
Source: BC Hydro

ENERGY CASE STUDY: CANADA

John Hart Generating Station Replacement Project

Location
Campbell River, British Columbia, Canada

Owner
BC Hydro

Private Partner
InPower BC (SNC Lavalin)

PPP Model
Design-build-finance-maintain (DBFM)

Operating Term
15 years

Project Value
CAD 1.1 billion/USD 815 million[1]

Asset Class
Energy

Awards

- Canadian Council for Public-Private Partnerships 2014 National Gold Award for Project Financing winner;
- P3 Bulletin 2015 awards for the 'Best Waste/ Water/Energy Project' and the 'Projects Grand Prix';
- Outstanding Project award from the Canadian Hydropower Association;
- Tunnelling Association of Canada: Canadian Innovation Project of the Year 2018; and
- BC Hydro received an 'Award of Excellence' from the Canadian Electricity Association of their 'Next-Generation Seismic Analysis of Concrete Dams' project: BC Hydro is the first non-nuclear utility in North America to elevate seismic hazard assessment of its dams using processes similar to those used by the U.S. Nuclear Regulatory Commission.

1 Assumed conversion rate of CAD/USD =1.35 as at May 15, 2019.

The project involves replacing the existing John Hart Generating Station, which was built in 1947, with one designed for improved seismic performance and reduced environmental impact.

Specifically, the update of the hydro power generating station includes:

- A new underground powerhouse with three 46 MW generating units to replace the existing above-ground powerhouse;
- The replacement of three 1.8 kilometre (km) woodstave and steel penstocks with a single 8.1 metre (m) diameter, and a 2.2 km power tunnel;
- A new water intake at the existing John Hart Dam; and
- A new water bypass facility that protects the downstream Campbell River and its fish habitat from flow reductions even when the generating units are shut down.

During the operations phase, the Owner retains responsibility for operations, however the Private Partner is responsible for all maintenance and rehabilitation. However, the Private Partner is required to use the Owner's staff to complete the routine/ planned maintenance activities.

The project has a phased completion process, with percentages of the availability payment assigned to the follow discrete phases:

- The completion of each turbine and generator;
- The commencement of the operating phase; and
- The completion of the bypass system.

The new facility has been generating power since 2018 and work is currently underway to decommission the existing facility.

Output Specifications Development Approach Used

The project is a good example of how a standard, market-tested PPP model (Partnerships BC[2] model) can be adapted to deliver project specific objectives. BC Hydro has a history of delivering hydro generating projects and has in-house technical expertise, however this project was the first one sourced as a PPP. At the time of procurement, BC Hydro also believes the project was the first hydro power facility PPP in Canada, and if not North America. Accordingly, to develop the specifications, a team was formed that consisted of in-house BC Hydro technical experts, with support from Partnerships BC and consultants with experience in the development of output specifications.

In developing the output specifications for this project, BC Hydro consulted international output specification examples, as well as recent, local projects, before finalising the project-specific specification. On this basis, the output specification development process focused on developing a clear vision, minimum requirements and measurable outcomes, prior to developing requirements and performance measures.

2 Partnerships BC (PBC), the provincial procurement agency in British Columbia has the mandate to support "the public sector in meeting its infrastructure needs by providing leadership, expertise and consistency in the procurement of complex capital projects by utilising private sector innovation, services and capital to deliver measurable benefits for taxpayers". To date PBC has participated in 52 projects with a combined capital value of almost CA $18 billion. Partnerships BC has developed and promoted a P3 model that adopts standard process and documentation to minimise bid costs and the time taken to get a project to market and financial close (typically 12-18 months from request for proposal to financial close).

