SITE C CLEAN ENERGY PROJECT:
BUSINESS CASE SUMMARY

UPDATED MAY 2014

SITE C | CLEAN ENERGY PROJECT

BC hydro
FOR GENERATIONS

A HERITAGE BUILT FOR GENERATIONS

Clean, abundant electricity has been key to British Columbia's economic prosperity and quality of life for generations.

From the time BC Hydro was created more than 50 years ago, it undertook some of the most ambitious hydroelectric construction projects in the world. These projects were advanced under the historic "Two Rivers Policy" that sought to harness the hydroelectric potential of the Peace and Columbia rivers and build the provincial economy.

Over time, BC Hydro's hydroelectric capacity grew from about 500 megawatts (MW) in 1961 to several times that in the late 1980s. Generations of residential, commercial and industrial customers in B.C. have benefited from these historical investments in hydroelectric power.

Some of the projects built during those years include:

- 1967: Completion of the W.A.C. Bennett Dam
- 1968: Hugh Keenleyside Dam constructed
- 1969: The fourth and fifth generating units at G.M. Shrum Generating Station are placed into service
- 1970: The first 500-kilovolt transmission system is complete
- 1973: The Mica Dam is declared operational
- 1979: The first generating unit at the Seven Mile generating station is placed into service
- 1980: The tenth and final generating unit at G.M. Shrum Generating Station begins operation
- 1980: The Peace Canyon Dam and Generating Station are completed
- 1984: The Cathedral Square Substation opens in downtown Vancouver
- 1985: The Revelstoke Dam and Generation Station is officially opened

B.C. became recognized as an attractive place to invest – in large part due to the abundance of affordable electricity. The provincial economy grew alongside of, and as a result of, BC Hydro investments in hydroelectric power. Known as BC Hydro's "Heritage Assets," these facilities help to provide an electricity supply to British Columbians that is more than 90 per cent clean – an achievement that few jurisdictions in the world can claim.

Today, the electricity system continues to be the backbone of B.C.'s economy and our quality of life, serving approximately 1.9 million customers throughout the province.

POWERING OUR FUTURE

As impressive as British Columbia's hydroelectric heritage is, it will not be enough to meet the electricity needs of future generations.

Since the 1980s, when BC Hydro's last new major hydroelectric facility was built, the province's population has grown by more than 1.5 million people. Along with this population increase, B.C.'s economy has expanded, bringing new businesses, residences and industrial activities.

As our province and our economy continue to grow, so will our demand for electricity. Current forecasts show that demand in B.C. is expected to increase by approximately 40 per cent over the next 20 years, driven by a projected population increase of more than one million residents, and continued economic expansion. B.C.'s emerging liquefied natural gas (LNG) industry could further increase electricity demand.

BC Hydro is planning to meet 78 per cent of future load growth through conservation, the first and best option to meet electricity demand. In addition, BC Hydro is investing $6 billion over the next three years to upgrade the capacity, safety and reliability of its aging facilities. However, even these important investments will not be sufficient to meet future need.

To meet long-term electricity demand, BC Hydro is proposing to build an additional hydroelectric generating facility that will provide clean and renewable power to households, businesses and industrial customers for more than 100 years.

The Site C Clean Energy Project (Site C) would be a third dam on the Peace River that would optimize BC Hydro's two existing heritage assets upstream and develop the hydroelectric potential of the Peace River. Once built, the project would provide 1,100 MW of capacity and 5,100 gigawatt hours (GWh) of energy per year – enough to power the equivalent of about 450,000 homes per year in B.C.

First identified in the late 1950s, the Site C project was originally proposed in the early 1980s, and was explored again in the 1990s. Had the project been built when first proposed decades ago, the energy produced would have long since been supplying power to meet the electricity needs of our growing province.

With Site C, BC Hydro is taking an essential step to ensure a secure and reliable source of electricity to meet future customer needs. As a cost-effective, renewable energy project, Site C will build on our province's hydroelectric legacy, contributing to the economic prosperity and quality of life for generations to come.

SITE C CLEAN ENERGY PROJECT: UPDATED BUSINESS CASE SUMMARY

The Site C Business Case Summary was originally published in January 2013 and was based on the January 2013 Site C Environmental Impact Statement (EIS). The Business Case Summary describes the need for the project, provides a review of project alternatives and highlights the project's benefits as compared to alternatives. In addition, it outlines the project cost estimate, explains the procurement approach for the project and discusses the management of key risks.

This April 2014 update incorporates analysis from BC Hydro's final Integrated Resource Plan (IRP), which was approved by the Province in November 2013. It also includes information and analysis submitted as part of the environmental assessment process for Site C, and provides updated information about the current status of procurements for construction contracts.

SITE C | CLEAN ENERGY PROJECT

A more detailed description of the Site C project is provided in the July 2013 amended EIS, which includes an analysis of the need for and alternatives to the project, and describes project benefits, potential effects and BC Hydro's proposed measures to avoid, mitigate or compensate for potential effects. An Executive Summary of the EIS is also available.

Further information can be found in the Site C Evidentiary Update, which was submitted to the regulatory agencies in September 2013, and in the Summary of BC Hydro's Position, submitted to the Joint Review Panel as part of the environmental assessment process in February 2014. Both documents are available at ceaa-acee.gc.ca, reference number 63919.

Site C requires environmental certification and other regulatory permits and approvals before it can proceed to construction. In addition, the Crown has a duty to consult and, where appropriate, accommodate Aboriginal groups.

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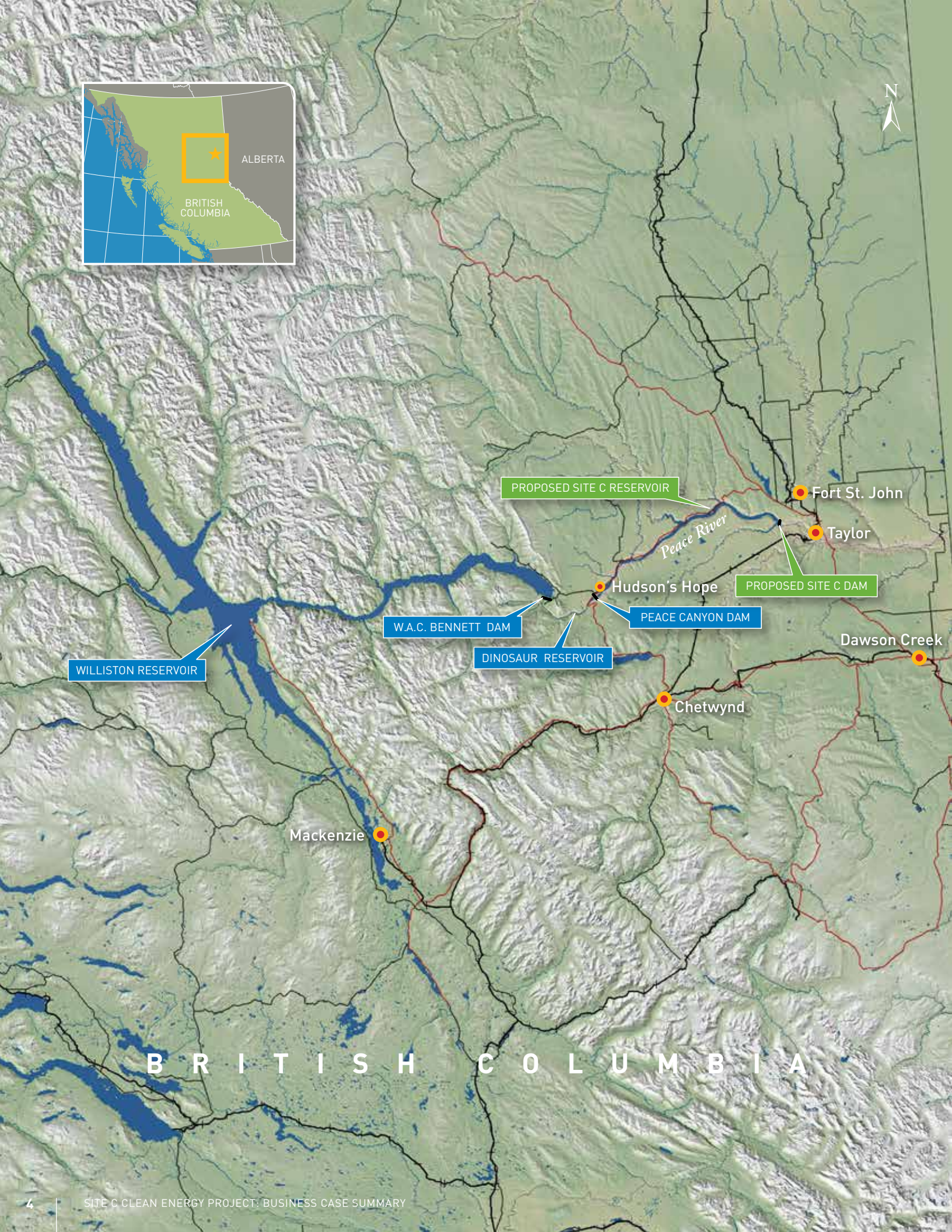

ALBERTA
BRITISH COLUMBIA
N
PROPOSED SITE C RESERVOIR
Fort St. John
Peace River
Taylor
PROPOSED SITE C DAM
Hudson's Hope
PEACE CANYON DAM
W.A.C. BENNETT DAM
DINOSAUR RESERVOIR
WILLISTON RESERVOIR
Dawson Creek
Chetwynd
Mackenzie
BRITISH COLUMBIA

EXECUTIVE SUMMARY

ECONOMIC AND POPULATION GROWTH IS DRIVING INCREASED DEMAND

Since the 1980s when BC Hydro's last new major hydroelectric facility was built, B.C.'s economy has continued to expand, bringing new businesses, residences and industrial activities.

Over the next 20 years, electricity demand will continue to grow. BC Hydro's current forecast shows demand increasing by approximately 40 per cent, driven by a projected population increase of more than one million residents and continued economic expansion. Electricity requirements from B.C.'s emerging LNG industry or significant electrification of vehicles could further increase demand. Even taking into account BC Hydro's upgrades to its existing facilities and its aggressive conservation targets, BC Hydro's electricity supply will not be enough to meet the long-term needs of BC Hydro customers.

There is a need for new dependable capacity and energy resources within the next 5 to 15 years. To meet this growing demand, BC Hydro is proposing the Site C project as a source of 1,100 MW of much-needed dependable capacity and 5,100 GWh of energy per year – enough to power the equivalent of about 450,000 homes per year in B.C.

ANALYSIS CONCLUDES SITE C PREFERRED OVER ALTERNATIVES

An analysis of alternatives reviewed portfolios of both clean and thermal resources. It confirmed that Site C is cost-effective and provides the best combination of financial, technical, environmental, and economic development attributes to meet the need for energy and dependable capacity.

Compared to alternatives, Site C would provide greater contributions to gross domestic product (GDP) during construction, a higher number of construction jobs, and lower greenhouse gas and local air emissions. In addition, as a dependable and flexible resource, Site C would help to integrate intermittent renewable generation resources such as wind and run-of-river hydro.

SIGNIFICANT JOBS AND ECONOMIC DEVELOPMENT BENEFITS

Construction of Site C would create approximately 10,000 person-years of direct construction employment, and approximately 33,000 total jobs through all stages of development and construction. BC Hydro is working to encourage local and Aboriginal participation in employment and business opportunities.

Site C construction would generate an estimated $3.2 billion to provincial GDP, including an approximately $130 million increase in regional GDP. Site C would result in a total of $40 million in tax revenues to local governments during construction and, once in operation, $2 million in revenue per year from grants-in-lieu and school taxes.

Activities during construction would result in approximately $179 million in provincial revenues, and approximately $270 million for the federal government. During operations, the Province would receive annual water rentals amounting to approximately $35 million per year.

In addition, a regional legacy benefits agreement would provide the Peace River Regional District (PRRD) and its member communities with an annual payment of $2.4 million (indexed to inflation) for a period of 70 years, commencing once Site C is operational.

COST-EFFECTIVE, CLEAN, RELIABLE POWER FOR GENERATIONS

Site C would build on BC Hydro's previous investments in hydroelectricity. As the third dam on the Peace River, Site C would gain significant efficiencies by taking advantage of water already stored behind BC Hydro's W.A.C. Bennett Dam, producing 35 per cent of that facility's energy with a reservoir five per cent of the size.

By proposing Site C, BC Hydro is taking an important step to ensure that British Columbians continue to enjoy the benefits of hydroelectric power, which has served our province well for decades. Site C would provide clean, reliable and cost-effective electricity for more than a century.

1.0 INTRODUCTION

CHAPTER HIGHLIGHTS

SITE C IS A COST-EFFECTIVE OPTION TO PROVIDE CLEAN, RENEWABLE POWER

- **Cost-effective, clean and renewable electricity:** BC Hydro proposes to build the Site C project to provide cost-effective, clean and renewable power to residents, businesses and industrial customers.
- **Provides both energy and capacity:** Site C would build on British Columbia's hydroelectric heritage by providing 1,100 MW of required capacity and 5,100 GWh of energy each year for BC Hydro customers.
- **Undergoing thorough and independent environmental assessment:** The Site C project is undergoing an independent environmental assessment by the Canadian Environmental Assessment Agency and the British Columbia Environmental Assessment Office, including a Joint Review Panel process. Site C requires environmental certification and other permits and approvals before it can proceed to construction.
- **Ongoing consultation:** Consultation continues to be a key component of planning for the Site C project. Since 2007, BC Hydro has consulted with the public, Aboriginal groups, communities and stakeholders.

BC Hydro's mandate is to power British Columbia with electricity for generations. Since it was created more than 50 years ago, BC Hydro has undertaken some of the most ambitious hydroelectric construction projects in the world on the Peace and Columbia rivers. Generations of residential, commercial and industrial customers in B.C. have benefited from these historical investments.

As B.C.'s economy expands and the province's population grows by more than one million people, electricity needs within the province are currently forecast to increase by approximately 40 per cent in the next 20 years, with the potential for additional load from LNG facilities to further increase demand. As extensive as BC Hydro's electricity supply is, it will not be enough to meet future electricity demand in the long-term.

Over successive long-term planning processes, BC Hydro has consistently identified Site C as an attractive resource to help meet B.C.'s future electricity needs. In the last decade, the project was identified in the 2004 and 2006 Integrated Electricity Plans (IEPs) and in the 2008 Long-Term Acquisition Plan (LTAP) as a low-cost, reliable source of electricity that would have economic benefits for customers. The approved 2013 IRP confirms Site C as an attractive, cost-effective resource option to meet customer demand, and recommends building the project for its earliest in-service date.

As the third generating station on the Peace River, downstream of the W.A.C. Bennett and Peace Canyon dams, the Site C project would gain significant efficiencies by taking advantage of water already stored in the Williston Reservoir. Site C would generate approximately 35 per cent of the energy produced at the W.A.C. Bennett Dam, BC Hydro's largest facility, with only five per cent of the reservoir area.

Construction of Site C is subject to the project receiving environmental certification through an independent federal and provincial environmental assessment process. In addition, the Crown's duty to consult and, where appropriate, accommodate Aboriginal groups must be fulfilled.

This report provides a summary of the business case elements included in the Site C EIS and other related documentation, and is organized as follows:

- **Chapter 2** provides an overview of BC Hydro's long-term electricity needs, including its requirements for both energy and peak capacity over the next 20 years.
- **Chapter 3** includes a comparison of Site C against other resource options within the existing legal and policy context in terms of technical, financial, environmental and economic development attributes. It explains the rationale for pursuing Site C over other resource options.

- **Chapter 4** includes BC Hydro's F2011 project cost estimate, based on the project's upgraded design, including direct and indirect construction costs, contingencies, inflation costs, and interest during construction. In addition, this chapter provides an estimate of long-term operating costs and the project's unit energy cost.
- **Chapter 5** outlines benefits provided by the Site C project, including firm, dependable, flexible electricity for the BC Hydro system; lower, more predictable costs than other alternatives; increased government revenues; economic development benefits including GDP contributions, employment, and economic benefits for Aboriginal groups and communities; and the project's clean and renewable energy attributes.
- **Chapter 6** describes BC Hydro's procurement planning process and approach, as well as a discussion of key project risks and risk management strategies.

1.1 MULTI-STAGE PLANNING AND EVALUATION PROCESS

Given the long lead time and the scope of evaluation and development work required for a major hydroelectric facility, BC Hydro adopted a multi-stage approach for the planning and evaluation of Site C. This approach provides multiple decision-making points during project development, and focuses on specific deliverables and objectives at each stage.

