically.

The buildings on site at BGS contain significant amounts of asbestos and therefore would be removed and disposed of appropriately as a part of the shutdown. The BGS Site is located adjacent to Imperial Oil Company Limited's major oil refinery site that is known to have serious subsurface petroleum contamination issues. It is possible that environmental remediation of these two sites would be conducted as a single project and therefore Compass Resource management has not included site remediation costs aspart of the scope of this project.

Job Creation

Construction Jobs Created (Person-years)	Unknown
Permanent Jobs Created (Full time equivalents)	Unknown

No data on employment was available.

PRIVATE SECTOR INVOLVEMENT

Estimated Level of Private Sector Involvement	Primary: 50% to 99%

UNCERTAINTY

Development Uncertainty	Medium

Until results from the Burrard MLA (Members of the Legislative Assemby) Review are available the development uncertainty of this project is estimated as medium.

Price Uncertainty	High

Shutdown does not currently include costs for full decommissioning and remediation, which are unknown, and may be high.

REFERENCES

Compass Resource Management, Burrard Alternative Financial Spreadsheet for Burrard Thermal Options Committee, Provided to BC Hydro 08 September 2003.

National Pollutant Release Inventory (NPRI) Report, May 2003.

PROJECT: **Burrard Repowering 1400MW - two 2x1 Gseries**

Resource Category: Resource Smart - Natural Gas | Level of Study: Feasibility | Region: Lower Mainland

PROJECT DESCRIPTION

The Burrard Generating Station (BGS) is a 950 MW conventional natural gas fired generating facility located in the Lower Mainland. Repowering would increase the efficiency of Burrard, therefore reducing operating costs and emissions (per GWh of power production).

This resource option involves the repowering of both sides of the plant with two 2-on-1 G-series (M501F) combustion turbines and one steam turbine to form the combined cycle module. Each side would contain one module and the repowered plant would have a total firm capacity of 1400 MW.

In November 2002 the BC Provincial Government announced a technical review of the future of BGS as part of its Energy Plan. This technical review is scheduled to complete at the end of 2003, and the findings of the Review Committee may affect the options for Burrard presented in the 2004 Integrated Electricity Plan.

This summary is not incremental to the Burrard base case as presented in Volume 2: Demand Supply Balance.

FINANCIAL INFORMATION

Total Capital Cost ($1000s of 2003$)	$1,060,000
Fixed Operating And Maintenance Cost ($1000s/year)	$12,260
Variable Operating And Maintenance Cost ($/MWh)	$4
Project Life (Years)	20
Project Lead Time (Years)	5
Unit Energy Cost ($/MWh)	Unknown

Costs have been escalated to 2003$ from 2002$ using inflation rates provided by BC Hydro Engineering, Estimating and Scheduling group (2003$=127.4/124.7 x 2002$). Total Capital Cost includes Direct Supply and Install, Indirects and Engineering, Interest During Construction & Overhead. Total Capital Cost also includes the incorporation of Selective Catalytic Reduction (SCR) technology which reduces the plant's NOx emissions by up to 90%. The capital cost estimates assumes a $150 million value in the existing site, infrastructure and permits, versus developing a similar gas fired plant at a greenfield site.

Unit energy costs for thermal resource options are not estimated in the database because the cost depends largely on the market price of fuel, which varies over time. In addition, for thermal resource where BC Hydro has the ability to adjust the dispatch depending on the market fuel price, operation & maintenance costs would vary over time based on the rate of plant usage. Thus, unit energy costs for thermal resources are calculated as part of the Portfolio Evaluation modelling and scenario analysis to account for these forecastable variables.

TECHNICAL INFORMATION

Installed Capacity (MW)	1400
Average Annual Energy (GWh/year)	11200
Dependable Capacity (MW)	1360
Firm Energy (GWh/year)	10960

The repowered plant will be available for generation for 8000 hours/yr (~700 hours of shutdown).