Alignment to QI Focus Areas		Mechanisms used to achieve QI alignment	Market Comparison Analysis
Sustainability and longevity of an infrastructure asset. Ability of the asset to meet the needs of end users	The asset management requirements adopt a plan-do-check-act cycle[3] through the project term, which involves both the Private Partner and the Owner. A key document is the Asset Management Plan (AMP). "*The objective of the AMP is to provide BC Hydro with plans and programs that demonstrate Project Co's compliance with the performance obligations in respect of the Services under the Agreement. The AMP should clearly describe Project Co's understanding and detailed approach to delivering all aspects of Services relative to the specified Performance Indicators.*" Below is an overview of the interrelated asset management requirements that aim to maintain the longevity of the asset. **Plan:** Planning for the management of the asset starts before construction is complete (an AMP is required 60 days prior to service commencement). The AMP is intended to support the achievement of performance obligations and to ensure that handback conditions are achieved. **Do:** Project Co is required to implement all maintenance and rehabilitation work in the AMP. For example, in the case of planned maintenance for this project, Project Co is required to identify and plan annual maintenance activities and document them in the Maintenance Plan and Schedule (MPS)[4], which forms part of the AMP, and which is the baseline for measuring performance. **Check:** "*The performance of the Asset Management Plan shall at a minimum be monitored monthly; reviewed annually; and updated or modified based on the experience of Responses and Rectifications and other relevant experience arising from the performance of the Services or mutually agreed upon changes.*" Specific tools include: • **Monthly Facility Performance Scorecard**, using quantitative data where possible to measure performance. • **Annual Asset Management Report:** summary of the performance from the previous year including (but not limited to) performance statistics, third party audit results, maintenance statistics, completed non-routine and capital projects, regulatory compliance, and a review of the program effectiveness. • **Service Period Joint Committee (SPJC) Annual Asset Review:** The SPJC meets yearly to conduct an asset review, including a review of past performance measured against the AMP. • **Condition Assessments:** Condition assessments are required to be completed in years 4, 8 and 12, which are used to monitor the effectiveness of the AMP. "*The condition assessment evaluation of Generation Systems will be made based on The Corps of Engineers hydroAMP methodology*" and are completed by an independent third party. **Act:** Revisions to the AMP: "*Updates to the Asset Management Plan shall be submitted annually on the anniversary date of Service Commencement Condition Assessment*".	**Review and Consent Procedure:** The AMP is subject to Owner Consent both prior to Service Commencement and annually for document revisions. Consent is required before the Private Partner can proceed with implementation. The Asset Management Report is also subject to Owner Consent. **Condition Precedent:** Service Commencement cannot be achieved if the Owner has outstanding objections on AMP. **Non-Performance Event:** The late delivery (more than five days late) of the defined asset management plans and reports is a Non-Performance Event (NPE) which can result in deductions. NPE deduction points persist until the deliverable is submitted. **Performance Measure:** There are several performance indicators to promote performance. For example, "*Maintenance performed as part of MPS at the times permitted per Schedule 7*", and "*100% of Planned Maintenance on life safety, emergency systems, and statutory/regulatory requirements completed within the times scheduled in the Annual Asset Management Plan*", **Owner Audit:** "*BC Hydro may at all times, without notice, access, audit and inspect the Facility and Project Co's delivery of the Services.*" **Condition Assessment Retention:** The Owner can retain a portion of the availability payment equal to the remedial costs identified in the 12-year condition assessment, and is authorised to retain payment based on the four-year and eight-year condition assessments in certain circumstances.	**ISO 55000 compliance:** Increasingly, ISO 55000 is being adopted in multiple jurisdictions and across multiple asset classes around the world as best practice. The development of an asset management plan in accordance with this standard is a significant step change for many organisations but is increasingly seen as the way forward.
Ability of the asset to withstand natural and other disasters, including climate change	BC Hydro identified the existing facility was likely to fail under low to moderate seismic loading, and an objective of the project was to provide a facility that met modern seismic guidelines. The output specification achieved this by specifying the design requirement and the performance requirement by project element. The National Building Code of Canada (NBCC), Canadian Dam Association (CDA) guidelines and Institute of Electrical and Electronics Engineers (IEEE) standard IEEE693 were the adopted standards that governs the seismic design requirements, and additional minimum standards were included in the output specification. Specifically, a hazard analysis was conducted to determine the appropriate site-specific ground motion to be used in conjunction with the adopted codes and standards.	**Review and Consent Procedure:** Although the Private Partner retains the risk of developing a compliant seismic design, there are a number of deliverables that are subject to Owner Consent to discuss design development and compliance prior to completing the design and starting construction: • Design Basis Memorandum • Design Management Plan • Proposed Checking Team (with independent checkers) • Interim Designs	The impact of climate change is increasingly being acknowledged as a key consideration in infrastructure development. Several jurisdictions have varying degrees of formal policy in place to support those initiatives that encourage climate resistance. For example, in 2018, Infrastructure Canada (Government of Canada) released the Climate Lens which requires climate change to be considered as a core part of Canada's infrastructure planning.