Stage 1, Review of Project Feasibility, took place from 2004 to 2007. The review of project feasibility concluded that it would be prudent to continue to investigate Site C as a potential resource option to address the growing electricity supply gap within the province.

BC Hydro moved to Stage 2, Consultation and Technical Review, following direction by the Province in the *BC Energy Plan* in 2007. Stage 2 included comprehensive consultations with Aboriginal groups and the public and stakeholders, as well as advancing environmental studies, field studies, engineering design and technical work. Based on Stage 2 key findings, BC Hydro recommended proceeding to the next stage of project planning and development, including an environmental and regulatory review.

CANADA'S HYDROELECTRIC POTENTIAL

Other provinces in Canada are also building or proposing hydroelectric generating projects where they have the geographic potential to do so. Current projects proposed or under construction include:

Newfoundland: Lower Churchill Projects

- Two facilities, at Gull Island and Muskrat Falls in Labrador
- Construction of the 824 MW Muskrat Falls project began in 2013 and is expected to finish in 2017

Manitoba: Nelson River Projects

- Three facilities on the Nelson River in Manitoba
- Construction of the 200 MW Wuskwatim project was completed in 2012
- Construction of the 695 MW Keeyask project is expected to begin in 2014 and finish in 2019
- The 1,485 MW Conawapa project is currently in the planning stages

Quebec: Romaine Hydroelectric Complex

- Series of four facilities on the Romaine River in Quebec, generating a total of 1,550 MW
- The project received environmental certification and began construction in 2009
- The first of the facilities is expected to be complete in 2014

Ontario: Lower Mattagami Projects

- Combination of a new powerhouse and dam improvements, as well as unit additions at three existing powerhouses, all on the Mattagami River in Ontario
- The projects are being constructed as a single development totaling 433 MW of additional capacity
- Construction began in 2010 and is expected to be complete in 2015

BC Hydro entered Stage 3, the Environmental and Regulatory Review stage, in April 2010, following a decision by the Province to advance the project to the next stage of development. Stage 3 includes an independent environmental assessment process by federal and provincial regulatory agencies.

Should the project receive environmental certification at the end of Stage 3, Stage 4 would include a decision by the BC Hydro Board of Directors and the Province to proceed to full project construction.

Stage 5, Construction, is the final stage, involving an approximately seven-year construction period, with one additional year for final project commissioning, site reclamation, and demobilization.

1.2 COOPERATIVE FEDERAL-PROVINCIAL ENVIRONMENTAL ASSESSMENT

As part of Stage 3, the Site C project is undergoing a cooperative environmental assessment by the Canadian Environmental Assessment Agency (CEA Agency) and the British Columbia Environmental Assessment Office (BCEAO), including a Joint Review Panel process. The environmental assessment process commenced in August 2011 and is anticipated to take approximately three years to complete.

The environmental assessment process for Site C is thorough and independent and has included several public comment periods, as well as public hearings under a Joint Review Panel. The process provides opportunities for timely and meaningful participation by the public, Aboriginal groups, all levels of government and other interested stakeholders.

Milestones of the environmental assessment process for Site C to date include:

- **May 2011:** BC Hydro initiated the environmental assessment process by submitting a Project Description Report for Site C to the CEA Agency and the BCEAO.
- **August 2011:** The Project Description Report was accepted by the regulators, which commenced the formal environmental assessment process.
- **September 2011:** A draft agreement was released by the regulatory agencies for a cooperative environmental assessment of Site C, including a Joint Review Panel process. The agreement was subject to a 30-day public comment period.
- **February 2012:** The agreement for a cooperative environmental assessment of Site C, including a Joint Review Panel process, was finalized by the regulatory agencies in February (and amended following the implementation of the *Canadian Environmental Assessment Act* 2012). This agreement provided guidance on expected timing for each review stage.
- **April 2012:** Draft EIS Guidelines for the Site C project were issued by the agencies for a 45-day public comment period, which included open house sessions in key communities in northern B.C. and Alberta.
- **September 2012:** Final EIS Guidelines were provided to BC Hydro by the regulatory agencies. The EIS Guidelines set out the information that must be included in the EIS for Site C.
- **January 2013:** The Site C EIS was filed with the federal and provincial environmental assessment agencies. The EIS provides a detailed report of potential environmental, economic, social, health and heritage effects of the proposed project and, where effects cannot be avoided, it identifies options for mitigation. An amended EIS was submitted in July 2013.
- **August 2013:** CEA Agency and BCEAO advised that the EIS as amended was satisfactory and the three-member Joint Review Panel was appointed.
- **November 2013:** Following an Evidentiary Update to the EIS in early September and several rounds of information requests, the Panel determined that the EIS as amended contained sufficient information to proceed to a public hearing.
- **December 2013-January 2014:** The Joint Review Panel held a public hearing over five weeks in five communities in the Peace region (Fort St. John, Hudson's Hope, Prince George, Dawson Creek and Town of Peace River, Alberta), as well as six First Nation communities (West Moberly, Saulteau, McLeod Lake, Doig River, Halfway River and Blueberry River). Final written submissions and closing arguments from all interested parties were submitted by February 3, 2014, concluding the official record and public hearing process.

- **May 2014:** The Joint Review Panel Report containing the Panel's recommendations was submitted to the BCEAO and the Federal Minister of Environment. The governments of B.C. and Canada are expected to make a decision on environmental approval within six months of receiving the report, or in fall 2014.

Figure 1.1 provides a summary of the environmental assessment process.

1.3 CONSULTATION

Consultation is a key component of planning for the Site C project, and has informed project planning, design and draft mitigation plans.

Aboriginal Consultation and Engagement

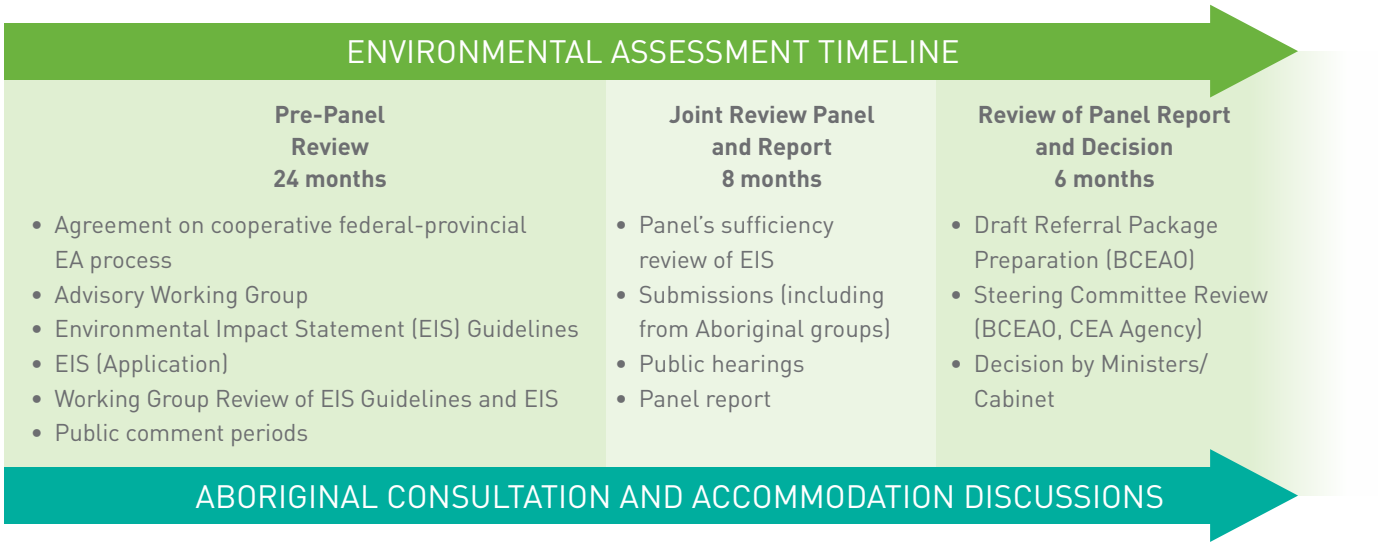
BC Hydro is responsible for the development, construction and operation of Site C and is therefore responsible for consultation with Aboriginal groups regarding the project.

BC Hydro began consultation with Aboriginal groups about Site C in late 2007, before the decision was made to advance Site C to an environmental assessment. BC Hydro and Aboriginal groups are currently engaged in a consultation and engagement process that will continue through all stages of the project, including the construction and operation stages.

To date, BC Hydro has engaged approximately 50 Aboriginal groups in B.C., Alberta, Saskatchewan and the Northwest Territories, with a greater depth of consultation with Treaty 8 First Nations that are in closer proximity to the project. Consultation activities include:

- Providing access to and facilitating an understanding of project-related information
- Identifying and understanding the issues, interests and concerns brought forward about the project
- Creating opportunities to receive input into the planning, design, construction and operation of the project
- Negotiating consultation agreements where appropriate. BC Hydro has concluded 13 consultation agreements representing 16 First Nations to date. Others remain under discussion.
- Acquiring, considering and incorporating traditional land use information
- Facilitating participation in the environmental assessment process through provision of capacity funding and access to technical expertise as it relates to the project
- Negotiating impact benefit agreements with First Nations that, in BC Hydro's view, are likely to be adversely affected or impacted by the project and where BC Hydro considers that accommodation beyond proposed mitigation measures is warranted
- Identifying potential training, employment, contracting and broader economic opportunities related to the project that may be of interest to Aboriginal groups or individuals

Figure 1.1: Environmental Assessment Process



Public and Stakeholder Consultation

Significant consultation with the public – including local and regional governments, communities, stakeholders, property owners and the general public – has taken place since 2007 and will continue throughout the environmental assessment process and through construction and operations.

BC Hydro-led streams of consultation and communication include:

- **Project Definition Consultation:** Project Definition Consultation has focused on gathering stakeholder and public input on a range of topics important to project planning and the ongoing environmental assessment. It includes engaging with the public through multiple rounds of consultation that include stakeholder meetings and open houses. Topics of consultation have included worker accommodation, transportation, clearing, reservoir impact lines and recreation, among others.
- **Regional and Local Government Liaison:** Since 2007, BC Hydro has engaged local and regional and governments to ensure that they are kept up to date on the status of the project and are consulted on key issues. BC Hydro has established committees with local and regional governments in the project area and continues to engage in discussions about the project.
- **Property Owner Liaison:** BC Hydro initiated a separate liaison with property owners and established a properties team to implement the program. The project team provides information and updates to property owners about the project, and negotiates with property owners to provide compensation for permissions and access to property.
- **Local Area Consultation:** BC Hydro conducts area-specific consultations where local issues arise. For example, consultation with the community of Hudson's Hope was held to gather local input about proposed shoreline protection options.
- **Business Liaison:** BC Hydro has established a business liaison program to keep businesses informed and updated on the project, and maintains a Business Directory for the project.
- **Community Relations:** BC Hydro's community relations program will continue through all stages of the project and includes two community consultation offices, regular presentations and project updates, a project website and participation in community events.

Since 2007, the project team has led or participated in more than 500 consultation meetings, presentations, local government meetings, community events or open houses. These activities are documented in the EIS.

In addition to these BC Hydro-led streams of consultation, the federal and provincial regulatory agencies led a separate consultation process as part of the cooperative federal and provincial environmental assessment of Site C.

PROJECT EFFECTS AND REVIEW PROCESS

While this document discusses the need for and benefits of Site C, BC Hydro acknowledges that there will be effects associated with a project of this size and scope.

BC Hydro has undertaken years of detailed studies to identify and assess potential effects from the project and has proposed a comprehensive set of mitigation measures that are expected to largely offset these effects. BC Hydro's findings are documented over five volumes in the Site C EIS, which was submitted to the federal and provincial environmental assessment agencies in January 2013. An amended EIS was submitted in July 2013, and an Evidentiary Update was submitted in September 2013.

In the EIS, BC Hydro recognizes that, like all new electricity-generation projects, the Site C project would have environmental impacts. While Site C has the potential to result in some significant effects, BC Hydro believes those effects are justified by the need for the project, and the environmental, economic and social benefits it would provide for British Columbia.

The EIS has been the subject of review and comment by the public, communities, Aboriginal groups and stakeholders, including a public hearing held by an independent Joint Review Panel in regional and First Nation communities.

For more information, an Executive Summary of the EIS and a Summary of BC Hydro's Position are available online at ceaa-acee.gc.ca, reference number 63919 or on the Site C project website at sitecproject.com.

2.0 B.C.'S FUTURE ELECTRICITY NEEDS

CHAPTER HIGHLIGHTS

AN EXPANDING ECONOMY AND GROWING POPULATION IS DRIVING INCREASED DEMAND FOR ELECTRICITY

- **Growing electricity demand:** Demand for energy and dependable capacity in B.C. is forecast to increase by approximately 40 per cent over the next 20 years. As extensive as BC Hydro's electricity supply is, it will not be enough to meet future electricity needs if demand continues to grow as projected.
- **Need both energy and dependable capacity:** To meet customer demand, BC Hydro requires resources that provide both energy (the total amount of electricity that customers will require over a year) and dependable capacity (the amount of electricity required by customers at a single point in time).
- **New resources are required:** BC Hydro's long-term forecast shows that new resources are required to meet the needs of BC Hydro customers within the next 5 to 15 years, even when taking into account BC Hydro's ambitious targets to meet demand through conservation and excluding any load from LNG facilities. Any potential demand from LNG facilities served by BC Hydro would increase the requirements for energy and capacity.
- **New projects have long lead times:** Hydroelectric projects require a long lead time to plan, design and complete the rigorous environmental assessment process. They also take many years to construct. BC Hydro looks at the long-term need for new energy and dependable capacity to determine the need for Site C.

Electricity demand in B.C., referred to as domestic demand or load, includes BC Hydro's three customer groups: residential, commercial and industrial. Each of these groups currently accounts for about one-third of total electricity use in B.C. Changes in any one of these customer groups can have significant impacts on the overall growth in electricity demand.

To ensure it has enough resources to meet future demand, BC Hydro establishes a forecast of how much electricity customers are expected to need each year and then compares that requirement to how much electricity BC Hydro can supply in that given year. This takes into account BC Hydro's own generating assets, as well as electricity purchased from Independent Power Producers (IPPs). The relationship between projected customer demand and BC Hydro's electricity supply is called the load-resource balance.

BC Hydro uses the load-resource balance to determine whether there is a gap between the needs of its customers and its electricity supply.

When a gap exists between projected customer demand and projected electricity supply, BC Hydro must plan to meet this gap within the existing policy context, including meeting the objectives of the B.C. government's *Clean Energy Act*.

CLEAN ENERGY ACT

The *Clean Energy Act* establishes a long-term vision for B.C. to become a clean energy leader. The Act guides government, BC Hydro and the British Columbia Utilities Commission (BCUC) in advancing the province's ambitious sustainable energy vision.

BC Hydro's long-term energy planning process supports the Province in achieving the objectives contained within the *Clean Energy Act*, including achieving electricity self-sufficiency, promoting economic development, reducing GHG emissions and investing in clean and renewable energy.

B.C.'s demand for electricity over the long term has two components: the amount of electricity required by customers in total over the course of a whole year, and the amount of electricity needed to meet instantaneous, or 'peak', demand at any given time.

ENERGY AND CAPACITY

ENERGY is the amount of electricity produced or used over a period of time measured in gigawatt hours (one gigawatt hour equals one million kilowatt hours). The average British Columbian household uses approximately 11,000 kilowatt hours per year.

DEPENDABLE CAPACITY refers to the maximum amount of electricity that BC Hydro can supply to meet peak customer demand in the province at a point in time. BC Hydro's system experiences both seasonal and daily peaks in demand. Typically, customer demand peaks at dinner time on the coldest day of the year.

Different resources deliver different levels of energy and capacity. For instance, wind generation delivers energy, but no dependable capacity. Large hydro and natural gas provide both energy and dependable capacity.

BC Hydro's legislated mandate is to plan to meet both the energy and peak capacity requirements of its customers today and in the future.