PROJECT: **Burrard Repowering 1400MW - two 2x1 Gseries**

Resource Category: Resource Smart - Natural Gas | Level of Study: Feasibility | Region: Lower Mainland

SOCIAL AND ENVIRONMENTAL INFORMATION

Meets BC Hydro Clean Criteria	No
Greenhouse Gas Emission Factor (Tonnes CO2 equivalent/GWh)	350

Atmospheric Emissions (Metric Tonnes/GWh)	SOx	NOx	CO	VOC	PM 10	PM 2.5	Hg
	0	0.05	0.06	0.01	0.03	Unknown	0

Project Footprint (Hectares)	0

Note: Some footprint aspects have not been estimated specifically.

Small quantities of ammonia are also emitted associated with the use of selective catalytic reduction (SCR) technology to reduce NOx. Although ammonia is not classified as a greenhouse gas the ammonia emission is usually regulated to a concentration of 7 mg/m3.

Opacity, which is a measure of the visible plume of emission gasses exhausted by the facility, is usually regulated to a opacity measure of less than 10%.

The 1400 MW repowered combined cycle plant would be contained within the footprint of the existing 950 MW plant.

No new road or transmission will be required since this is an upgrade project.

The project would lower two of the main emissions currently regulated for the existing plant. Cooling water emissions would be reduced from the current limit of 1.7 million cubic meters per day and lower NOx, which is currently limited to the equivalent of approximately 2 tonnes per day.

Job Creation

Construction Jobs Created (Person-years)	700
Permanent Jobs Created (Full time equivalents)	90

The project construction time will consist of 6 months demolition followed by 24 months of construction on each 700MW combined cycle module. It is likely that construction of each 700 MW module would be staggered about twelve months apart. Operations jobs figures includes required maintenance jobs for major overhauls.

The permanent job numbers are total jobs at the Burrard site, and are not incremental to existing jobs.

PRIVATE SECTOR INVOLVEMENT

Estimated Level of Private Sector Involvement	Primary: 50% to 99%

UNCERTAINTY

Development Uncertainty	High

Preliminary comments from the Burrard MLA (Members of the Legislative Assemby) Review committee indicate that this is a least preffered option.

Price Uncertainty	Low

This option includes standard proven equipement and has had site specific studies.

REFERENCES

Calder, P., BC Hydro Burrard Upgrade Project Files, 2003.

PROJECT: **Burrard Repowering 500MW - one 2x1 Fseries**

Resource Category: Resource Smart - Natural Gas | Level of Study: Feasibility | Region: Lower Mainland

PROJECT DESCRIPTION

The Burrard Generating Station (BGS) is a 950 MW conventional natural gas fired generating facility located in the Lower Mainland. Repowering would increase the efficiency of Burrard, therefore reducing operating costs and emissions on a per GWh of power production basis.

This resource option involves the repowering of the three units on the east side of the plant with a two-on-one F-series (M502F) combined cycle unit. The three units on the west side of the plant would continue to operate during construction. After construction, the west side units would be used for voltage support only. The repowered plant would have a total firm capacity of 500 MW (the current firm capacity is 900 MW).

In November 2002 the BC Provincial Government announced a technical review of the future of BGS as part of its Energy Plan. This technical review is scheduled to complete at the end of 2003, and the findings of the Review Committee may affect the options for Burrard presented in the 2004 Integrated Electricity Plan.

This summary is not incremental to the Burrard base case as presented in Volume 2: Demand Supply Balance.

FINANCIAL INFORMATION

Total Capital Cost ($1000s of 2003$)	$390,000
Fixed Operating And Maintenance Cost ($1000s/year)	$8,173
Variable Operating And Maintenance Cost ($/MWh)	$5
Project Life (Years)	20
Project Lead Time (Years)	4
Unit Energy Cost ($/MWh)	Unknown

Costs have been escalated to 2003$ from 2002$ using inflation rates provided by BC Hydro Engineering, Estimating and Scheduling group (2003$=127.4/124.7 x 2002$). Total Capital Cost includes Direct Supply and Install, Indirects and Engineering, Interest During Construction & Overhead. Total Capital Cost also includes the incorporation of Selective Catalytic Reduction (SCR) technology which reduces the plant's NOx emissions by up to 90%. The capital cost estimates assumes a $150 million value in the existing site, infrastructure and permits, versus developing a similar gas fired plant at a greenfield site.