3 Also known as The Deming Cycle, which describes a continuous feedback loop that allows improvements to be identified and changes implemented.

4 The Maintenance Plan and Schedule includes three rolling periods; one year, three years and 15 years.

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	Post-Disaster Facility: The powerhouse is designated to have a NBCC Post-Disaster Facility Importance Factor of 1.5. This means the seismic forces used in designing the powerhouse are essentially 1.5 times greater than those used to design a 'normal' building. The intention is that the buildings and facilities remain safe for immediate human occupancy. The output specifications provide measurable criteria for the required post-seismic event operating condition. For example: • "*Facility shall remain safely operable during and after an Operating Basis Earthquake and shall be capable of **132.5 MW of generation** at the Maximum Normal Powerhouse Flow immediately after an Operating Basis Earthquake.*" • "*The Facility shall be able to be safely shutdown following a Design Basis Earthquake and be readily reparable and safely returned to service **within 30 days** after a Design Basis Earthquake.*" • "*Low Level Outlet capable of passing at least **124 m³/s** after a Maximum Design Earthquake event.*" Design earthquakes (which link to the required operating condition) are specified based on the annual exceedance frequency (AEF): • Maintain operations or serviceability limit state: "*The Maximum Design Earthquake (MDE) corresponds to a mean Annual Exceedance Frequency (AEF) of 1 in 10,000.*" • Minor impact to operations (serviceability limit state): "*The Design Basis Earthquake (DBE) corresponds to a mean AEF of 1 in 2,475.*" • Life-safety or ultimate limit state: "*The Operating Basis Earthquake (OBE) corresponds to a mean AEF of 1 in 475.*" The output specification does not include specific requirements to address climate change, however during the planning phase the Owner considered the future operational risks and the ability for the existing dam to structure accommodate increased flows to validate the project's feasibility.	• Final Design Submission Reports • Report sealed by the Checking Team • Design Certificate • Final Designs	"*Applicants seeking federal funding for new major public infrastructure projects will now be asked to undertake an assessment of how their projects will contribute to or reduce carbon pollution, and to consider climate change risks in the location, design, and planned operation of projects*"[5]. The methodology to complete the climate change resilience assessment should employ the principles of the ISO 31000:2018, Risk Management – Guidelines standard.
Health and safety considerations during both construction and operation of the asset	The Owner identified ways to incorporate "safety by design" principles into the project requirements in all stages of the project development – procurement, design and construction as well as attempting to futureproof the project for future industry standard development. As an example, the design and construction requirements included general and specific requirements for operability and maintainability, confined spaces, isolation and lockout, isolation of mechanism apparatus, work at height, limits of approach, electromagnetic field, arc flash and constructability. "*A recognised human engineering/human factors standard shall be used to demonstrate that operator and maintenance interfaces have been designed to minimise Hazards, human error and mis-operation. In addition, ergonomic considerations shall be integrated into the Design Work and Construction. The Facility shall conform to the Human Factors Principles set out in Appendix 1.3A [Human Factor Design Principles] of this Schedule.*"	**Review and Consent Procedure:** The Private Partner is responsible for developing a design that is compliant with the project requirements, and to maintain the facility so it continues to be compliant with the requirements. **NPE/Default Points:** The Private Partner is incentivised to minimise safety risk to avoid incurring NPE or Default Points. For example, there are 13 different performance measures relating to safety and security with assigned NPE points and two incidents that would incur Default Points. The project has surpassed 3.5 million person hours of work without a lost time accident.	Contracts will typically include mechanisms that deduct for minor non-performances but allow the Owner to intervene, or in extreme cases for the contract to be terminated, in response to bad performance especially as it relates to health and safety, environmental or public relations performance. One approach in the Canadian model is to adopt the Non-Performance Event and Default Point regimes that allow the Private Partner to respond prior to the Owner intervening.
Capacity building, transfer of knowledge and expertise	The Private Partner is responsible for the maintenance of the asset, whereas the Owner is responsible for the operations. Knowledge transfer during the commissioning period focuses on training the Owner's team to successfully takeover operations, whereas the training at the end of term focuses on preparing the Owner to maintain and rehabilitate the asset. Knowledge transfer from the Private Partner to the Owner occurs at three stages during the project: **Commissioning** The Private Partner is required to "*provide training and education for BC Hydro staff sufficient to enable persons with appropriate qualifications and experience to operate and maintain the Facility*". Since the training requirements are specific to the design, the output specification puts the onus on the Project Co to develop a training plan that meets the performance requirement.	**Review Procedure:** Training materials are subject to Owner review. **Condition Precedent to Commercial Operation:** Once planned and documented in the Commissioning Plan, the completion of training requirements is a condition precedent to commercial operation. **Non-Performance Event:** If the commissioning or handback plans, which include the training plans, are delivered more than five days late, NPE points will be assigned and persist until a plan has been received.	Training and transfer of asset-specific skills to facilitate operations is generally considered standard as part of the development process. The challenge is coordinating the implementation of the plans with commissioning and completion activities. Typically, planning for operations will commence 12 to 18 months prior to service commencement, and important plans will have financial deductions if delivered late.