2.1 HISTORICAL SUPPLY AND DEMAND IN B.C.

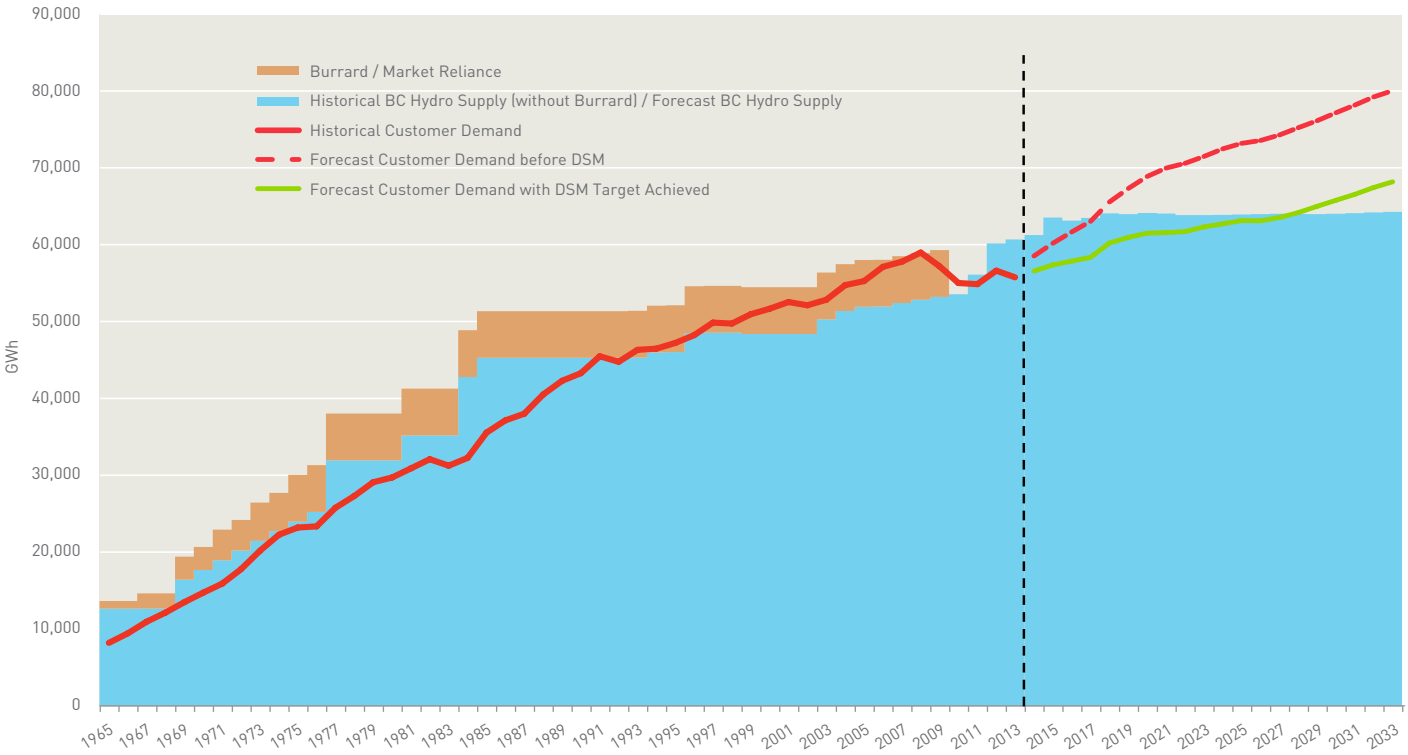
Since BC Hydro was first incorporated in the early 1960s, electricity demand has grown at an average rate of about two per cent per year. Over the same time period, the population of the province has grown by almost three million people, and the economy has expanded significantly.

While B.C.'s electricity demand can fluctuate from year to year depending on weather conditions, economic activity, population growth and consumer habits, the long-term trend is clear: demand for electricity is growing. Leaders of the 1960s recognized this trend and set out to build BC Hydro's heritage assets to meet the electricity demands of a growing province.

As these new large electricity resources were brought into service, they provided more electricity than domestic customers required for a time. However, as growth continued and new businesses and industries located in British Columbia, the electricity from these facilities was soon being used to help build the economic backbone of our province.

Figure 2.1 illustrates historical and forecast future customer demand increases over time, as compared to BC Hydro's historical and forecast electricity supply.

Figure 2.1: Historical and Forecast Future Customer Demand and BC Hydro Supply



2.2 ELECTRICITY DEMAND: FORECASTING FUTURE ELECTRICITY NEEDS

In keeping with good utility practice, BC Hydro regularly prepares a 20-year forecast for both the energy and peak capacity that will be required by BC Hydro's customers. This load forecast is undertaken in accordance with B.C. Utilities Commission (BCUC) guidelines, and is regularly updated.

2.2.1 LOAD FORECAST METHODOLOGY

BC Hydro's load forecast is developed by forecasting future demand by BC Hydro's three major customer groups: residential, commercial and industrial. When preparing its forecast, BC Hydro considers general demand trends, such as population growth and economic activity, as well as the size and likelihood of specific loads, such as those from large industrial customers.

The load forecast is based on factors such as projections of population, GDP, weather, technology, and energy conservation programs, among many other factors.

There is a potential for the actual load to be higher or lower than forecast. For planning purposes, BC Hydro uses a mid-load forecast. The mid-load forecast is constructed so that there is an equal probability that actual load could be higher or lower. The mid-load forecast is what BC Hydro has traditionally used for its applications to the BCUC, and is consistent with the use of mid-load forecasts by other public utilities.

BC Hydro's load forecasting methodology has been the subject of independent review in a number of BCUC regulatory proceedings, and the BCUC has accepted BC Hydro's load forecasting methodology. In addition, a June 2011 government review of BC Hydro found that *"BC Hydro's energy forecasting process is well planned and provides accurate, reliable forecasts. Each forecast receives multiple levels of review to ensure accuracy and completeness as well as being monitored on a month-to-month and quarterly basis."*

The current forecast was prepared in 2012 and has tracked within 1 per cent accuracy in F2014.

2.2.2 BC HYDRO'S 2012 LOAD FORECAST

Table 2.1 presents the energy and peak demand requirements from the 2012 Load Forecast before accounting for BC Hydro's Demand-Side Management (DSM) targets that aim to meet growth through conservation and efficiency measures. The table is based on a scenario that does not include potential from B.C.'s emerging LNG sector. This forecast shows that demand for electricity is expected to increase by approximately 40 per cent over the next 20 years.

After applying load reduction from DSM, BC Hydro projects a 1 per cent growth in electricity demand per year. This is in line with other jurisdictions' assessments of their growing electricity needs. The 2012 Load Forecast is prepared using industry-standard forecasting model approaches, and is a prudent basis on which to evaluate the need for additional resources. Except for unusual events such as the 2008 recession, actual long-term load growth in the past has trended higher than BC Hydro's current long-term projection.

Table 2.1: Energy and Peak Demand Forecast Before Demand-Side Management (excluding load from LNG)

YEAR	Energy Forecast (GWh)	Peak Demand Forecast (MW)
2024	72,700	13,150
2028	75,500	13,800
2033	80,300	14,900
Compound Annual Growth Rate (F2014-33)	1.7 %	1.6 %

NOTES:

1. Energy values rounded to nearest 100, capacity values rounded to nearest 50.
2. Peak demand forecast does not include 14% reserve requirement.

FIGURE 2.1 NOTES:

1. As directed by the *Clean Energy Act*, energy from Burrard Thermal will no longer be relied upon from 2011 onwards. F2010 shows a drop in supply as a result.
2. Forecast demand is based on the December 2012 Load Forecast, both before and after accounting for BC Hydro's conservation (DSM) targets. These targets are explained in Section 2.3.
3. The forecast demand shown on this chart does not include potential electricity demands from proposed LNG projects. Should LNG load be added, electricity demand over the next 20 years would increase above what is shown in this chart.

LNG: AN EMERGING INDUSTRY SECTOR

The export of liquefied natural gas (LNG) is an emerging sector in British Columbia's economy. Today, there are approximately a dozen publicly-announced LNG projects proposed for Kitimat, Prince Rupert and other areas of the province that are in various stages of development.

BC Hydro understands that while most LNG producers will use direct-drive natural gas turbines to run the cooling process to convert natural gas to liquid form, many are expected to take electricity for ancillary requirements, such as lighting, control systems and office requirements. Others may choose electricity for all their energy needs. These potential LNG projects would be energy intensive, and therefore could have a significant impact on BC Hydro's resource plans. As the LNG industry develops, BC Hydro will continue to support the needs of this sector.

The November 2013 IRP includes a range of LNG scenarios, including an 'Expected LNG' scenario that includes 3,000 GWh of energy requirements per year and 360 MW of peak capacity requirements by F2022. However, it is important to note that the load forecast used in the Site C EIS and the Business Case does not include potential electricity demand from proposed LNG projects. This demonstrates that new resources are required, whether or not BC Hydro is required to serve LNG load.

2.3 ELECTRICITY SUPPLY: EXISTING AND COMMITTED RESOURCES

The other major input into the energy and capacity load-resource balance is determining what existing and committed resources are available to the BC Hydro system to provide energy and capacity. Existing and committed resources include BC Hydro's hydroelectric and thermal resources, and supply from IPPs.

- **Heritage Hydroelectric Resources:** BC Hydro's most significant existing resource is its hydroelectric system. BC Hydro's 31 existing hydroelectric facilities currently provide more than 95 per cent of the total electricity BC Hydro generates, and are located in the Peace, Columbia and coastal regions of B.C.
- **Heritage Thermal Resources:** BC Hydro's Burrard Thermal and Prince Rupert Generating Stations are the only two BC Hydro-owned thermal generating stations that serve the integrated system. As directed in the *Clean Energy Act*, energy from Burrard Thermal is not taken into account for the purposes of long-term planning. In November 2013, the Province announced that BC Hydro will stop generating electricity at Burrard Thermal in 2016.
- **Existing and Committed IPP Supply:** BC Hydro is forecast to have the rights to approximately 9,900 GWh/year of energy in F2024 through approximately 130 Energy Purchase Agreements (EPAs) with IPPs, after taking into account forecast attrition. Energy from EPAs with IPPs is expected to make up approximately 15 per cent of BC Hydro's existing and committed supply by F2024.

Table 2.2: Long-term Existing and Committed Energy Supply

YEAR	Energy Supply (GWh)
2024	58,500
2028	57,500
2033	56,500

NOTE: 1. Values rounded to nearest 100

2.3.1 PLANNED RESOURCES

In addition to BC Hydro's existing and committed resources, BC Hydro is also planning aggressive DSM measures and a number of new and renewed IPPs.

- **Demand-Side Management:** BC Hydro's first and best option to meet electricity demand is through conservation and efficiency. As such, BC Hydro plans to meet 78 per cent of its load growth through DSM measures, which are defined in the *Clean Energy Act* as "a rate, measure, action or program undertaken (a) to conserve energy or promote energy efficiency; (b) to reduce the energy demand a public utility must serve; or (c) to shift the use of energy to periods of lower demand."

BC Hydro's current target is to meet 7,800 GWh and 1,400 MW of electricity demand through DSM in F2021.

BC Hydro uses three main tools to achieve its DSM targets: codes and standards; rate structures aimed at conserving energy, promoting energy efficiency or reducing energy demand; and programs designed to address remaining barriers to energy efficiency and conservation.

- **New and Renewed IPPs:** IPPs represent a significant component of BC Hydro's electricity supply. IPPs currently supply about 20 per cent of the electricity required to serve BC Hydro's domestic customers. In addition to the existing and committed IPP supply, BC Hydro has developed a Clean Energy Strategy to continue to provide opportunities to the clean energy sector in future years. This strategy will result in new energy supply from the following sources:
  - BC Hydro will provide new opportunities for IPP developers through mechanisms such as the Standing Offer Program for clean energy.
  - About 20 IPP contracts will expire over the coming decade, and BC Hydro plans to attempt to renew expiring contracts at cost-effective prices. For planning purposes, BC Hydro has assumed that about 75 per cent of run-of-river IPPs expiring in the next five years will be renewed and about 50 per cent of bioenergy IPPs will be renewed.

2.4 ENERGY AND DEPENDABLE CAPACITY LOAD-RESOURCE BALANCES

The need for new resources in the future is determined by comparing the annual mid-load forecast, including BC Hydro's DSM target, with the annual capability of BC Hydro's existing and committed resources. This calculation is done for both energy and capacity requirements.

The load-resource balances are reviewed in three stages:

- First, the load-resource balance is reviewed without incorporating the DSM target or new and renewed IPPs.
- Then, the load-resource balance is reviewed with the DSM target and new and renewed IPPs taken into account. These activities are expected to be enacted regardless of whether Site C proceeds.
- Finally, the load-resource balances are reviewed including an 'Expected LNG' scenario in which BC Hydro services approximately 3,000 GWh/year and 360 MW of non-compression load from LNG facilities.

Tables 2.3 and 2.4 illustrate the energy and capacity load-resource balances (respectively) in the years 2024, 2028 and 2033.

Table 2.3: Forecast Energy Deficit (Surplus) in GWh

Year	No DSM or New/ Renewed IPPs No LNG Load	With DSM and New/ Renewed IPPs No LNG Load	With DSM, New/Renewed IPPs and Expected LNG Load
2024	14,200	(1,200)	1,800
2028	17,900	200	3,200
2033	23,800	3,900	6,900

NOTE: 1. All values rounded to nearest 100

Table 2.4: Forecast Capacity Deficit (Surplus) in MW

Year	No DSM or New/ Renewed IPPs No LNG Load	With DSM and New/ Renewed IPPs No LNG Load	With DSM, New/Renewed IPPs and Expected LNG Load
2024	2,550	350	750
2028	3,350	800	1,150
2033	4,500	1,650	2,050

NOTE: 1. All values rounded to nearest 50

The load-resource balance shows that new resources are required to meet the capacity and energy needs of BC Hydro customers within the next 5 to 15 years, even when taking into account BC Hydro's aggressive DSM targets and new and renewed IPPs, and excluding LNG. Within 20 years, there is a significant gap between electricity supply and demand that will continue to grow beyond the 20-year planning horizon. As shown in the 'Expected LNG' scenario, the addition of LNG load served by BC Hydro would increase the demand for new resources.

2.5 LOAD-RESOURCE BALANCE UNCERTAINTY

Long-term load and resource forecasting is based on BC Hydro's best available information regarding future conditions. Like all forecasts, they include some assumptions that have some uncertainty. Key assumptions that may change include:

Load Forecast: BC Hydro's load forecast is sensitive to a number of factors, including changes in economic activity, changes in technology and consumer behaviour, or an increase in fuel switching from fossil-based fuels to electricity (e.g., through higher adoption of electric plug-in vehicles). In addition, the emerging load requirements related to LNG facilities in British Columbia have the potential to increase electricity demand.

To address this inherent uncertainty, BC Hydro quantifies the level of confidence in its load forecast and prepares a mid- (expected), low and high forecast. These high and low forecast bands represent the magnitude of uncertainty in the forecast.

DSM Deliverability Risk: BC Hydro is planning to meet the majority of its energy and capacity demand with DSM, so understanding uncertainties and risks associated with this approach is essential. It is important to note that DSM requires British Columbians to make significant behavioural changes that can be difficult to implement in a low-rate jurisdiction like B.C.

While BC Hydro is among the leading jurisdictions in DSM activity, a failure to achieve these aggressive targets could result in a shortage of supply to meet customer demands. This is particularly important in the case of capacity requirements, because a failure to deliver can result in reliability impacts to BC Hydro customers.

Based on this deliverability risk, BC Hydro continues to pursue all cost-effective DSM, but also pursues other resources to ensure that if DSM targets are not met, BC Hydro's ability to meet customer requirements is not jeopardized. Deliverability risk is especially high for DSM capacity-focused resources given the limited knowledge and experience in attaining the estimated potential. As a result it would not be prudent to rely on additional DSM capacity savings due to the potential impacts to customer service should these savings not materialize.

IPP Delivery/Renewal Risk: Like all new projects, some IPPs that have signed EPAs with BC Hydro may not proceed. BC Hydro has included an assumption regarding the level of attrition in signed EPAs with IPPs in its load-resource balance. There is the potential for this rate of attrition to be higher or lower than assumed.

In addition to the risk associated with new IPP attrition, BC Hydro assumes that a number of existing EPAs with IPPs that are reaching expiry will be renewed. There is risk associated with both the volume and pricing of the renewal of these contracts.

2.6 REQUIREMENT FOR NEW ENERGY AND DEPENDABLE CAPACITY RESOURCES

Electricity demand in B.C. is forecast to increase by approximately 40 per cent over the next 20 years. BC Hydro's long-term planning process has determined that, as extensive as BC Hydro's electricity supply is, it will not be enough to meet the forecast electricity needs of BC Hydro customers. Even when factoring in BC Hydro's aggressive DSM target and new and renewed IPP contracts, there is a need for new dependable capacity and energy resources within the next 5 to 15 years. If new LNG facilities require service from BC Hydro, the need for new resources would be accelerated.

BC Hydro has a legislated obligation to serve its customers now and in the future. Bringing new resources – like large hydro projects – into service requires a long lead time due to the lengthy construction period and the requirement for design work, stakeholder engagement and regulatory and permitting processes. While the timing of BC Hydro's energy and capacity deficit has some uncertainties associated with it, the long-term trend is clear – demand for electricity is growing. The consequences of being short of electricity would be significant both for B.C.'s economy and BC Hydro's customers. As such, BC Hydro believes it is important to plan conservatively to ensure that resources are available when customers require them.

