

August 14, 2023
Patrick Wruck
Commission Secretary and Manager
Regulatory Services
British Columbia Utilities Commission

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Patrick Wruck
Commission Secretary and Manager
Regulatory Services
British Columbia Utilities Commission
Suite 410, 900 Howe Street
Vancouver, BC V6Z 2N3

Dear Patrick Wruck:

**RE: Project No. 1599319
British Columbia Utilities Commission (BCUC or Commission)
British Columbia Hydro and Power Authority (BC Hydro)
Energy Management System Upgrade Project Application (EMS Project)
Semi-Annual Progress Report No. 1
January 2023 to June 2023 (Report)**

BC Hydro writes to provide its confidential Report in compliance with BCUC Order G-39-23. The Report is consistent with other project-specific progress reports filed with the BCUC and provides an update on the EMS Project's scope and activities, cost, benefits, risks, and schedule, as applicable for the period from January 1, 2023, to June 30, 2023.

BC Hydro is providing the confidential Report to the Commission only. A public version of the Report is being filed under separate cover redacting commercially sensitive and contractor-specific information and is available at www.bchydro.com. BC Hydro seeks this confidential treatment pursuant to section 42 of the *Administrative Tribunals Act* and Part 4 of the Commission's Rules of Practice and Procedure.

For further information, please contact Frankie Vaide by email at bchydroregulatorygroup@bchydro.com.

Yours sincerely,



Chris Sandve
Chief Regulatory Officer

sg/kl

Enclosure

**BC Hydro Energy Management System Upgrade
Project**

Semi-Annual Progress Report No. 1

Six Month Period

January 2023 to June 2023

PUBLIC

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Appendix A Project Schedule

1 Background

BC Hydro has a complex network of generation resources, transmission lines, interconnections with neighbouring systems and associated equipment, generally operated at voltages of 100 kV or higher, which is known collectively as the Bulk Electric System. The Energy Management System (**EMS**) is critical to BC Hydro for it to monitor, control, and optimize the Bulk Electric System in a safe and reliable manner, and to support its function as Reliability Coordinator, Balancing Authority, and Transmission Operator.

On March 11, 2022, BC Hydro filed an application under section 44.2 of *the Utilities Commission Act* seeking BCUC's acceptance of an expenditure schedule for upgrading the EMS (from software version 3.0 to version 3.3) (**EMS Upgrade Project** or **Project**) on the basis that the current EMS is at end-of-life, that both the software and hardware of the EMS need to be upgraded, and that vendor support is a critical component of the EMS. It is unacceptable to operate the Bulk Electric System with an EMS that is beyond end-of-life and does not have vendor support. As part of the Project, BC Hydro will update the intrusion detection system.

On February 28, 2023, the BCUC issued Order No. G-39-23 accepting the EMS Upgrade Project's capital expenditure estimated cost range of \$24.5 million to \$32.8 million. BC Hydro was directed to file semi-annual progress reports on the EMS Upgrade Project, with a start date of January 2023. The first progress report is being filed, as directed, within 45 days of the end of the first period ending June 30, 2023.

This report (**Report**) covers the period from January 1, 2023, to June 30, 2023 (**Reporting Period**).

2 Project Status

The Project is progressing well. There are no material changes to scope, schedule, or budget, and there is currently no forecasted use of Project contingency or reserve. This Report provides an update on major activities to date including the following:

- Procurement of hardware and software;
- Completion of the upgrade of the Intrusion Detection System. The system has been procured, configured, tested, and deployed;
- Technical design and technical solution build (development and configuration of the EMS hardware and software at both Fraser Valley and Southern Interior control centres); and
- Test planning, integration, and Pre-Factory Acceptance Testing.

[Table 1](#) provides a summary of the Project status as at the end of the Reporting Period.