Unit energy costs for thermal resource options are not estimated in the database because the cost depends largely on the market price of fuel, which varies over time. In addition, for thermal resource where BC Hydro has the ability to adjust the dispatch depending on the market fuel price, operation & maintenance costs would vary over time based on the rate of plant usage. Thus, unit energy costs for thermal resources are calculated as part of the Portfolio Evaluation modelling and scenario analysis to account for these forecastable variables.

TECHNICAL INFORMATION

Installed Capacity (MW)	500
Average Annual Energy (GWh/year)	4000
Dependable Capacity (MW)	485
Firm Energy (GWh/year)	3900

The repowered plant will be available for generation for 8000 hours/yr (~700 hours of shutdown).

PROJECT: **Burrard Repowering 500MW - one 2x1 Fseries**

Resource Category: Resource Smart - Natural Gas | Level of Study: Feasibility | Region: Lower Mainland

SOCIAL AND ENVIRONMENTAL INFORMATION

Meets BC Hydro Clean Criteria	No
Greenhouse Gas Emission Factor (Tonnes CO2 equivalent/GWh)	350

Atmospheric Emissions (Metric Tonnes/GWh)	SOx	NOx	CO	VOC	PM 10	PM 2.5	Hg
	0	0.05	0.06	0.01	0.03	Unknown	0

Project Footprint (Hectares)	0

Note: Some footprint aspects have not been estimated specifically.

Small quantities of ammonia are also emitted associated with the use of selective catalytic reduction (SCR) technology to reduce NOx. Although ammonia is not classified as a greenhouse gas the ammonia emission is usually regulated to a concentration of 7 mg/m3.

Opacity which is a measure of the visible plume of emission gasses exhausted by the facility is usually regulated to a opacity measure of less than 10%.

No new road or transmission will be required since this is an upgrade project.

The project uses 60% of existing cooling water permit allowances of 620 million cubic meters per year.

Job Creation

Construction Jobs Created (Person-years)	350
Permanent Jobs Created (Full time equivalents)	50

For this project, roughly 23 of the 50 Operation jobs created will be maintenance jobs on a contract basis. The project construction time will consist of 6 months demolition followed by 24 months of construction.

The permanent job numbers are total jobs at the Burrard site, and are not incremental to existing jobs.

PRIVATE SECTOR INVOLVEMENT

Estimated Level of Private Sector Involvement	Primary: 50% to 99%

UNCERTAINTY

Development Uncertainty	Medium

Until results from the Burrard MLA (Members of the Legislative Assemby) Review are available the development uncertainty of this project is estimated as medium.

Price Uncertainty	Low

This option includes standard proven equipement and has had site specific studies.

REFERENCES

Calder, P., BC Hydro Burrard Upgrade Project Files, 2003.

PROJECT: **Burrard Repowering 500MW - second 2x1 Fseries**

Resource Category: Resource Smart - Natural Gas | Level of Study: Feasibility | Region: Lower Mainland

PROJECT DESCRIPTION

The Burrard Generating Station (BGS) is a 950 MW conventional natural gas fired generating facility located in the Lower Mainland. Repowering would increase the efficiency of Burrard, therefore reducing operating costs and emissions on a per GWh of power production basis.

This resource option involves the repowering of the three units on the west side of the plant with a two-on-one F-series (M502F) combined cycle unit. The repowered plant would have a total firm capacity of 500 MW (the current firm capacity is 900 MW).

In November 2002 the BC Provincial Government announced a technical review of the future of BGS as part of its Energy Plan. This technical review is scheduled to complete at the end of 2003, and the findings of the Review Committee may affect the options for Burrard presented in the 2004 Integrated Electricity Plan.

This summary is not incremental to the Burrard base case as presented in Volume 2: Demand Supply Balance.