3.0 COMPARING RESOURCE OPTIONS

CHAPTER HIGHLIGHTS

ANALYSIS SHOWS SITE C PREFERRED OVER OTHER RESOURCE ALTERNATIVES

- **Comparing Site C to other resources:** The technical, financial, environmental and economic development attributes of the project were compared against portfolios of other resources that could meet the annual energy and peak capacity requirements in the same time frame.
- **Site C provides both energy and dependable capacity**, as compared to many renewable resources that primarily provide energy. Dependable capacity is essential to meet peak demand for electricity, as well as to integrate intermittent renewable resources into the BC Hydro system.
- **Site C is cost-effective:** BC Hydro's analysis of resource options concludes that Site C is cost-effective compared to alternative resource portfolios with similar amounts of energy and dependable capacity.
- **Lower GHG emissions per gigawatt hour:** GHG emissions from Site C would be at levels comparable to other renewable resources such as wind and run-of-river hydro. The project would produce substantially less GHG emissions, per unit of energy, than thermal sources such as natural gas, diesel or coal. In addition, the project would have lower local air emissions during operations.
- **Additional economic development benefits:** Site C would have additional benefits compared to other resource options, including contributing more to GDP during construction and providing a higher number of construction jobs than alternative resource portfolios.

BC Hydro has undertaken a comparison of alternative resource options that could be built instead of Site C to meet the growing energy demands of British Columbians.

3.1 PORTFOLIO ANALYSIS

In order to evaluate the cost-effectiveness and other attributes of the Site C project compared to other resource options, BC Hydro developed several portfolios of resources that would provide comparable energy and capacity to the project. Portfolio analysis is consistent with good utility practice for long-term resource planning and the Resource Planning Guidelines provided by the BCUC. These portfolios of resources take into account the relevant policy context, including the legislative requirements of the *Clean Energy Act*. The portfolios were established using three sets of assumptions regarding available resources:

- **Site C Portfolios:** These portfolios include the Site C project, with the remaining energy and capacity gap being filled using clean or renewable generation resources.
- **Clean Generation Portfolios:** These portfolios were created using available resources that would be clean or renewable. In these portfolios, the energy and capacity that would be provided by Site C is replaced by a combination of energy resources (such as wind, run-of-river and biomass resources) and clean capacity resources (e.g., Revelstoke Unit 6, GMS Units 1-5 and pumped storage).
- **Clean + Thermal Generation Portfolios:** In these portfolios, the energy that Site C would provide is replaced by clean or renewable resources, while the capacity Site C would provide is replaced by thermal generation in the form of simple-cycle gas turbines (SCGTs) and clean capacity resources (e.g., Revelstoke Unit 6 and GMS Units 1-5).

BC Hydro compared the financial, technical, environmental and economic development attributes between the portfolios with and without Site C.

It is important to note that BC Hydro's DSM target of 7,800 GWh and 1,400 MW in F2021 (discussed in Chapter 2) is included in the load-resource balance upon which the need for Site C is based. As such, this level of DSM is currently being pursued in conjunction with Site C and is not considered an alternative to the project. BC Hydro did review the potential for further DSM savings beyond this target. The results of this analysis can be found in Section 3.1.2.

THE ROLE OF NATURAL GAS

Natural gas has a role to play in electricity generation in B.C. However, there are some considerations that are important to take into account:

B.C. Government Policy: The *Clean Energy Act* requires BC Hydro to maintain a portfolio that is 93 per cent clean or renewable resources (except for resources needed to supply exporting LNG facilities). The remaining seven per cent of BC Hydro's portfolio can be used for non-renewable options, such as natural gas-fired generation. Within this amount, there would not be sufficient room for enough gas-fired generation to replace Site C, due to the amount of gas-fired generation already in the BC Hydro system.

Cost Profile and Price Volatility: A natural gas-fired generation facility would have relatively lower upfront capital costs compared to Site C. However, its operating costs would be relatively higher due to the cost of fuel. This leads to a higher level of uncertainty in the annual cost of energy for natural gas-fired generating facilities compared to renewable options such as Site C, due to the potential for fluctuations in natural gas prices in the future.

Lifespan: The expected 30-year operating life of a natural gas-fired facility would be less than half of the planning life of a hydroelectric facility such as Site C. After this point, significant upgrades would be required to continue operating the facility, or a new facility would need to be built. This is an important consideration when comparing alternatives.

Greenhouse Gas Emissions: Site C would produce among the lowest GHG emissions compared to other forms of electricity generation in B.C. per unit of energy produced. Generation options that rely on the combustion of fossil fuels, such as a natural gas-fired facility, would have substantially higher levels of GHG emissions.

3.1.1 TECHNICAL ATTRIBUTES

Portfolios were constructed to have similar overall technical attributes. Therefore, each portfolio was built to include approximately 5,100 GWh of average annual energy and 1,100 MW of dependable capacity. However, there are some differences between these portfolios that are important to highlight.

Energy: In both the Clean Generation and Clean + Thermal Generation portfolios, energy is provided by a combination of clean or renewable resources. These resources are generally intermittent, and require additional dependable capacity resources.

The Clean Generation portfolios require more energy resources in total, due to the requirement to offset energy losses from pumped storage. This is because pumped storage uses energy to pump water into a higher elevation reservoir during periods of low load in order to produce energy during periods of high load. There are losses of 30 per cent in the pumping-generation cycle. Due to this inefficiency, approximately 5,500 GWh of energy generation resources are required in the Clean portfolios due to the 400 GWh of net energy consumption from the pumped storage capacity resource. It should also be noted that no pumped storage project has ever been developed in B.C.

Capacity: Dependable capacity is essential to BC Hydro's ability to meet electricity needs when customer demand is highest, as well as to BC Hydro's ability to integrate intermittent renewable resources into the system. Intermittent resources such as wind and run-of-river hydro provide energy, but do not provide dependable capacity as they cannot be counted on to generate when the wind is not blowing or when river flows are low.

In the Clean portfolios, the majority of dependable capacity is provided by pumped storage and upgrades to the Revelstoke and G.M. Shrum (GMS) generating stations, with a small remainder provided by biomass resources. Dependable capacity in the Clean + Thermal portfolios is primarily provided by SCGTs and upgrades to Revelstoke and GMS, again with a small remainder provided by biomass resources. Because both the Clean and Clean + Thermal portfolios rely significantly on intermittent resources, there may be additional firming and/or shaping capability required for the BC Hydro system that is not included in the portfolio analysis.

3.1.2 FINANCIAL ATTRIBUTES

The financial analysis compared the present value of portfolio costs, and the adjusted unit energy costs (UECs) between portfolios with and without Site C. The UEC of a resource option represents the annualized unit cost of the energy generated over the life of a project, and provides a simplified basis for comparing resource options. The financial attributes can be compared using a Block Analysis or a Portfolio Present Value (PV) Analysis.

Block Analysis compares the UECs between portfolios with and without the project in 2013 real dollars. It shows that the Site C portfolios have the lowest UEC of the portfolios considered. The Clean Generation portfolios would have higher costs than the Site C portfolios over the lifetime of the projects. While the use of thermal generation lowers the portfolio costs, the Clean + Thermal Generation portfolios would still have a higher cost of producing electricity compared to the Site C portfolios. The results of the Block Analysis are shown in Table 3.1.

Portfolio PV Analysis compares the detailed PV costs of portfolios and reflects timing of resources, system operation costs and benefits including trade. The results shown in Table 3.1 show the higher present value costs of pursuing the Clean and Clean + Thermal Generation portfolios instead of portfolios including Site C. This analysis showed that the Site C portfolios provided ratepayer savings compared to the Clean and Clean + Thermal Generation portfolios.

BC Hydro also reviewed a portfolio that considered more aggressive DSM targets (referred to as DSM Option 3) that go beyond the DSM measures already planned. The key conclusions were that, on its own, DSM Option 3 would defer the energy gap by one year, and would not defer the capacity gap. DSM Option 3 on its own is therefore not an alternative to Site C. When included in a Clean + Thermal Generation portfolio, DSM Option 3 had a higher present value cost ($330 million more) than a portfolio with Site C.

Predictability of Costs

A further consideration is the predictability of costs of resources, which is not reflected in the analysis in Table 3.1. The majority of the Site C project's costs come from upfront capital costs, which are followed by low, predictable operating costs over a long period of time. This is different for other resources such as natural gas-fired facilities which have lower up front capital costs, but have higher operating costs and are subject to fluctuating fuel prices. Site C would be unaffected by fuel price fluctuations and would have a predictable cost of electricity for more than 100 years. See Section 5.2 for further discussion.

Table 3.1: Financial Attribute Comparison

	Site C Portfolios	Clean Portfolios	Clean + Thermal Portfolios	
			Block #1	Block #2
Construction Costs *($ billions, F2013 dollars)*	5.6	6.4	4.6	4.8
Operating Costs *$ millions/year, F2013 dollars*	50	120	170	150
Adjusted Unit Energy Cost *($/MWh, F2013 dollars)*	94	153	128	130
Portfolio PV Differential *($ millions, F2013 dollars)*	n/a	630	150	

NOTE:

1. UEC values for the purposes of portfolio analysis are based on the project UECs of the mix of resource options at the point of interconnection, and have then been adjusted to include transmission-related costs, wind integration costs, soft costs and costs of capacity backup, and exclude sunk costs. The UEC for Site C portfolios is based on the $83/MWh UEC as described in Chapter 4.
2. Clean + Thermal Block #1 excludes upgrades at GMS and includes six 100 MW SCGTs for capacity. Clean + Thermal Block #2 includes upgrades at GMS and includes four 100 MW SCGTs for capacity.

Sensitivity Analysis

To test its findings against uncertainties in future conditions, BC Hydro conducted a sensitivity analysis that compares the cost-effectiveness of Site C to alternative resources in a range of potential future scenarios, including:

- **Increases or decreases in the future gap between electricity supply and demand.** The size of the gap informs the timing of resource requirements and the level of short-term surplus created by Site C and alternative resources as they come into service.
- **Increases or decreases in future market prices for electricity and natural gas.** Electricity market prices affect the value of the short-term surplus created by Site C and alternative resources, while natural gas prices affect the cost of gas-fired generation such as SCGTs.
- **Decreases in the difference between the cost of capital for BC Hydro and the cost of capital for IPPs.** The cost of capital affects the cost of resources as it represents the financing costs for the projects.
- **Increases or decreases in the system costs of integrating intermittent wind resources.** As generation from wind resources can vary significantly on a daily, weekly, and monthly basis there are reserve requirements to integrate this generation into BC Hydro's electricity system while ensuring reliable supply. The cost of this integration affects the cost of wind resources.
- **Increases in the cost of construction for resources.** BC Hydro evaluated scenarios where Site C's costs are increased by 10 per cent, 15 per cent and the unlikely scenario of 30 per cent while the costs of other alternatives remain constant. Because it is unlikely that circumstances would affect Site C's cost but not that of other alternatives, a further analysis tested a scenario in which both Site C and alternatives experience a 30 per cent increase in cost.

The sensitivity analysis determined that Site C is the preferred alternative in a wide range of future scenarios. The scenarios in which alternatives are preferred to Site C are generally low probability, and associated with low long-term economic growth or market prices and higher Site C construction costs.

Further information is available in Chapter 6 of the IRP.

UNIT ENERGY COST

UECs are calculated by taking the present value of the total annual cost of an energy resource and dividing that by the present value of its annual energy generation.

In this document, UECs for all projects are provided at the point of interconnection (POI) with the bulk transmission system. For example, the UEC of Site C at POI is $83/MWh (in F2013 dollars).

UECs for portfolios are provided including adjustments to reflect the costs of delivery to the major load centers in B.C. (i.e., the Lower Mainland). This includes the cost of transmission, line losses, freshet energy adjustments, wind integration costs and capacity backup. Based on the $83/MWh UEC at POI, the adjusted UEC of the Site C portfolios is $94/MWh in F2013 dollars.

Note that the Province announced in November 2013 that Tier 3 water rental rates (which would apply to Site C) will be eliminated. This results in a reduction in the Site C UEC at POI from $83/MWh to $82/MWh, with a corresponding decrease to the portfolio adjusted UEC.

3.1.3 ENVIRONMENTAL ATTRIBUTES

BC Hydro used planning-level information to compare portfolios with and without Site C based on their environmental attributes, as shown in Table 3.2.

Land and Freshwater Footprint

The environmental attributes for the Site C project are unique compared to the alternatives shown as a result of the advanced level of project definition for Site C, which allows a higher level of accuracy in determining the project footprint. The portfolios without Site C are populated with forecast "typical" projects with estimated footprints. As a result, the differences in environmental attributes between portfolios shown in this chapter compare a defined attribute for Site C to a representative estimate for other resources. This means that the actual difference in attributes between portfolios cannot be known with certainty.

Both the Clean and Clean + Thermal portfolios identified wind resources as providing the majority of the energy required. Based on the composition of these portfolios, the comparison of environmental attributes shows that portfolios with the Site C project could have a larger land and freshwater footprint than portfolios without the project.

These differences in land and freshwater footprints are highly dependent on the mix of resources selected in the portfolio. For instance, if these portfolios were to include a higher proportion of run-of-river resources instead of wind (as was the result of BC Hydro's recent calls for power), it is possible they would have a comparable or larger land and freshwater footprint compared to portfolios including Site C.

The land and stream footprint of the Site C reservoir represents a conversion of habitat from terrestrial and river environments to a reservoir environment. As a result, portfolios with the project include the creation of a 9,330-hectare reservoir, while portfolios without Site C do not. It should be noted, however, that pumped storage, an alternative capacity option, is assumed to occur on existing water bodies with no reservoir footprints for this modelling analysis. Since no pumped storage project has ever been developed in B.C., this is a planning assumption only to allow for comparison of options. Future assessment of this option may revise the footprint of pumped storage.

It is also important to note that the land and freshwater footprints in Table 3.2 only include the footprint of the primary generation site. For hydroelectric projects such as Site C and run-of-river resources, this footprint includes the structures to capture the fuel (i.e., the water) for generation purposes. For other resource options such as natural gas and biomass, the fuel collection footprint (e.g., fuel extraction and transportation) is not included in the land footprint. Due to this difference, the footprints provided here are not equivalent and are only relevant for high-level planning studies, as thermal and other resources would have an additional footprint to extract and transmit fuel.

Greenhouse Gas Emissions

Portfolios including the Site C project would have lower GHG emissions during operations than both sets of portfolios not including the project. The Clean Generation portfolios include a municipal solid waste resource option that includes GHG emissions from fuel combustion. The Clean + Thermal Generation portfolios have the highest level of GHG emissions due to the combustion of natural gas and municipal solid waste.

GHG comparisons between portfolios are done at a high level, and only on emissions during operations. More detailed information about life-cycle GHG emissions, including emissions during construction of Site C and other resources, is included in Section 5.5.

Local Air Emissions

Site C portfolios would have lower local air emissions than both portfolios not including the project. The Clean portfolios include both wood-based biomass and municipal solid waste resource options, which create local air emissions from fuel combustion. The Clean + Thermal portfolios include biomass resources as well as natural gas-fired generation and, as a result, have the highest level of local air emissions.

Table 3.2: Environmental Attribute Comparison

Environmental Attribute		Site C Portfolios	Clean Portfolios	Clean + Thermal Portfolios (Block #2)
Land Footprint *(ha)*		5,660	2,560	2,070
Affected Stream Length *(km)*		125	0	0
Operational GHG Emissions *(tonnes per year, 000s)*		0	220	510
Local Air Emissions *(tonnes/year, 000s)*	Oxides of Nitrogen	0	0.3	0.5
	Carbon Monoxide	0	0.0	0.9

NOTES:
1. All values are rounded.
2. The values provided for portfolios without Site C are indicative general values, with a high degree of variability for the purposes of a comparative analysis. The values provided for Site C are defined with much more accuracy due to the high degree of project definition.
3. GHG and local air emissions are only shown for fuel combustion during operations. For an estimate of life-cycle project GHG emissions including the construction period, see Table 5.5.
4. The Clean + Thermal Portfolio Block #1 provides similar values to Clean + Thermal Portfolio Block #2.

3.1.4 ECONOMIC DEVELOPMENT ATTRIBUTES

Based on the portfolio composition selected, Site C portfolios deliver greater levels of economic development during construction as compared to portfolios without the project. Jobs and GDP related to construction are higher for Site C portfolios due to the high job intensity during the construction period. Site C portfolios would contribute significantly more to GDP over the construction period than other alternatives, and would also increase employment during the construction period. Jobs and GDP during operations are expected to be lower for portfolios including Site C as a result of the project's low operating costs.