Table 1: Project Status Summary

● Green: No Concerns;
 ● Amber: Some Concerns but in Control;
 ● Red: Serious Concerns

Status as of: June 30, 2023	
Overall Assessment	● The Project continues to progress well, has had no material scope variance, is on budget, and is expected to be In-Service between the original earliest possible In-Service Date and committed In-Service Date of April to July 2024. The current planned In-Service Date is June 2024. As expected, there were hardware / equipment supply chain delays, that resulted in the Project moving from ahead of schedule to on schedule. The Project team has installed and configured the development and test environments. All development activities are complete. The team is now configuring the production environment and is expected to complete by September 30 th . The first test phase of Pre-Factory Acceptance Testing, which is completed by General Electric and witnessed by BC Hydro, is complete.
Scope	● There have been no material changes to Project scope.

● Green: No Concerns; ● Amber: Some Concerns but in Control; ● Red: Serious Concerns	
Schedule	● The delays in the supply chain had an impact on the Project schedule, which resulted in a later-than-expected date for development stabilisation in the test environment. Although interim activity dates have shifted, the Project is currently estimated to meet the Committed In-Service date. Please refer to Section 4 for an updated assessment of the Project schedule.
Cost	● The Project’s forecast cost at completion is within the approved budget. Please refer to Section 4 for an updated assessment of the Project cost.
Risk	● The risk profile of the Project continues to improve as the Project progresses through testing. Please refer to Section 6 for an updated assessment of the Project risks.

3 Project Scope and Activities

There were no material changes in Project scope in the Reporting Period. This section covers the major accomplishments and work completed in the Reporting Period and provides information on planned activities in the next reporting period.

3.1 Work Completed

The following section describes the Project work completed during the Reporting Period. The work described below included significant co-ordination between BC Hydro and General Electric (**GE**) resources. The teams from both companies have been working well with each other and the positive relationship with the GE team has benefited the Project.

3.1.1 Infrastructure and Equipment Configuration

The new hardware and software for development and testing was installed and configured, allowing both the BC Hydro and GE teams to begin development of the custom code, as well as to validate the code which had been migrated from BC Hydro specific customizations to the GE base product. This activity also included using a copy of the existing production data model to ensure there are no data migration issues during the parallel operations or cutover. The installation and configuration of the future version 3.3 production infrastructure is now underway.

3.1.2 Design and Development

All design and development activities were completed by both GE and BC Hydro teams during this Reporting Period. This included the development of new source code, the migration and modification of existing code to accommodate base product changes. The development also includes integration with other functions and unit / developer testing of that code prior to the start of the formal test.

3.1.3 Testing

To ensure accurate reporting, all test plans and test cases were migrated into a test system used by GE prior to the start of the Pre-Factory Acceptance Testing. Once testing is complete, the test results, as well as an export of all the test cases, will be provided to BC Hydro for potential use in future upgrades.

The intention of Pre-Factory Acceptance Testing is to find as many issues and defects as early in the Project as possible. Finding defects early ensures those defects are fixed and overall stabilization of the system happens early in the test cycles. Pre-Factory Acceptance Testing was completed by GE at its facilities in Bothell, WA. BC Hydro staff travelled to GE for 10 weeks to witness testing, which proceeded smoothly and generated a lower-than-expected number of defects.

A total of [REDACTED] test cases were executed during this period, resulting in [REDACTED] defects. The previous upgrade project, completed in 2017, logged a total of [REDACTED] defects during Pre-Factory Acceptance Testing. The lower number of defects found in Pre-Factory Acceptance Testing in this Project indicates this version of the software is, as expected, more stable.

There are currently no concerns related to the overall quality of the system. Defect resolution will begin in July 2023.

3.1.4 Go-Live Planning

The Project team has the cutover scripts from the previous system upgrade. A Project team member has been identified as the cutover lead and has begun reviews and updates with team leads to update the scripts to accommodate changes for this upgrade. This iterative process will continue throughout 2023.