FINANCIAL INFORMATION

Total Capital Cost ($1000s of 2003$)	$540,000
Fixed Operating And Maintenance Cost ($1000s/year)	$8,173
Variable Operating And Maintenance Cost ($/MWh)	$5
Project Life (Years)	20
Project Lead Time (Years)	4
Unit Energy Cost ($/MWh)	Unknown

Costs have been escalated to 2003$ from 2002$ using inflation rates provided by BC Hydro Engineering, Estimating and Scheduling group (2003$=127.4/124.7 x 2002$). Total Capital Cost includes Direct Supply and Install, Indirects and Engineering, Interest During Construction & Overhead. Total Capital Cost also includes the incorporation of Selective Catalytic Reduction (SCR) technology which reduces the plant's NOx emissions by up to 90%. The capital cost estimate does not include a price reduction for existing site, infrastructure and permits, as this $150 million saving was allocated to the first 500 MW plant. An alternative approach to allocating this cost saving would be to split the saving between the two plants, or allocate a second $150 million saving to the second plant. Each approach requires further evaluation.

Unit energy costs for thermal resource options are not estimated in the database because the cost depends largely on the market price of fuel, which varies over time. In addition, for thermal resource where BC Hydro has the ability to adjust the dispatch depending on the market fuel price, operation & maintenance costs would vary over time based on the rate of plant usage. Thus, unit energy costs for thermal resources are calculated as part of the Portfolio Evaluation modelling and scenario analysis to account for these forecastable variables.

TECHNICAL INFORMATION

Installed Capacity (MW)	500
Average Annual Energy (GWh/year)	4000
Dependable Capacity (MW)	485
Firm Energy (GWh/year)	3900

The repowered plant will be available for generation for 8000 hours/yr (~700 hours of shutdown).

PROJECT: **Burrard Repowering 500MW - second 2x1 Fseries**

Resource Category: Resource Smart - Natural Gas | Level of Study: Feasibility | Region: Lower Mainland

SOCIAL AND ENVIRONMENTAL INFORMATION

Meets BC Hydro Clean Criteria	No
Greenhouse Gas Emission Factor (Tonnes CO2 equivalent/GWh)	350

Atmospheric Emissions (Metric Tonnes/GWh)	SOx	NOx	CO	VOC	PM 10	PM 2.5	Hg
	0	0.05	0.06	0.01	0.03	Unknown	0

Project Footprint (Hectares)	0

Note: Some footprint aspects have not been estimated specifically.

Small quantities of ammonia are also emitted associated with the use of selective catalytic reduction (SCR) technology to reduce NOx. Although ammonia is not classified as a greenhouse gas the ammonia emission is usually regulated to a concentration of 7 mg/m3.

Opacity which is a measure of the visible plume of emission gasses exhausted by the facility is usually regulated to a opacity measure of less than 10%.

No new road or transmission will be required since this is an upgrade project.

The project uses 60% of existing cooling water permit allowances of 620 million cubic meters per year.

Job Creation

Construction Jobs Created (Person-years)	350
Permanent Jobs Created (Full time equivalents)	50

For this project, roughly 23 of the 50 Operation jobs created will be maintenance jobs on a contract basis. The project construction time will consist of 6 months demolition followed by 24 months of construction.

The permanent job numbers are total jobs at the Burrard site, and are not incremental to existing jobs.

PRIVATE SECTOR INVOLVEMENT

Estimated Level of Private Sector Involvement	Primary: 50% to 99%

UNCERTAINTY

Development Uncertainty	Medium

Until results from the Burrard MLA (Members of the Legislative Assemby) Review are available the development uncertainty of this project is estimated as medium.

Price Uncertainty	Low

This option includes standard proven equipement and has had site specific studies.

REFERENCES

Calder, P., BC Hydro Burrard Upgrade Project Files, 2003.

PROJECT: **Burrard Repowering 800MW - one 3x1 Fseries**

Resource Category: Resource Smart - Natural Gas | Level of Study: Feasibility | Region: Lower Mainland

PROJECT DESCRIPTION

The Burrard Generating Station (BGS) is a 950 MW conventional natural gas fired generating facility located in the Lower Mainland. Repowering would increase the efficiency of Burrard, therefore reducing operating costs and emissions (per GWh of power production).