These estimates are high level for use in comparing the resource options at a portfolio level, and as with the environmental attributes, the exact difference between the economic development attributes is uncertain. As a result, while the comparison below is useful for planning purposes, it is not appropriate to directly compare the estimates of jobs and GDP during operations due to the large difference in estimating methodologies. For more detailed estimates of the effect of Site C on jobs and GDP, see Section 5.4.

3.2 RATIONALE FOR SELECTING SITE C

There is a need for new dependable capacity and energy resources within the next 5 to 15 years to meet the electricity needs of BC Hydro's customers. BC Hydro has an obligation to meet this customer demand, and has evaluated a range of different options to do so. Analysis of alternative resource options shows that portfolios including Site C would be cost-effective compared to other portfolios and would provide additional benefits to ratepayers and the province. This analysis confirms that Site C is the preferred option to meet future need.

Compared to the Clean Generation portfolios, portfolios with Site C would provide lower costs to ratepayers, more construction jobs and greater levels of economic development opportunities. In addition, levels of GHGs and local air emissions would be similar or lower in the Site C portfolios. Finally, as Site C provides both energy and dependable capacity, it would not require the additional dependable capacity that would be required to support intermittent resources.

Compared to the Clean + Thermal Generation portfolios, portfolios with Site C would provide lower costs to ratepayers, and would again provide more construction jobs and economic development opportunities. An important advantage of the Site C portfolios over the Clean + Thermal Generation portfolios is that they would produce significantly lower levels of greenhouse gas emissions and local air emissions. Finally, the Site C portfolios provide greater predictability in ratepayer costs because hydroelectric projects are not exposed to market fuel price fluctuations.

Based on the analysis of alternative resource options, Site C provides the best combination of financial, technical, environmental and economic development attributes and is therefore the preferred option to meet the need for energy and dependable capacity within BC Hydro's planning horizon. As a result, BC Hydro is proposing to build Site C to add 5,100 GWh of annual energy and 1,100 MW of dependable capacity to the system for its earliest in-service date.

Table 3.3: Economic Development Attribute Comparison

	Site C Portfolios	Clean Portfolios	Clean + Thermal Portfolios (Block #2)
Construction Jobs *(total jobs)*	44,250	30,790	20,960
Construction GDP *(millions)*	$3,680	$2,510	$1,710
Operations Jobs *(jobs per year)*	70	1,000	960

NOTES:
1. The values provided here are for the purposes of a high-level analysis of Site C compared to portfolios without Site C on an equivalent basis. For a more detailed consideration of the economic development attributes of Site C, see Chapter 5.
2. All values rounded to nearest 10.
3. The Clean + Thermal Portfolio Block #1 provides similar values to Clean + Thermal Portfolio Block #2.

4.0 PROJECT COSTS

CHAPTER HIGHLIGHTS

SITE C HAS A ROBUST, PEER-REVIEWED COST ESTIMATE

- **Project capital cost estimate of $7.9 billion is peer-reviewed**, and includes construction and development costs, inflation, contingencies and interest during construction.
- **Site C would be a cost-effective resource option** to help meet B.C.'s future electricity needs. Electricity from Site C would be produced at a unit energy cost of $83/MWh, which accounts for all anticipated costs over the project life.
- **Site C has higher capital costs, lower operating costs:** Like other large hydro projects, Site C would have high upfront capital costs, but low operating costs over its long life. This is different from other resource options like natural gas, which incur most of their costs over the operating life of the facility.
- **A lifespan of more than 100 years:** The project is expected to operate as long as it is maintained through regular investment of sustaining capital.

Site C has an estimated capital cost of $7.9 billion (nominal dollars), including an 18 per cent contingency on direct construction costs (see Table 4.1). It would produce electricity at a cost of $83 per megawatt hour (in F2013 dollars) at the point of interconnection, based on a real discount rate of 5 per cent. Site C would be among the most cost-effective resource options to help meet B.C.'s future electricity needs.

4.1 PROJECT CAPITAL COST ESTIMATE

BC Hydro developed a bottom-up cost estimate for Site C in F2011, based on the project's upgraded design and detailed construction schedule, with updated market prices for labour, equipment and materials.

An external peer review by KPMG determined that both the process for developing the assumptions and the construction of the financial model used in the cost estimate were appropriate.

The cost estimate for the Site C project is built up as follows:

- **Direct Construction Costs** were estimated using a bottom-up approach and were based on detailed quantity estimates and assumptions regarding the scope of work and construction schedule. Unit prices were based on updated market information for equipment, materials and labour.
- **Indirect Costs** were estimated using a mix of detailed estimates and industry experience with similar work. Costs associated with owner's supervision, engineering, and management requirements were estimated based on expected staffing levels during the development phase and during construction. Other costs, such as construction insurance and mitigation and compensation, were estimated based on experience with projects both in BC Hydro and worldwide.
- **Contingencies** on direct construction costs were evaluated. Separate analysis was completed for each major work package, and the cost implications of the following risks were evaluated:
  - Technical content (level of precision of design and associated quantity take-offs)
  - Precision of estimate (productivities, equipment selection, material costs and market variations)
  - Schedule (acceleration of activities to maintain overall schedule, if required)

- **Inflation** is added to reflect the cost increases that are anticipated to occur between the time of the estimate and the time at which the costs would actually be incurred.
- **Interest During Construction** is added to reflect the financing costs associated with the capital investment between the time at which costs are incurred and completion of the asset.

Table 4.1: Project Cost Estimate Breakdown

Project Cost Estimate Component	Cost Estimate F2011 millions
Dam and Associated Structures	$ 1,790
Earthfill Dam	
Approach Channels and RCC Buttress	
Spillway, Intakes and Penstock	
Left (North) Bank Stabilization	
Cofferdams, Dikes and Diversion Tunnels	
Power Facilities	$ 990
Powerhouse and Switchgear Building	
Stations and Transmission	
Offsite Works	$ 530
Highway 29 Relocation, Access Roads, Clearing, Land and Rights	
Construction Management and Services	$ 515
Worker Accommodation	
Construction Management and Construction Services	
Total Direct Construction Costs	**$ 3,825**
Indirect Costs	$ 1,005
Development Costs	
Regulatory Costs	
Construction Insurance	
Project Management and Engineering	
Mitigation and Compensation	
Contingency	$ 730
Total Construction and Development Costs (real dollars)	**$ 5,560**
Inflation	$ 790
Interest During Construction	$ 1,550
Total Construction and Development Costs (nominal dollars)	**$ 7,900**

NOTES:
1. Development costs starting April 2006
2. Contingency includes 18% on direct construction costs and 10% on indirect costs (excluding some costs in reserves)

4.1.1 COST CONTROL MEASURES

The Site C cost estimate has been prepared to an advanced feasibility study level (i.e., a Class 3 estimate as defined by the Association for the Advancement of Cost Engineering) and is sufficient to be used as a budgetary control estimate going forward. The advanced level of estimate is a reflection of the engineering, environmental and consultation work done in Stages 1, 2 and early Stage 3 to define the scope of the project.

BC Hydro is utilizing project management and project control methods to deliver the project within this mandate. The project cost estimate includes an appropriate level of contingency to reflect uncertainty in future conditions. In addition, the project procurement approach (see Chapter 6) has been designed to efficiently allocate and manage project risks to reduce the likelihood of construction cost overruns or delays.

Maintaining the project cost estimate is a key BC Hydro priority. It is the subject of regular review and ongoing tracking, and the project remains on track for delivery within the $7.9 billion cost estimate.

4.2 PROJECT OPERATING COST ESTIMATE

Site C would have low operating costs over the project's long life of more than 100 years. Costs during the operating phase of the Site C project have been estimated based on BC Hydro experience with comparable-sized facilities and equipment within the BC Hydro system. The components of costs during operations are as follows:

- **Water Rentals** are fees paid to the provincial government for the use of water for power generation or storage.
- **Grants-in-lieu** are payments related to electricity generating facilities located within an electoral area. These grants are in lieu of general, local improvement and regional district levies.
- **School Taxes** are paid on the assessed value of transmission assets.
- **Operations and Maintenance Costs** are non-capital costs associated with the operations of the project. These would generally consist of wages and benefits for plant staff, environmental monitoring costs, maintenance costs and general and administrative costs.
- **Sustaining Capital** reflects the capital investments BC Hydro expects to make in order to maintain project operations at required levels. This generally consists of the refurbishment or replacement of project components (e.g., turbines or generators). Sustaining capital expenditures vary significantly from year to year as different project components require rehabilitation or replacement on different schedules. The sustaining capital costs reported in Table 4.2 show the annual cost that would have an equivalent net present value to the forecast sustaining capital schedule for the project over the economic planning life.

Table 4.2 shows the breakdown of the annualized, real dollar operating costs for Site C.

Table 4.2: Annualized Operating Costs

Expenditure	(millions, F2011$)
Water Rentals	$ 34.0
Grants-in-Lieu and School Taxes	$ 2.6
Operations and Maintenance Costs	$ 7.5
Annualized Sustaining Capital	$ 10.2

GOVERNMENT REVIEW OF BC HYDRO

In June 2011, a government review of BC Hydro concluded that: "Site C is a reasonable cost alternative to meet load growth."

The independent panel noted in their report that Site C's cost of energy "compares favourably with other benchmarks for clean energy."

With regard to BC Hydro's load forecasting methodology, the review noted that: "BC Hydro's energy forecasting process is well planned and provides accurate, reliable forecasts. Each forecast receives multiple levels of review to ensure accuracy and completeness as well as being monitored on a month-to-month and quarterly basis."

The report is available at: www.newsroom.gov.bc.ca/downloads/bchydroreview.pdf.

4.3 UNIT ENERGY COST

The UEC of a resource option represents the annualized cost of the energy generated, and reflects both capital and operating costs. The UEC provides a basis for comparing resource options. Site C would produce electricity at a UEC of $83/MWh (in F2013 dollars at a 5 per cent discount rate) at the point of interconnection.

UECs are calculated by taking the present value of the total annual cost of an energy resource and dividing that by the present value of its annual energy benefit. The actual costs of the project to ratepayers will vary year to year and will be subject to decisions by the BCUC, particularly regarding the timing of cost recovery from ratepayers. For Site C, this calculation is performed for the 70-year planning life of the project. This 70-year period represents an appropriate evaluation period, however the project is expected to operate as long as it is maintained through regular investment of sustaining capital. The composition of Site C's UEC is shown in Table 4.3.

Table 4.3: Unit Energy Cost Composition

	($/MWh, F2013$)
Capital Cost	$ 70.75
Sustaining Capital	$ 2.00
Water Rentals	$ 8.25
Operating Costs	$ 1.50
Grants-in-Lieu and Taxes	$ 0.50
UEC at Point of Interconnection, in F2013 dollars at Tier 3 Rates	$ 83.00
Elimination of Tier 3 Water Rental Rates (see page 20)	($1.25)
UEC at Point of Interconnection, in F2013 dollars at Tier 2 Rates	$ 81.75

The Site C project's cost profile differs considerably compared to other fossil fuel-based resource options such as natural gas. Approximately 85 per cent of the costs for Site C are upfront capital costs followed by low operating costs over the long operating life of the project. Due to fuel costs, a natural gas-fired facility is the opposite, with most of its costs (approximately 70 per cent) being incurred over the operating life of the facility. Section 5.2 provides more information about Site C's comparative cost profile.

5.0 PROJECT BENEFITS

CHAPTER HIGHLIGHTS

SITE C DELIVERS SIGNIFICANT BENEFITS THROUGH EMPLOYMENT, ECONOMIC DEVELOPMENT, GOVERNMENT REVENUES, AND COST-EFFECTIVE ELECTRICITY FOR BC HYDRO RATEPAYERS

- **Significant increases to provincial and regional GDP:** The construction of Site C would contribute $3.2 billion to provincial GDP, including an approximately $130 million increase in regional GDP during the construction period.
- **Thousands of jobs:** Construction of Site C would create approximately 10,000 person-years of direct construction employment, and approximately 33,000 total jobs through all stages of development and construction. BC Hydro is committed to working with Peace region communities to provide local contracting and employment opportunities.
- **Energy and dependable capacity to meet peak demand:** Site C would have significant benefits for the BC Hydro system, including the ability to provide firm energy that can be relied upon to meet customer need throughout the year, and dependable capacity that can meet peak customer demand.
- **Lower costs and more predictable rates:** Site C would result in lower costs for BC Hydro customers than other clean energy options for the equivalent amount of energy and capacity. Site C would also reduce uncertainty in customer rates, as compared to fossil fuel-dependent generation resources that rely on fluctuating market prices for fuel.
- **Increased revenues for all levels of government:** During construction, Site C would result in a total of $40 million in tax revenues to local governments and, once in operation, $2.4 million in revenue from grants-in-lieu and school taxes. Activities during construction would result in approximately $179 million in provincial revenues, and approximately $270 million for the federal government. In addition, the Province would receive annual water rentals amounting to approximately $35 million per year.
- **Benefits for local communities:** A regional legacy benefits agreement will provide the Peace River Regional District (PRRD) and its member communities with an annual payment of $2.4 million (indexed to inflation) for a period of 70 years, commencing once Site C is operational. In addition, BC Hydro has been negotiating community agreements with communities affected by the proposed Site C project. Agreements have been reached with the District of Chetwynd and District of Taylor, and discussions are continuing with other communities.
- **Benefits for Aboriginal groups:** BC Hydro is endeavouring to advance economic opportunities for Aboriginal groups through capacity-building and procurement opportunities. BC Hydro is working to develop sustainable long-term relationships through actions such as the negotiation of impact benefit agreements.
- **Lower GHG emissions per unit of energy:** Sustainable energy benefits from Site C include having among the lowest GHG emissions, per gigawatt hour, compared to other electricity generation options. This would have the added benefit of helping the provincial and federal governments reach their GHG reduction targets.
- **Facilitates integration of renewables:** As a dependable and flexible resource, Site C would be able to quickly increase or decrease generation to match the output of intermittent resources such as wind and run-of-river.
- **Optimizes existing resources:** Site C would take advantage of water already stored behind the existing W.A.C. Bennett Dam, generating about 35 per cent of the facility's energy with only five per cent of the reservoir area.

The Site C project would provide key benefits, including energy, dependable capacity and flexibility, regional economic development, job creation and increased government revenues, as well as benefits for communities and Aboriginal groups.

5.1 ECONOMIC BENEFITS

Construction and operation of Site C would generate economic benefits at the local, provincial and federal level due to the purchase of goods and services for construction, operations and sustaining capital investment. These purchases would result in an increase in output from supplier industries, GDP and household income. The full analysis is described in the Site C EIS.

The estimated effect on output, GDP and household income at the regional and provincial level during construction and operation of the project is presented in Table 5.1. The majority of the effect on federal GDP would be due to the increase in B.C. provincial GDP. However, estimated imports from other provinces are provided in order to reflect the GDP increase in other provinces.

As Table 5.1 shows, the construction of Site C would result in an increase of $3.2 billion to provincial GDP, including a $130 million increase in regional GDP during the construction period.

5.1.1 EMPLOYMENT BENEFITS

Construction of Site C would create approximately 10,000 person-years of direct construction employment, and approximately 33,000 total jobs through all stages of development and construction.

In addition, the Site C project would provide 25 permanent direct jobs during operations. Additional employment would result from sustaining investments in the project such as refurbishment and/or replacement of project components over the life of the project. These sustaining capital investments would vary significantly from year to year, as different components of the project require investment.

Table 5.1: Economic Development Benefits from Site C

	Total Increase During Construction *($ millions)*	Total Increase During Operations *($ millions per year)*
Regional		
GDP	130	0.4
Output	320	1.1
Household Income	80	0.3
Provincial (including Regional)		
GDP	3,230	7.0
Output	3,020	13.5
Household Income	2,230	4.9
Federal		
Imports from Other Provinces	580	1.8

NOTES:
1. All values rounded
2. Total increase for both construction and operations include increases from direct, indirect and induced suppliers.
3. Total increase during operations shown is an average of annual values.

Table 5.2: Estimated Employment Provided by Site C			
	Direct Jobs	Indirect and Induced Jobs	Total Employment
Development and Construction Phase (person years)			
Development Phase	2,200	1,500	3,700
Construction Phase	10,200	19,100	29,300
Total Jobs Prior to In-Service Date	**12,400**	**20,600**	**33,000**
Operations Phase (average person-years per year)			
Operations and Maintenance	25	65	90
Sustaining Capital (levelized)	35	40	75
Total Employment After In-Service Date	**60**	**105**	**160**

NOTE:
1. All values rounded. Sums may not add up due to rounding.