3.2 The Next Six Months

The following activities are scheduled in the coming six months:

- Remediation of defects found in Pre-Factory Acceptance Testing;
- Refresh Systems to include defect fixes and updated configurations;
- Complete Factory Acceptance Testing;
- Finalize Configuration of Future version 3.3 Production Environment;
- Conduct Performance Testing – Round 1;
- Remediation of defects found in Factory Acceptance & Performance Testing;
- Conduct Cybersecurity Testing; and
- Continue Ongoing Go-Live Planning.

4 Project Schedule

The table below provides an update of key Project dates. Additional time was used in Pre-Factory Acceptance Testing; primarily accommodated using float available between Project activities. The Project has a planned In-Service date of June 2024 and is expected to meet the Committed In-Service Date of July 2024.

Table 2: Project Schedule Update

Activity	Estimated at Implementation Start (Presented in Table 10 of the Application)		Current Estimated Dates (as of June 30, 2023)		Status & Comments
	Start Date	End Date	Start Date	End Date	
Updating the BC Hydro specific customizations	Oct-21	Nov-22	Oct-21	Nov-22	Activity is complete.
BC Hydro specific customizations functionality and integration testing	Nov-22	Mar-23	Nov-22	Apr-23	Activity is complete. The delay in hardware delivery impacted the integration of sub-systems during this phase, resulting in a month delay in completion.
Pre-Factory Acceptance Testing	Apr-23	May-23	Apr-23	Jun-23	Activity is complete. Hardware delivery was delayed, and additional resources were added to mitigate delay. Project stakeholders agreed to add all medium and low priority test cases into this phase. The intention to find as many defects as possible early in the Project, reducing the risk of finding major defects in Factory Acceptance Testing. Additional time used in Pre-Factory Acceptance Testing was primarily accommodated using float available between Project activities.

	Estimated at Implementation Start (Presented in Table 10 of the Application)		Current Estimated Dates (as of June 30, 2023)		
	Jun-23	Jul-23	Jul-23	Oct-23	
Factory Acceptance Testing	Jun-23	Jul-23	Jul-23	Oct-23	In consultation with the GE team, the Project has decided to apply additional defect fixes which have been found by other customers during other upgrade projects. This approach provides a better quality end result, critical to manage the Bulk Electric System. Factory Acceptance testing includes the development work necessary to merge and the time to verify these changes. Factory Acceptance testing is now the longest test cycle and will include all of the testing in Pre-Factory Acceptance, all testing related to verify defect fixes from Pre-Factory Acceptance testing, the new product defect fixes, and ad-hoc testing by BC Hydro's Real Time Operations Engineers. The additional defect fixes create the three month variance in the planned schedule and adds to the duration of this activity. The additional time for this testing is primarily accommodated by using float available between Project activities, as well as one month of schedule contingency, reducing the impact to the overall schedule.
Site Acceptance Testing	Jul-23	Oct-23	Oct-23	Feb-24	Site acceptance testing will start later than previously scheduled as a result of the changes to Factory Acceptance Testing. Site Acceptance Testing will start with the verification of servers and build process on the future version 3.3 production servers. That verification will overlap with the end of Factory Acceptance Testing. Site acceptance testing duration includes NERC CIP Asset commissioning.
Parallel Operations	Nov-23	Feb-24	Feb-24	May-24	The updated start and end dates reflect the impact of the above schedule changes. The parallel operations phase ensures issues are fixed prior to a full cutover to the new system. The schedule maintains six weeks of defect remediation within this phase. The length of this phase will vary based on the number of issues the team finds during the activity.

	Estimated at Implementation Start (Presented in Table 10 of the Application)		Current Estimated Dates (as of June 30, 2023)		
In-Service Date		Apr-24 [1]		May-24 [1]	Schedule shows the earliest possible In-Service date in May 2024. The current planned date based on the above six weeks of remediation in parallel operations is June 2024.
		Jul-24		Jul-24	The Project is expected to meet the Committed In-Service Date.
Stabilization	Mar-24	May-24	June-24	Aug-24	The duration for stabilization has not changed.
Project Closure	May-24	Aug-24	Aug-24	Oct-24	Project close has moved to reflect schedule changes.
Project Completion Date		Oct-24 [2]		Oct-24 [2]	Planned completion date is October 2024.
		Jan-25		Jan-25	The Project is expected to meet the Committed Project Completion.