5 Further information available at: https://www.canada.ca/en/office-infrastructure/news/2018/06/backgrounder-applying-a-climate-lens-to-infrastructure-projects.html

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	Training forms part of the Commissioning process and training activities are documented in the Commissioning Plan which is required be submitted to the Owner 6 months prior to target operation dates. The Owner then reviews the plan which, once accepted, forms the requirement for the Private Partner to deliver. To coordinate Owner participation, there is a defined 15-day notice period for training and education sessions. **Service Period** The training plan developed during the commissioning process is taken forward into the service period and forms the basis for the Private Partner's training requirements. The Private Partner is required to continue to provide training to the Owner's personnel during the service period. The Owner retains the responsibility for ensuring their personnel have the appropriate levels of skill, training and experience for the planned work activities. **Handback** The Private Partner develops a plan, issuing it to the owner within six months of handback, who must comment no later than 90 days before the scheduled handback date. The Owner identifies gaps that may restrict its personnel's ability to operate and maintain the facility, and the Private Partner then revises the training program within 60 days.		
Environmental impacts	A key project objective is to provide flow continuity in the Campbell River by installing a bypass system. This was successfully incorporated into the output specifications by specifying quantifiable requirements, which could be measured through a performance-based payment mechanism. The requirement does not, however, prescribe the design of the bypass system. Instead, it focuses on the required system performance. The payment mechanism adopts an availability approach, and the output specifications clearly define what 'availability' means for the bypass system. For example: • **Quantifiable requirement:** "*The Bypass System shall be connected to the Water Conveyances upstream of the Turbine Inlet Valves and provide a means of safely, efficiently, accurately and reliably delivering a compensating flow (matching the real-time decrease in Powerhouse Flow, up to the maximum capacity of the Bypass System) to the Tailrace area* ***within 3 minutes*** *of the occurrence of any Generating Unit Outage […]*" • **Definition of 'Available':** "*Bypass System Non-Availability Event" means (a) the failure of the Bypass System to be Available (up to* **80m³/s** *between September 22 and June 30, or up to* **36m³/s** *between July 1 and September 21, as such flows may be revised from time to time in accordance with GOO 4G-44), due to a Monthly Test Failure, equipment condition or maintenance activities; or (b) the failure of the Bypass System to meet the Bypass System Response Time*". • There were also requirements to protect water quality within the John Hart Reservoir, with the domestic water intake for about 35,000 people about 300 metres away from the work zone. The water bypass is operating as intended following a four-year construction period without any water quality incidents.	Mechanisms promote both the successful construction and continued operational performance of the asset **Availability Payment** (Construction): A percentage of the total availability payment was linked to the successful completion of the bypass, with the value of the payment greater than the construction cost **Non-Performance Event** (Construction): Points linked to financial deductions, are assigned if construction deficiencies are not rectified within 30 days of completion. Deficiencies are both defects in the work or incomplete design or construction scope. **Non-Availability Events** (Operations): If the bypass is not available, there is a payment deduction consisting of: • a flat rate per occurrence to incentivise proactive maintenance to prevent an unavailability event; and • a time dependent component that is measured to the minute to incentive timely response should an unavailability event occur. **Default Points** (Operations): If the bypass is working but does not meet the performance requirement (i.e. takes longer than three minutes), default points are assigned. Default points can accumulate if there is repeated poor performance which can lead to Project Co default. **Non-Performance Event** (Operations): To incentivise preventative testing of the bypass, points are assigned that are linked to financial deductions, if required monthly tests are not completed successfully.	Refer to the comment in the '*Health and safety considerations during both construction and operation of the asset*' section of this case study on the principles behind Default Points.