5.1.2 BENEFITS FOR ABORIGINAL GROUPS

BC Hydro is committed to the advancement of economic opportunities for Aboriginal groups to build capacity and develop sustainable long-term relationships. BC Hydro has an existing Aboriginal Contract and Procurement Policy to increase the involvement of Aboriginal groups in economic opportunities associated with BC Hydro's business activities. Procurement practices under this policy include:

- **Capacity-Building Initiatives:** BC Hydro is implementing capacity-building initiatives, which provide funding or resources in order to provide training, improve skills or increase business capacity in Aboriginal businesses.
- **Directed Aboriginal Procurement:** BC Hydro will undertake directed Aboriginal procurement initiatives that could include set-asides, restricted tendering and single-source negotiations.
- **Aboriginal Evaluation Criteria:** The use of Aboriginal evaluation criteria in procurement packages will provide an incentive for primary contractors to establish working relationships with Aboriginal groups and increase Aboriginal participation in construction contracts while maintaining a competitive environment that provides maximum benefits to ratepayers.
- **Aboriginal Business Directory:** BC Hydro's Aboriginal Business Directory is accessible to suppliers and contractors, and enables BC Hydro to promote partnerships between non-Aboriginal and Aboriginal businesses in contract work for BC Hydro.

5.1.3 BENEFITS FOR COMMUNITIES

Building on benefits related to local government revenues, economic development opportunities and employment opportunities, local communities would benefit from additional economic and social benefits initiatives being pursued by BC Hydro. These include:

- **Improved Infrastructure:** Some roads and highways that would be upgraded and enhanced during the construction phase would support the long-term economic development of regional communities, both during and after project construction. In addition, it is anticipated that quarry development will result in a surplus of materials following construction that would be available for use by the Ministry of Transportation and Infrastructure and others.
- **Recreation and Tourism Opportunities:** The construction and operation of Site C would provide new and expanded recreation and tourism opportunities for residents of the Peace Region, such as new boat launches and day use areas, public viewpoints of the dam site and funding for community recreation sites. Fishing opportunities during operations would also be expected to increase as the Site C reservoir would support increased boating and angling use, and would continue to support sport fish.
- **Affordable Housing:** To encourage workers to live locally, BC Hydro is working in cooperation with BC Housing toward building approximately 40 new housing units for use by BC Hydro's workforce and their families during construction, plus 10 new affordable housing units. After construction of the Site C project, all of the housing units would be available as affordable housing in the community. BC Hydro's participation would provide a financial contribution to offset the cost of building affordable housing for the region.
- **Legacy Benefits:** A regional legacy benefits agreement will provide the Peace River Regional District (PRRD) and its member communities with an annual payment of $2.4 million (indexed to inflation) for a period of 70 years, commencing once Site C is operational. In addition, BC Hydro has been negotiating community agreements with communities affected by the proposed Site C project. Agreements have been reached with the District of Chetwynd and District of Taylor, and discussions are continuing with other communities.

5.1.4 CAPACITY BUILDING FOR ABORIGINAL GROUPS AND COMMUNITIES

With the current high level of labour participation in the local area, BC Hydro recognizes the need to ensure a local labour supply for Site C and other BC Hydro projects in the Peace region. BC Hydro is working with contractors, employers, educational institutions, local and Aboriginal community groups, employment agencies and related organizations to advance initiatives to secure an available supply of qualified local workers. Some examples of initiatives aimed at providing local labour opportunities include:

Skilled trades capacity building:

- Providing $1 million to support trades and skills training at Northern Lights College, 50 per cent of which is dedicated to Aboriginal students
- Participating in the Northeast Regional Workforce Table Task Force, which works toward a current understanding of labour demand and supply in the northeast
- Contributing over $175,000 to the Northern Opportunities Partnership over five years to aid in the continued attraction of new entrants into trades training
- Liaising with local education and training institutions to identify required training and facilitate its availability
- Providing $184,000 to Northern Opportunities for the creation of a school district career counsellor position to help students transition into trades and career training
- Providing $100,000 to the North East Native Advancing Society to support Aboriginal entry into trades training

Enabling activities:

- Promotion of job opportunities within the local community, including working with construction contractors to facilitate local and Aboriginal hiring
- Collaboration with local community partners for the provision of a daycare facility

More information about local business opportunities can be found in Chapter 6.

5.2 RATEPAYER BENEFITS

Value of Energy to the Economy: BC Hydro electricity is currently among the most competitively priced in North America, which benefits households and provides a competitive advantage for businesses and industries operating in B.C. This is largely due to BC Hydro's system of heritage hydroelectric projects, the costs of which have been depreciated and now produce electricity at a very low cost to ratepayers. These projects were built decades ago, in anticipation of customer needs over the long term. At the time they came into service, these projects not only met need, but also provided more electricity than was required at that specific point in time. B.C. became recognized as an attractive place to invest – in large part due to the abundance of affordable electricity. The economy grew alongside of, and as a result of, BC Hydro's own investments in the system.

By keeping electricity bills competitive relative to other jurisdictions, BC Hydro has helped British Columbia remain an attractive place for doing business. However, without planning and building for anticipated need, the ability of BC Hydro to maintain this competitive advantage could be impaired. Site C would help BC Hydro maintain this advantage by having a lower rate impact on BC Hydro customers than other clean energy options for the equivalent amount of energy and capacity.

Lower Cost to Ratepayers: Large hydro projects, such as Site C, have a significant upfront capital cost, followed by low operating costs and a long life of more than 100 years. To reduce the rate impact on customers, BC Hydro anticipates that the costs for Site C would be amortized over a long period, the duration of which would be determined through a future regulatory process with the BCUC.

Site C would result in a lower cost for BC Hydro customers than other clean energy options for the equivalent amount of energy and capacity. The impact on BC Hydro ratepayers is estimated as the expected difference in unit energy costs between different portfolios of resources to meet B.C.'s energy gap, as described in Chapter 3.

Figure 5.1 depicts the difference in rate impacts between portfolios including Site C and the Clean Generation portfolios without Site C. While the project will create an approximately 3 per cent cumulative rate increase for the first few years, rates would then be lower for the remainder of Site C's operating life of more than 100 years.

Figure 5.1: Difference in Rate Impact between Site C Portfolio and Clean Portfolio

Cost Profile: Site C would improve predictability in customer rates. Site C's operating costs would be stable and predictable because the majority of costs are incurred during construction and development. In contrast, for a thermal resource such as a natural gas-fired generation facility, a significant portion of the costs are incurred during operations, particularly due to the cost of fuel. This dependency on fuel prices results in the potential for cost fluctuations due to changing natural gas market conditions.

Table 5.3 demonstrates the difference in the UEC composition of Site C compared to a sample natural gas-fired generating facility.

5.3 SYSTEM BENEFITS

Site C would be a clean, renewable and reliable power resource that would provide long-term energy, capacity and other system benefits to the provincial power grid.

Energy: Site C would provide an average of 5,100 GWh of energy every year. Over 90 per cent of this average energy is firm energy, available to serve BC Hydro customers even in the driest historical weather conditions.

Dependable Capacity: Site C would add 1,100 MW of dependable generation capacity to the BC Hydro system. Dependable capacity is the maximum amount of power that can be reliably supplied to meet peak instantaneous demand.

Flexibility: Due to the ability to store water in a reservoir, power produced from large hydroelectric resources like Site C can typically be adjusted to meet the needs of the overall power grid, such as the fluctuations in the system load, or in response to varying levels of energy supplied by intermittent resources. As discussed in more detail in Section 5.5, Site C would be capable of varying its generation within a short period of time to match instantaneous demands for the benefit of BC Hydro customers and the system as a whole.

The flexibility of a resource like Site C is an important means of keeping rates low for customers. This is because BC Hydro can make economic decisions about when to use the stored water to generate electricity, and when to use other sources such as market electricity purchases. The ability to trade electricity with other jurisdictions is a key tool that BC Hydro uses to help keep electricity rates low.

Table 5.3: Comparison of UEC Between Site C and Sample Combined-Cycle Gas Turbine

Component of UEC	Site C	Combined-Cycle Gas Turbine
Construction and Development Costs	85%	30%
Operations Costs, Sustaining Capital, Taxes	5%	10%
Fuel Costs (water rentals / natural gas)	10%	60%

NOTE:
1. All numbers rounded to nearest 5 per cent.

BENEFITS OF ELECTRICITY TRADE TO BC HYDRO RATEPAYERS

With the flexibility of the large reservoirs behind its major dams, BC Hydro can make economic decisions about when to use the stored water to generate electricity, and when to use other sources such as purchases. These economic decisions are based on buying electricity from our neighbours in Alberta and the western United States when prices are generally lower (e.g., non-peak periods) and selling electricity to our neighbours when prices are generally higher (e.g., peak periods).

Electricity trade activities help optimize BC Hydro's electricity system resources and provide significant economic benefits to BC Hydro customers. Electricity trade is important because it:

1. **Improves system reliability** by allowing BC Hydro to purchase electricity when required for domestic need
2. **Provides value to ratepayers** by allowing BC Hydro to optimize its system operations, which helps keep electricity rates lower for all British Columbians

Electricity sales help balance the BC Hydro system for periods when there is excess water in the system while generating additional revenue that benefits BC Hydro ratepayers. Site C would add to BC Hydro's system flexibility, increasing the opportunities to trade for the benefit of BC Hydro customers.

Optimizing Existing Facilities on the Peace River: A key advantage of the Site C project is its location on the Peace River downstream of the existing W.A.C. Bennett and Peace Canyon dams and their respective Williston and Dinosaur reservoirs. The Williston Reservoir has a multi-year storage capacity, capable of storing water in wet years for use in dry years, and in high runoff seasons for use in low runoff seasons.

As a result of the upstream facilities, the flow into the proposed Site C reservoir is already regulated to provide year to year, as well as seasonal and weekly shaping. The generating facilities at Site C would further optimize the storage value provided by the Williston Reservoir, as the regulated flows would be used for generation a third time after being run through turbines at the two upstream facilities. This upstream regulation allows the Site C project to generate electricity to match the timing of BC Hydro customer demand without establishing a large multi-year storage reservoir similar to the Williston Reservoir. As a result, Site C would be able to produce approximately 35 per cent of the energy produced at the W.A.C. Bennett Dam, with only five per cent of the reservoir area.

5.4 GOVERNMENT REVENUES

Table 5.4 provides a summary of local, provincial and federal government revenues from Site C.

Construction of Site C would result in a total of about $490 million for all three levels of government through taxation and water rental revenues generated by the project. Once operational, Site C would contribute about $40 million annually to provincial and local governments through grants-in-lieu of taxes, school taxes, water rental fees, and the legacy benefits agreement. These revenues are described in more detail on the following page.

Table 5.4: Summary of Government Revenues (selected years) (F2012 $millions)

	Construction Period Total	Operations Period				
		Year 1	Year 5	Year 10	Year 25	Year 50
Local Revenues	40	5	5	5	5	5
Provincial Revenues	179	35	35	35	35	35
Federal Revenues	270	<1	<1	<1	<1	<1

5.4.1 LOCAL GOVERNMENT REVENUES

The Site C project would provide additional revenues to local governments during both construction and operation of the project. The major sources of these revenues would be general taxation revenues, grants-in-lieu and school taxes. These revenues are in addition to the $2.4 million annual payment to the PRRD for a period of 70 years (indexed to inflation) under the Site C legacy benefits agreement (discussed in Section 5.1.3).

Taxation Revenues: The key source of additional taxation revenues to local governments would be from incremental property taxes collected from new residents and businesses in local communities that would be attracted by the opportunities presented by the construction of the project. There would be a total of $40 million in direct, indirect and induced incremental tax revenues resulting from the construction phase of the project. Once in operation, the majority of traditional taxation revenues from Site C would be replaced by grants-in-lieu of taxes.

Grants-in-Lieu of Taxes: While BC Hydro's generating facilities are generally exempt from assessment and taxation, in most cases the Province authorizes BC Hydro to pay an additional annual grant-in-lieu of taxes to local communities during project operations. If authorized by the Province to pay grants-in-lieu for the Site C project, BC Hydro would pay an estimated $1.3 million per year (in 2012 dollars), based on current rates. This rate would be indexed to annual inflation in municipal tax revenues.

School Taxes: As discussed above, BC Hydro generating facilities are generally exempt from assessment and taxation, and pay grants-in-lieu instead. However, this exemption does not extend to transmission assets. As a result, transmission assets associated with Site C would be subject to school taxes. The estimated school taxes on Site C's transmission assets would provide approximately $0.8 million per year (in 2012 dollars), but would depend on the actual assessed value of the assets once constructed. The school tax rate varies annually, but typically increases at the rate of inflation.

5.4.2 PROVINCIAL AND FEDERAL GOVERNMENT REVENUES

The provincial and federal governments would be expected to receive incremental revenues as a result of the Site C project during both construction and operations. The major sources of provincial government revenue would be general taxation revenues and water rentals. Federal government revenues would be primarily from taxation revenues.

Taxation Revenues: During construction, incremental revenues would come from taxes on a range of sources that would be associated with the project, such as income taxes, property taxes and sales taxes. It is estimated that the provincial government would receive approximately $176 million in revenues from direct, indirect and induced activities during the construction phase. The federal government would collect an estimated $270 million over the same period from direct, indirect and induced activities.

Water Rentals: Water rentals are fees paid by BC Hydro and collected by the Water Stewardship division of the B.C. Ministry of Environment. Based on current water rates, the annual water rental revenues to the Province associated with Site C are expected to be about $35 million dollars (in 2013 dollars). Water rentals are currently indexed to escalate at the rate of inflation and are therefore expected to stay constant, on a real dollar basis.

5.5 SUSTAINABLE ENERGY BENEFITS

Site C would be a clean and renewable electricity generation option. Key attributes include Site C's low level of GHG emissions on a per-gigawatt-hour basis, as well as the project's ability to support the integration of intermittent clean or renewable energy resources into the provincial power grid.

Low Greenhouse Gas Emissions: All generation resources emit some GHGs associated with construction and operations during their life-cycle. GHG emissions for Site C were modelled using International Panel on Climate Change guidelines. This modelling found that the Site C project would have among the lowest emissions per unit of energy produced compared to other forms of electricity generation.

Table 5.5 provides a comparison of GHG emissions intensities from renewable and non-renewable resources.

Table 5.5: Comparison of GHG Emissions intensity

Generating Facility Type	Average *(g CO_2e/kWh)*
Site C Clean Energy Project	10.5
Canadian Boreal Hydroelectric	36
Tropical Hydroelectric	2,150
Modern Coal	1,000
Integrated Gasification Combined Cycle (Coal)	798
Diesel	717
Natural Gas Combined Cycle	545
Solar Photovoltaic	58
Wind Turbines	14

NOTE:
1. Table includes GHGs emissions during both construction and operations. For the portfolio analysis in Chapter 3, GHG emissions are shown only during operations due to availability of data.

GHG emissions from Site C, per unit of energy, would be at levels comparable to other renewable sources such as wind. The project would produce substantially less GHG emissions, per gigawatt hour, than thermal sources such as natural gas, diesel or coal, because they have additional GHG emissions associated with the operational combustion of hydrocarbons.

Table 5.5 also shows that GHG emissions from the Site C reservoir would fall within the low end of the emission range reported for reservoirs around the world as a result of being located in a northern environment. The project also benefits from having a smaller reservoir than would typically be required for a project of its generating capability, due to the upstream storage provided by the Williston and Dinosaur reservoirs.

Over the next 100 years, Site C would produce the same or lower GHG emissions than all other options available in B.C. for the 5,100 GWh of energy that Site C would generate per year. This would have the added benefit of helping the provincial and federal governments reach their GHG reduction targets.

Integration of Intermittent Resources: The flexibility and dependability of the power produced by Site C would facilitate the integration of intermittent energy resources, such as wind and run-of-river hydro, to the provincial power grid.

Intermittent resources rely on fuel supplies that may not always be available when required. For example, run-of-river hydro projects do not have any significant storage, meaning their output varies with the natural flow in the river. Site C would benefit from the upstream storage in the Williston Reservoir, and would complement the availability of run-of-river hydro by generating less electricity when run-of-river projects are providing power to the system, and generating more electricity when run-of-river systems are generating less.

Wind generation is another example of an intermittent resource. Due to natural variations in wind speed, wind power generation is variable from hour to hour and, in some cases, minute to minute. Wind generation is difficult to forecast in the hour-to-day-ahead timeframe, which results in a need to set aside flexible system resources to prepare for the potential for more or less electricity than expected in that time frame. Site C could facilitate the integration of wind while maintaining system reliability by providing power that could quickly respond to variations. Preliminary modelling indicates that Site C could increase the maximum amount of wind power that can be integrated into the BC Hydro system.