[1] Earliest possible In-Service Date

[2] Earliest possible Project Completion Date

5 Project Cost

The Project cost is forecasted to remain within the authorized budget. Currently, there is no forecasted use of contingency or reserve. The following table summarizes the current financial status and shows that as of June 30, 2023, the Project is expected to be on or below budget at completion. There was no access to the Special Reserve funding during this Reporting Period.

Table 3: Project Expenditure Summary

Ref	Cost Component	1	2	3	4	5	6	7	8	9
		Authorized Budget			Actual Cost to June 20, 2023			Estimate at Complete		
		Capital Cost	Operating Cost	Total Cost	Capital Cost	Operating Cost	Total Cost	Capital Cost	Operating Cost	Total Cost
A	Pre-Implementation Costs									
B	Definition Phase Direct Costs									
C	Definition Interests During Construction									
D	Total Costs at end of Definition									
E	Direct Implementation Costs									
F	Server hardware									
G	Server related software									
H	Server dismantling costs									
I	General Electric and Other Vendors									
J	BC Hydro Resource costs									
K	Total Direct Implementation Costs									
M	Total Project Direct Cost Estimate									
N	Contingency (M*15%)									
O	Total Expected Cost plus Contingency (M+N)									
P	Implementation Interest During Construction									
Q	Total Interest During Construction (C+P)									
R	Expected Cost Estimate (O+Q)									
S	Project Reserve									
T	Special Reserve									
U	Total Project Reserve									
V	Incremental Interest During Construction on Project Reserve									
W	Total Authorized Budget (R+U)									

Notes:

- Minor differences attributable to rounding.
- Direct costs are inclusive of inflation. Contracts with third parties are inclusive of inflation. Internal labour cost estimates are built using BC Hydro’s standard labour rates, which are also inclusive of inflation.
- As BC Hydro resources charge their time directly to Information and Operational Technology projects, capitalized overheads are not allocated to BC Hydro’s Information Technology projects.
- Implementation quote for server hardware and software was based off quotes in USD; however, final purchasing costs were equivalent to the original quote, but in CAD.
- Planned additional testing will increase GE scope and pricing.
- Resourcing, and allocation for BC Hydro resources will increase from now to the end of the project, no significance variance is expected.
- No use of project contingency or reserve is anticipated at this time.

6 Project Risks

The tables below summarise and provide updates to the risks identified relevant for the Implementation Phase.

6.1 Project Technology Risk

[Table 4](#) below provides an update to Project Technology Risks and Risk Mitigation, the status of those plans, and an assessment of the likelihood and impact for the remainder of the Implementation phase of the Project.

There are no new Project Technology Risks to report.

Table 4: Project Technology Risks and Risk Mitigation

Risk Event/Threats	Mitigation Plans	Mitigation Status	Current Likelihood and Impact	Risk Level
<p>Software defects delay Project delivery.</p> <p>Update: No change.</p>	<ul style="list-style-type: none"> • While the EMS version 3.3 is currently being implemented at other utilities as well as BC Hydro, it does not yet have an established client base as earlier versions do. GE will provide BC Hydro with updates on their work on other EMS version 3.3 implementation and upgrade projects to help identify any such issues that may impact the delivery of the Project; • GE is a member of the Project delivery and working team and attends the Steering Committee by invitation, when required to provide updates on other utility implementations and identify and address any GE related issues with the Project as they arise; and • Certain BC Hydro software functionalities are provided by custom developed code from either BC Hydro or GE and may have a higher risk of defects. Special reserve has been allocated to additional effort and schedule to resolve any issues with these components. 	<p>In Progress</p> <p>In Progress</p> <p>In Progress</p>	<p>Possible, Moderate</p>	<p>Medium</p>
<p>Software defects impact production operations</p> <p>Update: No change.</p>	<ul style="list-style-type: none"> • The transition to an operations approach will utilize the successful approach from previous upgrades, whereby extensive parallel operations and a phased cutover are utilized. 	<p>Planned</p>	<p>Unlikely, Major</p>	<p>Medium</p>

6.2 Project Delivery Risk

The Project delivery risk assessment considers the material project delivery-related risks that have been identified as having the potential to impact BC Hydro’s ability to deliver the Project on-time and on-budget.