This resource option involves the repowering of the three units on the east side of the plant with a three-on-one F-series (M501F) combined cycle unit. The three units on the west side of the plant would continue to operate during construction. After construction, the west side units would be used for voltage support only. The repowered plant would have a total firm capacity of 800 MW (the current firm capacity is 900 MW).

In November 2002 the BC Provincial Government announced a technical review of the future of BGS as part of its Energy Plan. This technical review is scheduled to complete at the end of 2003, and the findings of the Review Committee may affect the options for Burrard presented in the 2004 Integrated Electricity Plan.

This summary is not incremental to the Burrard base case as presented in Volume 2: Demand Supply Balance.

FINANCIAL INFORMATION

Total Capital Cost ($1000s of 2003$)	$550,000
Fixed Operating And Maintenance Cost ($1000s/year)	$9,195
Variable Operating And Maintenance Cost ($/MWh)	$5
Project Life (Years)	20
Project Lead Time (Years)	4
Unit Energy Cost ($/MWh)	Unknown

Costs have been escalated to 2003$ from 2002$ using inflation rates provided by BC Hydro Engineering, Estimating and Scheduling group (2003$=127.4/124.7 x 2002$). Total Capital Cost includes Direct Supply and Install, Indirects and Engineering, Interest During Construction & Overhead. Total Capital Cost also includes the incorporation of Selective Catalytic Reduction (SCR) technology which reduces the plant's NOx emissions by up to 90%.

Unit energy costs for thermal resource options are not estimated in the database because the cost depends largely on the market price of fuel, which varies over time. In addition, for thermal resource where BC Hydro has the ability to adjust the dispatch depending on the market fuel price, operation & maintenance costs would vary over time based on the rate of plant usage. Thus, unit energy costs for thermal resources are calculated as part of the Portfolio Evaluation modelling and scenario analysis to account for these forecastable variables.

TECHNICAL INFORMATION

Installed Capacity (MW)	800
Average Annual Energy (GWh/year)	6400
Dependable Capacity (MW)	776
Firm Energy (GWh/year)	6300

The repowered plant will be available for generation for 8000 hours/yr (~700 hours of shutdown).

PROJECT: **Burrard Repowering 800MW - one 3x1 Fseries**

Resource Category: Resource Smart - Natural Gas | Level of Study: Feasibility | Region: Lower Mainland

SOCIAL AND ENVIRONMENTAL INFORMATION

Meets BC Hydro Clean Criteria	No
Greenhouse Gas Emission Factor (Tonnes CO2 equivalent/GWh)	350

Atmospheric Emissions (Metric Tonnes/GWh)	SOx	NOx	CO	VOC	PM 10	PM 2.5	Hg
	0	0.05	0.06	0.01	0.03	Unknown	0

Project Footprint (Hectares)	0

Note: Some footprint aspects have not been estimated specifically.

Small quantities of ammonia are also emitted associated with the use of selective catalytic reduction (SCR) technology to reduce NOx. Although ammonia is not classified as a greenhouse gas the ammonia emission is usually regulated to a concentration of 7 mg/m3.

Opacity which is a measure of the visible plume of emission gasses exhausted by the facility is usually regulated to a opacity measure of less than 10%.

Note: Any field left blank in the atmospheric emission boxes represent a field that is not applicable to this project.

No new road or transmission will be required since this is an upgrade project.

The project uses 60% of existing cooling water permit allowances of 620 million cubic meters per year.

Job Creation

Construction Jobs Created (Person-years)	500
Permanent Jobs Created (Full time equivalents)	70

The project construction time will consist of 6 months demolition followed by 24 months of construction. The 70 Operation jobs created includes Maintenance jobs on a contract basis.

The permanent job numbers are total jobs at the Burrard site, and are not incremental to existing jobs.

PRIVATE SECTOR INVOLVEMENT

Estimated Level of Private Sector Involvement	Primary: 50% to 99%

UNCERTAINTY

Development Uncertainty	Medium

Until results from the Burrard MLA (Members of the Legislative Assemby) Review are available the development uncertainty of this project is estimated as medium.

Price Uncertainty	Low

This option includes standard proven equipement and has had site specific studies.

REFERENCES

Calder, P., BC Hydro Burrard Upgrade Project Files, 2003.