6.0 PROCUREMENT APPROACH AND RISK MANAGEMENT

CHAPTER HIGHLIGHTS

OPPORTUNITIES FOR SMALL, MEDIUM AND LARGE BUSINESSES

- **Approach provides appropriate risk transfer and value for money:** BC Hydro's procurement planning process considered the benefits, costs and risks of a range of traditional and alternative forms of capital procurement for the Site C project. This process identified opportunities to transfer risk and to benefit from private sector innovation while meeting target levels of performance and achieving value for money for the ratepayer.
- **Multiple large contracts for major works, smaller contracts for other works:** A procurement approach has been developed that supports the project objectives. It consists of a number of large contracts for major project components, as well as multiple smaller contracts for supporting activities and ancillary works.
- **Opportunities for small, medium and large businesses:** The procurement approach for Site C is expected to result in opportunities for small, medium and large businesses. Site C opportunities are well-aligned to the skills present in the local business community, and these skills, combined with local knowledge, are expected to create opportunities for local businesses.
- **Encourage local and Aboriginal participation:** One of BC Hydro's project objectives for Site C is to provide lasting economic and social benefits for northern communities, Aboriginal groups and the province.
- **Construction of Site C subject to environmental certification and other requirements:** Construction of Site C is subject to the project receiving required environmental certification and other permits and approvals, and fulfilling the Crown's duty to consult and, where appropriate, accommodate Aboriginal groups.

6.1 PROCUREMENT APPROACH

A procurement planning process was undertaken to develop a procurement approach for the Site C project. The process was led by an integrated team that included BC Hydro staff and consultants.

BC Hydro's procurement approach for the construction of Site C was designed to achieve the following procurement objectives for the project:

- Achieve value for money for ratepayers
  - Maximize cost-effective project performance (generation capacity, energy and flexibility)
  - Structure a fair and competitive procurement process
  - Meet project schedule
  - Meet project budget
  - Optimally manage project risks
  - Support the Site C project objectives, including providing economic opportunities for Aboriginal groups, northern communities and the province

In addition, the Site C procurement approach considered the guiding principles of the B.C. government's Capital Asset Management Framework, which emphasizes the principles of fairness, openness, transparency, risk allocation and management, value for money, public interest, and competition in public sector capital procurement.

6.1.1 PROCUREMENT PLANNING PROCESS

The *Clean Energy Act* mandates that Site C will be a publicly owned heritage asset. Within this context, the Site C procurement planning process considered a range of traditional and alternative forms of capital procurement for construction of the components of the overall facility. The approach evaluated the benefits, costs and risks of traditional and alternative procurement approaches.

In doing so, BC Hydro identified opportunities to transfer risk and to benefit from private sector innovation while meeting target levels of performance and achieving value for money for the ratepayer.

The procurement planning approach adopted by BC Hydro included three key steps, as shown in Figure 6.1 and described to the right.

Step 1 - Component Definition

- Disaggregation of project scope into sets of components
- Definition of component boundaries according to scope, geography, and construction logistics and interfaces

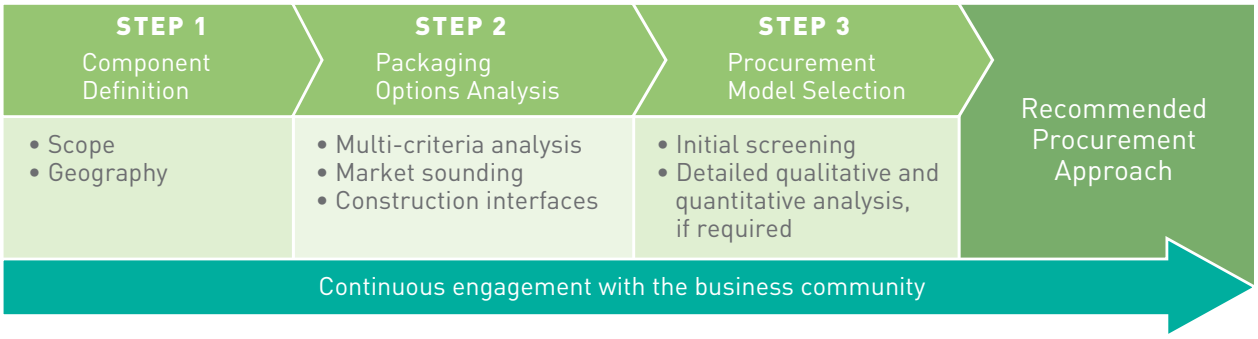
Step 2 – Packaging Options Analysis

- Identification and consideration of component combinations based on benefits, costs and risks
- Development and assessment of a range of packaging options for each component

Step 3 – Procurement Model Selection

- Initial screening of procurement models for each component package, based on commercial factors and public policy constraints
- Qualitative and/or quantitative analysis, if required, of short-listed models based on procurement objectives including ratepayer value

Figure 6.1: Procurement Planning Process



6.1.2 PROCUREMENT APPROACH

The procurement approach for Site C consists of a number of large contracts for major project components, as well as multiple smaller contracts for supporting activities and ancillary works. It is expected that additional small and medium-sized contracts will be identified as the design work progresses.

The recommended procurement approach is based on the project design, the expected construction sequencing and schedule, and assumptions about market conditions. These assumptions will be refined as the project moves closer to construction and additional opportunities to encourage the participation of regional and First Nations contractors are identified. The procurement approach was therefore developed to retain flexibility in its implementation wherever possible. The procurement approach for Site C is summarized in Table 6.1

Construction of Site C is subject to the project receiving required environmental certification and other permits and approvals, and fulfilling the Crown's duty to consult and, where appropriate, accommodate Aboriginal groups.

As shown in Table 6.1, some procurements for the construction of Site C are underway. It is standard practice for major infrastructure projects like Site C to initiate procurements during environmental and other regulatory processes. This allows BC Hydro to better manage risks to budget and schedule by starting the procurement process early. However, no construction will take place until the project receives environmental certification and other approvals.

OPPORTUNITIES FOR LOCAL BUSINESSES AND ABORIGINAL GROUPS

One of BC Hydro's project objectives for Site C is to provide lasting economic and social benefits for northern communities and Aboriginal groups.

The procurement approach for Site C is expected to provide opportunities for small, medium and large businesses to participate in the construction of the project. Site C opportunities are well-aligned to the skills present in the regional business community, and these skills, combined with local knowledge, are expected to create opportunities for these businesses.

Opportunities for local businesses was a key theme raised during two rounds of Site C Business Information Sessions in the region. Based on this feedback, BC Hydro has developed a regional contractor engagement approach to assess the capacity of regional contractors, identify potential matches between regional contractors and project work, and build relationships and communicate with businesses about opportunities.

Site C Business Directory

The Site C Business Directory ensures that interested businesses are provided with information about project opportunities. Registered companies receive updates, via email, on potential business opportunities as they arise, as well as notifications about events such as business information sessions. Registrants are encouraged to identify their affiliation with an Aboriginal group, if applicable. Interested businesses are encouraged to visit sitecproject.com to register. The business directory will be shared with contractors involved with project-related activities.

Business-to-Business Networking Sessions

BC Hydro will facilitate local and regional businesses having access to work opportunities on the Site C project by holding business-to-business networking sessions where successful contractors can meet local suppliers and potentially form partnerships.

Business-to-business networking sessions for the Main Civil Works and Worker Accommodation contracts are expected to be held in the Peace region in summer 2014, once the proponents have been selected. At these sessions, local, regional and Aboriginal businesses will have the opportunity to meet the proponents, with the objective of building partnerships and opportunities for regional contractors.

Table 6.1 refers to a number of procurement models, which are defined as follows:

- **Design-Bid-Build (DBB)** A procurement model where design and construction elements of a scope of work are procured under separate contracts, while the owner retains the design risk and responsibility for interface management, as well as the operations and maintenance associated with the scope of work.
- **Design-Build (DB)** A procurement model where the design and construction of a scope of work is procured under a single contract. The counterparty assumes a significant portion of the design and construction risks for the scope included in the contract. The owner retains responsibility for the operations and maintenance associated with the scope of work.
- **Design-Build-Finance-Operate-Maintain (DBFOM)** A procurement model where the design and construction of a scope of work is procured under a single contract, as well as the associated operations and maintenance for a set term. The counterparty is responsible for providing all or a portion of the financing during the term of the contract and is generally paid based on project availability.

Table 6.1: Summary of Procurement Approach for Site C				
	Component	Scope of Work	Procurement	Rationale
Generating Facilities	Main Civil Works	Excavation and bank stabilization – more than 32 million m^3 of excavation associated with diversion, foundations and stabilizations. Diversion Works – Two ~11m diameter concrete-lined tunnels between 700m and 800m in length, plus associated cofferdams, and intake and outlet structures Earthfill Dam – Zoned earth embankment approximately 1,050m long and 60m above the present riverbed RCC Buttress – Roller Compacted Concrete (RCC) gravity structure approximately 800m in length and at a maximum height of 70m (total RCC volume of approximately 2.4 million m^3). **Construction Timing:** 2015 to 2022/23	**Approach:** Single contract for all major earthworks, including diversion works, earthfill dam and RCC buttress. Contract to be DBB. **Procurement Timing:** RFQ issued April 2014 Contract award anticipated: 2015	Single contract for all major earthworks components at the dam site allows the contractor to: • Optimize the sequencing of the construction activities • Maximize the utilization of staff, labour and equipment resources • Maximize efficiencies in the reuse of excavated material and the relocation of surplus material. Packaging all major earthworks components at the dam site also allows BC Hydro to transfer the schedule and construction interfaces between the components, and their associated risks, to the contractor. DBB model selected due to limited ability to transfer long-term geotechnical risks associated with the design of the earthfill dam.
	Generating Station and Spillways	Reinforced concrete – for spillways, intakes, penstock encasement, powerhouse substructure and retaining walls (total of approximately 1.1 million m^3 of concrete). Structural Steel – fabrication and erection of powerhouse and penstocks. Balance of plant – electrical and mechanical works, HVAC, compressed air, fire protection, etc. Hydromechanical equipment – gates, stoplogs, trashracks, etc. **Construction Timing:** 2017 to 2022	**Approach:** Single contract for civil works, hydromechanical equipment, transformers, and balance of plant. Contract to have both DBB and DB elements. **Procurement Timing:** Anticipate initiating procurement in 2015/2016	Single contract for the majority of works associated with the generating station and spillways allows the contractor to optimize the sequencing of the construction activities and achieve efficiencies in the execution of the construction. Packaging the majority of works associated with the generating station and spillways also allows BC Hydro to transfer the schedule and construction interfaces between the components, and their associated risks, to the contractor. DBB-DB hybrid model selected enables transfer of some design responsibility, allowing for innovation and an efficient delivery of components.

Table 6.1: Summary of Procurement Approach for Site C (continued)				
	Component	Scope of Work	Procurement	Rationale
Generating Facilities	Turbines and Generators	Supply and installation of six 183 MW vertical axis Francis turbines. Supply and installation of generators, governors and exciters. **Construction Timing:** Design: 2016 Fabrication: 2017 Installation: 2018 to 2022	**Approach:** Single DB contract for turbines, generators and associated equipment, including governors and excitors. **Procurement Timing:** RFQ issued summer 2012 Contract award anticipated: 2015	Single contract for the turbines, generators and associated equipment allows BC Hydro to transfer the schedule and operational interfaces between the components, and their associated risks, to the contractor. DB model selected, as Site C requires custom-designed turbines to suit head and flow conditions.
Supporting Works	Worker Accommodation	Fabrication, installation and servicing of two construction camps, including housing, cafeterias and recreational facilities to house approximately 1,700 persons (total) during peak construction periods. Includes: • North Bank Camp – estimated maximum size 500 persons (constructed first) • South Bank Camp – estimated maximum size 1,200 persons in Years 5 and 6 **Construction and Operations Timing:** 2015 to 2022	**Approach:** Single DBFOM contract for both construction and operations of on-site worker accommodation. Other contracts may be required for off-site accommodation. **Procurement Timing:** RFQ issued March 2014 Contract award anticipated: 2015	Single contract for both camps promotes consistency in the quality of facilities and the level of service delivered at both camps. The DBFOM model is expected to provide the greatest incentive for the contractor to provide the best full life-cycle solution, since the contractor will be responsible for all aspects of worker accommodation, from design through to decommissioning. The DBFOM model is also considered to be consistent with current industry practice and it is therefore expected that it will generate the most competition among industry participants and allow BC Hydro to establish the most competitive terms.

Table 6.1: Summary of Procurement Approach for Site C (continued)				
	Component	Scope of Work	Procurement	Rationale
Supporting Works	Reservoir Clearing	Clearing and removal of timber and vegetation, and salvage of merchantable timber, over the area that will be inundated by the reservoir. Total clearing including early clearing and reservoir clearing estimated to be 1.4 million m^3 of merchantable and 1.2 million m^3 of non-merchantable fibre, including early works. **Construction Timing:** Currently under consideration	**Approach:** Multiple contracts: each contract would be for a specific lot of land, and include all reservoir clearing activities associated with that lot (e.g., access road construction, clearing and marketing of merchantable timber, and removing/ disposing of non-merchantable timber/ vegetation). **Procurement Timing:** Anticipate initiating procurement in 2015	Packaging all reservoir clearing activities associated with a specific lot of land allows BC Hydro to transfer the schedule and quality interfaces between the activities, and their associated risks, to the contractor. Dividing the work into lots of land allows BC Hydro to align the contracts with market capacity (the size of the lots will be determined by the prevailing market conditions at the time of procurement) and should provide opportunities for regional and First Nations participation.
	Public Road Infrastructure	Realignment of multiple sections of Highway 29 over a total distance of approximately 30km, and any additional modifications to public road infrastructure. Activities include paving, excavation, embankment construction, bridge removal and construction and shoreline protection measures. **Construction Timing:** Local infrastructure: 2015 to 2017 Early highway sections: 2017 to 2019 Final highway sections: 2019 to 2021	**Approach:** Under discussion with the Ministry of Transportation and Infrastructure. **Procurement Timing:** Anticipate initiating procurement over the period from 2015 to 2019 for the various scopes	Agreement on responsibilities will result in a more efficient procurement process.
	Transmission Line	Two-77km 500kV transmission lines from Site C substation to Peace Canyon substation. Decommissioning of existing 138kV transmission lines and integrating 138kV circuits to Site C substation. Three 500kV overhead lines from the generating station to the Site C substation. **Construction Timing:** 2016 to 2021	**Approach:** Single contract for all transmission lines work. Additional analysis is required to confirm delivery method. **Procurement Timing:** Anticipate initiating procurement in 2016	Packaging all scopes of work associated with the transmission lines allows BC Hydro to transfer the schedule and logistical interfaces between the activities, and their associated risks, to the contractor.

Table 6.1: Summary of Procurement Approach for Site C (continued)				
	Component	Scope of Work	Procurement	Rationale
Supporting Works	Site C Substation	Substation connecting the power feed from the Site C generating station to the two 500kV lines from Peace Canyon and the 138kV local power supply. **Construction Timing:** 2017 to 2019	**Approach:** Single contract for Site C substation. Additional analysis is required to confirm delivery method. **Procurement Timing:** Anticipate initiating procurement in 2016	Consideration was given to combining the substation and transmission line scopes of work. However, as the types of contractors undertaking transmission line and substation work are distinct, awarding separate contracts for the Site C substation and the transmission lines allows BC Hydro to select the optimal contractor for each type of work.
	Supporting Activities	There will be a large number of activities required to support the construction of the project. Examples of supporting activities include: • Boat launches • Day use recreation areas • Environmental monitoring • Hudson's Hope shoreline protection • Operation of satellite worker accommodation camps (if required) • Park and ride facilities • Peace Canyon substation expansion • Site security • Site re-vegetation • Transportation and shuttle services • Wildlife or fish mitigation projects • Other supporting activities **Construction Timing:** 2015 to 2022	**Approach:** Varies; direct or subcontract. **Procurement Timing:** Varies	The procurement approach for supporting activities has not yet been defined in detail. The approach will be determined with reference to the procurement objectives. It is likely that some of the supporting activities will be procured through direct contracts, while some will be packaged with other contracts.