[Table 5](#) below provides a summary of updates to BC Hydro’s mitigation plans, the status of those plans, and an assessment of the likelihood and impact for the remainder the Implementation phase of the Project.

There are no new Project Delivery Risks to report.

Table 5: Project Delivery Risks and Risk Mitigation

Risk Event/Threats	Mitigation Plans	Mitigation Status	Current Likelihood and Impact	Risk Level
<p>Increased costs due to foreign exchange rates for U.S.-based vendor.</p> <p>Update: No change. The hardware and software procurement is complete. There remains the balance of professional services from GE, including testing and deployment support.</p>	<ul style="list-style-type: none"> BC Hydro standard currency exchange rates have been used in the cost estimates. Due to the significant portion of the budget being from a U.S. vendor and the duration of the Project, there is a risk that the exchange rate could fluctuate outside this rate; and Special reserve was requested during the Implementation phase, which will be the bulk of the GE work in the event exchange rate changes have a material impact; 	<p>In Progress</p> <p>In Progress</p>	<p>Possible, Moderate</p>	<p>Medium</p>
<p>Impacts on Project delivery due to the COVID-19 pandemic.</p> <p>Update: The risk related to the COVID-19 pandemic has been reduced to “unlikely” and impact to “minor”.</p>	<ul style="list-style-type: none"> Added three-month contingency schedule to the Implementation phase to account for potential COVID-19 pandemic impacts; and Added Special Reserve funding to deal with any additional delays that may be encountered due to COVID-19 impacts. 	<p>In Progress</p> <p>In Progress</p>	<p>Unlikely, Minor</p>	<p>Low</p>

Risk Event/Threats	Mitigation Plans	Mitigation Status	Current Likelihood and Impact	Risk Level
<p>Supply chain delays for hardware may impact delivery schedule.</p> <p>Update: The hardware and software procurement is complete. The risk related to supply chain issues materialized, and the impact to the Project schedule was described in Table 2.</p>	<ul style="list-style-type: none"> Hardware orders have been placed at the start of the Implementation phase to provide longest possible lead time before the equipment is required. 	Materialized	Low, Minor	Low
<p>Poor product quality may result in a higher number of defects than anticipated and cause schedule delays.</p> <p>Update: No change.</p>	<ul style="list-style-type: none"> GE delivery team includes several resources who have experience working on BC Hydro’s EMS version 3.0 upgrade Project. Special Reserve was added for additional rounds of testing due to high priority defect fixes. 	<p>In Progress</p> <p>In Progress</p>	Possible, Moderate	Medium

6.3 Readiness Risk

This risk assessment considers the material risks related to organizational readiness that have the potential to impact BC Hydro’s ability to successfully undertake the Project.

[Table 6](#) below provides a summary of updates to BC Hydro’s mitigation plans, the status of those plans, and an assessment of the likelihood and impact for the remainder the Implementation phase of the Project.

Table 6: Project Readiness Risks and Risk Mitigation

Risk Event/Threats	Mitigation Plans	Mitigation Status	Current Likelihood and Impact	Risk Level
Resource constraints of key BC Hydro technical experts required for the deployment and configuration of the EMS. Update: No change.	<ul style="list-style-type: none"> The EMS is supported by a group of specialist Real Time Systems engineers. Additional contract resources will be secured to augment this team of specialists during Project delivery to manage and reduce the risk of resource constraints. 	In Progress	Possible, Moderate	Medium

BC Hydro Energy Management System Upgrade Project

Appendix A

Project Schedule

Project Schedule Update