Table 6.1: Summary of Procurement Approach for Site C (continued)				
	Component	Scope of Work	Procurement	Rationale
Early Works	Early Clearing	Clearing of dam site and lower reservoir (expected to be approximately 300,000 m^3 merchantable timber, plus additional non-merchantable fibre) **Construction Timing:** 2015	**Approach:** Multiple contracts for clearing and disposal of specific lots. Size of lots to be determined. **Procurement Timing:** Anticipate initiating procurement in 2014	Packaging all clearing activities associated with a specific lot of land allows BC Hydro to transfer the schedule and quality interfaces between the activities, and their associated risks, to the contractor. Dividing the work into lots of land allows BC Hydro to align the contracts with market capacity (the size of the lots will be determined by prevailing market conditions at the time of procurement) and should provide opportunities for regional and First Nations participation.
	Early Civil Works	The early civil works include preparatory works, primarily at the dam site, such as: • Site preparation • Excavation and bank stabilization • Construction of access roads Site preparation may include clearing, grubbing and stripping, as well as removal or disposal of wood debris. **Construction Timing:** 2015	**Approach:** Primarily DBB **Procurement Timing:** Anticipate initiating procurement in 2014	Contract(s) for preparatory site works enables scheduling advantages to be achieved through early mobilization.
	Infrastructure Contracts	Includes site power and communications infrastructure **Construction Timing:** 2015	**Approach:** Varies **Procurement Timing:** Anticipate initiating procurement in 2015	Procuring and installing the infrastructure required for construction enables scheduling advantages to be achieved.

6.1.3 NEXT STEPS IN PROCUREMENT PLANNING

Subsequent steps in procurement planning include the preparation of procurement documentation, issuance of requests for qualifications and proposals or tenders, and contract awards.

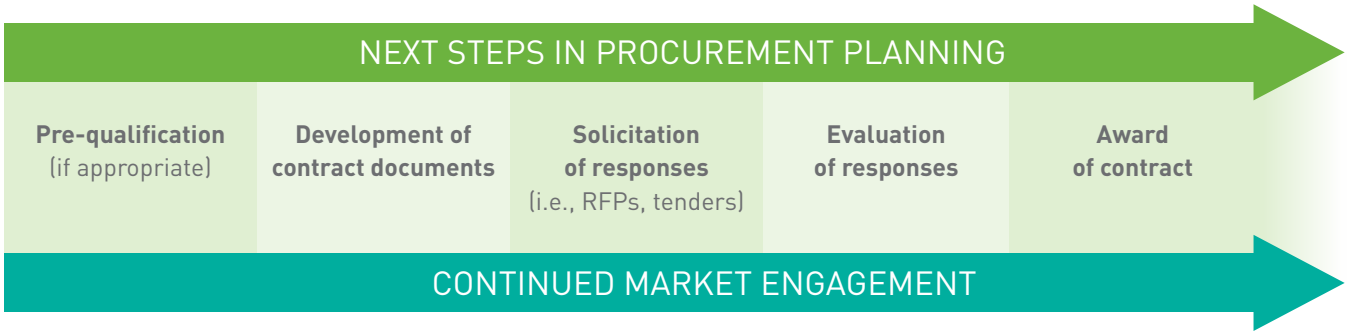
Figure 6.2 provides an overview of a typical procurement process that could be expected. The actual procurement process will vary from contract to contract.

BC Hydro will continue to conduct market engagement throughout the procurement process. For example, Business Information Sessions on Site C were held in 2011 and 2012 in several regional communities to engage with businesses about potential opportunities related to the Site C project. Respondent Information Meetings have also been held for procurements that have already been initiated, and will continue to be held for future procurements, where appropriate.

Businesses are encouraged to sign up for the Site C Business Directory to stay apprised of information sessions and procurements for the project. In addition, the Site C project website lists all current and upcoming major procurements, including anticipated timelines.

BC Hydro will ensure accessibility for procurement opportunities through the use of BC Bid, which is an electronic sourcing and bid notification system used by public sector buyers in B.C. This allows BC Hydro to advertise bid opportunities widely, and for potential bidders to receive notifications of these opportunities. Interested parties are encouraged to register at bcbid.gov.bc.ca.

Figure 6.2: Sample Procurement Process



6.2 KEY PROJECT RISKS AND RISK MANAGEMENT

A component of project planning and procurement is the management of key project risks. BC Hydro has identified a number of project risks for the Site C project and has developed management strategies to address these risks. Table 6.2 provides an overview of some of these key project risks.

Table 6.2: Key Project Risks and Risk Management

Risk: Regulatory Schedule and Permits/Authorizations	
Description	Risk Management
The regulatory process and schedule for Site C is determined by the federal and provincial regulatory bodies and decision-makers, and may be subject to changes in schedule and/or scope. In addition, BC Hydro must obtain permits and authorizations to proceed with Site C construction.	Prior to commencing the formal environmental assessment process, BC Hydro undertook project definition work, early environmental studies and other work to determine whether it was prudent to proceed to the environmental assessment stage. This work also included the establishment of several Technical Advisory Committees on key regulatory topics to consult with regulatory bodies and stakeholders regarding the potential scope of required studies. This preparatory work enabled some anticipation of the requirements of the environmental assessment process, and mitigates the risks of a process delay. In February 2012, the federal and provincial governments announced that an agreement had been finalized for a cooperative environmental review of the Site C project. This agreement identified defined timelines associated with the key steps of the environmental assessment process. To date, these defined timelines have been met and the regulatory process is on schedule. The project has now completed the both the pre-Panel and Panel stages of the environmental assessment process, with only the federal and provincial decision stage remaining. A decision on environmental certification is expected in fall 2014. BC Hydro is currently engaged with the federal and provincial authorities to seek the necessary permits and authorizations required for the construction and operation of the Site C project. This includes seeking opportunities to streamline and optimize the submission and review of permits for Site C based on the extensive material included in the EIS and supporting documents.
Risk: Achieving Accommodation Agreements with First Nations, where appropriate	
Description	Risk Management
The Crown has a duty to consult, and where appropriate, accommodate Aboriginal groups.	BC Hydro and Aboriginal groups are engaged in a thorough consultation and engagement process that continues through all stages of the Site C project. To date, BC Hydro has engaged approximately 50 Aboriginal groups in B.C., Alberta, Saskatchewan and the Northwest Territories. Consultation activities include: • Providing access to and facilitating an understanding of project-related information • Identifying and understanding the issues, interests and concerns brought forward by Aboriginal groups about the project • Creating opportunities to receive input from Aboriginal groups into the planning, design, construction and operation of the project • Negotiating consultation agreements, where appropriate. BC Hydro has concluded 13 consultation agreements representing 16 First Nations to date. Others remain under discussion. • Acquiring, considering and incorporating traditional land use information • Facilitating participation in the environmental assessment process through provision of capacity funding and access to technical expertise as it relates to the project • Negotiating impact benefit agreements, where appropriate • Identifying potential training, employment, contracting and broader economic opportunities related to the project that may be of interest to Aboriginal groups or individuals

Table 6.2: Key Project Risks and Risk Management (continued)	
Risk: Project Design	
Description	Risk Management
New technical information could require a change in project design or construction.	BC Hydro undertook significant site investigation work in the design phase of the project. This allowed BC Hydro to characterize ground conditions for design and construction purposes. As a result of these investigations and associated engineering work, the project design has been upgraded from the historical project design to meet current seismic, safety and environmental guidelines. The project design for Site C is robust and capable of meeting unexpected conditions. Key design upgrades have resulted in improved foundation stability, greater seismic protection, enhanced spillway safety and additional generating capacity. In keeping with BC Hydro and international practice for major projects, an external technical advisory board, composed of global experts in hydroelectric development, reviewed and provided feedback on BC Hydro's design choices for Site C.
Risk: Project Costs	
Description	Risk Management
There is the risk of additional costs or delays during the construction phase.	Due to engineering, environmental and consultation work done in Stages 2 and 3, the Site C project has reached an advanced level of project definition. As a result, the $7.9 billion project cost estimate is at a higher level of accuracy than previous estimates (the Site C cost estimate is a Class 3 cost estimate). BC Hydro is regularly monitoring changes to cost drivers, and is using project management and project control methods to deliver the project within this mandate. The Site C cost estimate includes contingencies (18 per cent on direct construction costs and 10 per cent on indirect costs, excluding some costs in reserves). This level of contingency reflects an appropriate level of uncertainty in future conditions. BC Hydro's capital cost for Site C has undergone an external peer review by KPMG, which determined that both the process for developing the assumptions and the construction of the financial model used in the cost estimate were appropriate. The project procurement approach has been designed to, among other things, efficiently allocate and manage project risks to reduce the likelihood of construction cost overruns or delays. Maintaining the project cost estimate is a key BC Hydro priority. It is the subject of regular review and ongoing tracking, and the project remains on track for delivery within the $7.9 billion cost estimate.
Risk: Labour	
Description	Risk Management
Availability of labour could be constrained during the construction period.	BC Hydro is working with contractors, employers, educational institutions, local and Aboriginal community groups, employment agencies and related organizations to advance initiatives to secure an available supply of qualified local workers. Some examples of initiatives aimed at providing local labour opportunities include undertaking skilled trades capacity building. Examples of capacity building include providing $1 million to support trades and skills training at Northern Lights College, and other contributions aimed at attracting new entrants into trades training. More information about BC Hydro's capacity-building initiatives is available in Section 5.1.4. The Site C cost estimate includes an appropriate level of contingency to reflect uncertainty in future conditions.

7.0 CONCLUSION

BC Hydro's mandate is to power British Columbia with electricity for generations. Over the past 50 years, BC Hydro has made legacy investments to develop our province's hydroelectric potential, which continue to contribute to our economy and quality of life today.

As it has over the last several decades, electricity demand will continue to grow, along with B.C.'s population and economy. Over the next 20 years, BC Hydro's forecast shows demand will increase by approximately 40 per cent, and could further increase due to demand from B.C.'s emerging LNG industry.

As extensive as BC Hydro's electricity supply is, it will not be enough to meet the needs of BC Hydro's residential, commercial, and industrial customers. New dependable capacity and energy resources are required within the next 5 to 15 years, and Site C is being proposed to help meet that need.

Like the hydroelectric facilities that were built decades ago that today meet the needs of approximately 1.9 million customers, Site C would provide reliable energy and dependable capacity for more than 100 years into the future.

As hydroelectric projects are complex, they require a long lead time to plan, design, and to complete the rigorous environmental assessment process. In addition, they take many years to construct. For these reasons, BC Hydro believes the project should proceed now to ensure that the energy and dependable capacity is available to meet forecast customer demand.

Building on the legacy of the past, Site C would further develop the hydroelectric potential of the Peace River as contemplated in the historic "Two Rivers Policy." It will use the water already stored behind the existing W.A.C. Bennett Dam to provide about 35 per cent of that facility's energy, with only five per cent of the reservoir area.

BC Hydro is proposing Site C over other resource options because the project provides the best combination of financial, technical, environmental, and economic development attributes to meet the need for energy and dependable capacity. Site C would also provide benefits through greater contributions to GDP during construction, a higher number of construction jobs, and lower GHG and local air emissions than other portfolios of resource options. In addition, as a dependable and flexible resource, Site C would help to integrate intermittent renewable generation resources such as wind and run-of-river hydro.

As a cost-effective, clean and renewable project, Site C would contribute to the economic prosperity and quality of life for generations to come.

7.1 NEXT STEPS

The Site C project requires environmental certification and other regulatory permits and approvals before it can proceed to construction.

The Joint Review Panel stage of the environmental assessment recently concluded, with the completion of public hearings and the Panel's submission of a Report containing their recommendations to the BC EAO and the Federal Minister of Environment. The governments of B.C. and Canada are expected to make their decisions on environmental approval within six months of receiving the report, or by fall 2014.

If the project receives certification and all required permits and authorizations, construction of Site C is expected to take place over a period of seven years to bring the first unit into service. The remaining five generating units would be commissioned within the following year.

As a major addition to BC Hydro's hydroelectric generating assets, Site C would be continually maintained and upgraded over time. With reinvestment in the facility over the long term, Site C's operating life would be indefinite, providing clean, renewable and cost-effective electricity for generations to come.

SITE C | CLEAN ENERGY PROJECT

GLOSSARY

British Columbia Utilities Commission (BCUC) An independent regulatory agency of the provincial government operating under and administering the *Utilities Commission Act*.

Capacity (1) The instantaneous power output or electricity demand at any given time, normally measured in kilowatts (kW) or megawatts (MW); (2) The instantaneous electricity demand at any given time, normally measured in kW or MW;

Clean or Renewable Energy is defined by the *Clean Energy Act* as including biomass, biogas, geothermal heat, hydro, solar, ocean, wind or other prescribed resources.

Combined Cycle Gas Turbine (CCGT) The combination of combustion and steam turbines to generate electricity from two thermodynamic cycles. Exhaust gases from a combustion turbine flow to a heat recovery steam generator that produces steam to power a steam turbine, resulting in higher thermal efficiency than achievable by operating the combustion or steam turbines individually.

Conservation Reducing energy consumption. For example, turning off unused lights to conserve resources.

Demand Customers' requirement for electric power.

Demand-Side Management (DSM) Actions, programs and initiatives aimed at modifying or reducing energy consumption through conservation and energy efficiency.

Dependable Capacity The maximum generator output that can be reliably supplied coincident with the system peak load, taking into account the physical state and availability of the equipment, and/or water or fuel constraints.

Design-Bid-Build (DBB) A procurement model where design and construction elements of a scope of work are procured under separate contracts, while the owner retains the design risk and responsibility for interface management, as well as the operations and maintenance associated with the scope of work.

Design-Build (DB) A procurement model where the design and construction of a scope of work is procured under a single contract. The counterparty assumes a significant portion of the design and construction risks for the scope included in the contract. The owner retains responsibility for the operations and maintenance associated with the scope of work.

Design-Build-Finance-Operate-Maintain (DBFOM) A procurement model where the design and construction of a scope of work is procured under a single contract, as well as the associated operations and maintenance for a set term. The counterparty is responsible for providing all or a portion of the financing during the term of the contract and is generally paid based on project availability.

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

Energy Capability is the amount of energy that can be generated under specified conditions by a generating unit or by the electric system over a period of time, typically expressed in GWh/year.

Environmental Attributes Attributes used to provide high level descriptions of the environmental footprint of resource options used in portfolio analysis

Firm Energy refers to electricity that is available at all times. Resources typically providing firm energy include large hydroelectric dams, bioenergy, geothermal and natural gas.

Greenhouse Gases (GHG) Gases that contribute to global climate change, or the "greenhouse effect," including carbon dioxide, nitrous oxide and methane.

Gross Domestic Product (GDP) All economic activity (i.e., the monetary value of all goods and services produced) taking place in a geographical region

GWh stands for gigawatt hour, a unit of electrical energy equal to one billion watt hours.

Hydroelectric Generation Production of electricity by using turbines propelled by falling water and connected to a generator.

Independent Power Producer (IPP) A non-utility-owned electricity-generating facility that produces electricity for sale to utilities or other customers.

Integrated System An interconnected network of transmission lines, distribution lines and substations linking generating stations to one another and to customers throughout a utility's service area. Excludes customers located in remote locations who are connected via non-integrated generating plants.

Intermittent Electricity supply that fluctuates or is not available at all times. For example, wind energy only produces power when the wind is blowing.

Load The amount of electricity required by a customer or group of customers.

Load Forecast The expected amount of electricity required to meet customer needs in future years.

Load-Resource Balance (LRB) The difference between B.C. Hydro's Load Forecast and existing and committed resources available to meet the load.

MW stands for megawatt, a unit of electrical power equal to one million watts.

Peak Capacity The maximum amount of electrical power that generating stations can produce in any instant.

Peak Demand The maximum instantaneous demand on a power system.

Portfolio A group of individual resource options to be acquired in a sequence over time to fill customers' future electricity needs.

Pumped Storage The use of electricity generated during off-peak hours to pump water from a lower elevation reservoir to a higher reservoir. The stored water is then released during peak demand periods and used to propel a reversible pump/turbine generator before returning to the lower reservoir.

Reliability A measure of the adequacy and security of electric service. Adequacy refers to the existence of sufficient facilities in the system to satisfy the load demand and system operational constraints. Security refers to the system's ability to respond to transient disturbances in the system.

Resource Option A source of electricity that is available to help meet or reduce electricity demand, including generation, purchases, demand-side management and transmission facilities.

Run-Of-River A hydroelectric facility that operates with no significant storage facilities.

Simple-Cycle Gas Turbine (SCGT) A stand-alone generating plant that uses combustion gases to propel a turbine similar to a jet engine connected to an electrical generator.

Thermal Generation Generation of electricity by converting heat energy into electric energy through the controlled combustion of fossil fuels or biomass.

Transmission System Electrical facilities used to transmit electricity over long distances, usually at voltages greater than 69 kV.

Unit Energy Cost (UEC) Present value of the total annual cost of an energy resource divided by the present value of its annual average energy benefit.

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