Stakeholder Engagement Pre-Reading Hydro Dispatch Data (Part 2)

The external stakeholder engagement session on February 6, 2020 will cover the following topic(s):

- Hydroelectric Dispatch Data (Part 2)

The purpose of this document is to provide stakeholders with information on the detailed design for the Intertemporal Dependencies on Cascade River Systems topic and set expectations for the session. These materials are required reading for the session.

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1. Session Objective

The detailed design engagement meetings are to be considered technical working sessions. The sessions will focus on specific topics that external stakeholders either expressed an interest in during the high- level design phase or where the IESO has identified the need for further stakeholder input to inform the draft detailed design. Each session will concentrate on the proposed design for one specific aspect of the energy market detailed design.

The IESO is publishing materials for each engagement session no later than two weeks in advance of the session. This information is being shared in advance to provide stakeholders the opportunity to review and consider the potential impacts on their organization. The material should also help stakeholders identify who from their respective organizations may be most appropriate to attend the session and provide feedback. Stakeholders are encouraged to submit questions in advance of the sessions that will be addressed either at or before the session.

Stakeholder feedback, questions or concerns can be sent directly to engagement@ieso.ca.

These sessions will allow for interactive discussions with stakeholders regarding the reading material which will be focused on the questions identified below.

Stakeholders may also submit written feedback after the session if they choose to do so. However, these engagement sessions are designed to collect stakeholder feedback in-person and to facilitate a discussion with other stakeholders on that feedback. The IESO will use the input from these sessions to inform the detailed design decisions. Following each engagement session, the IESO will publish a brief summary of the discussion and allow for a short window for feedback for those not able to participate.

In the pre-engagement session, the IESO will be asking the following questions:

- What questions do stakeholders have on the proposed methodologies?
- What questions do stakeholders have on the rationale for the proposed methodologies?
- Do stakeholders agree that the proposed methodologies are consistent with the Market Renewal principles? If not, what changes would be required to better align with the principles?

Figure 1 - Principles of Market Renewal

Efficiency	Competition	Implementability	Transparency
Lower out-of market payments and focus on delivering efficient outcomes to reduce system costs	Provide open, fair, non-discriminatory competitive opportunities for particapnts to help meet evolving system needs	Work together with our stakeholders to evolve the market in a feasible and practical manner	Accurate, timely and relevant information is available and accessible to market participants to enable their effective participation in the market

2. Background

Hydroelectric resources have unique operating constraints that can impact the amount of energy and operating reserve they are able to provide. Some operating constraints are physical equipment limitations, while others are determined by safety, regulatory and environmental requirements. These constraints should be considered, to the extent possible, when evaluating resource offers within the market optimization. Under the current Day-Ahead Commitment Process (DACP), few operating constraints associated with dispatchable hydroelectric resources are considered. While sub-optimal, this shortcoming has had limited market impact given the non-financially binding nature of the current DACP.

Under a day-ahead market (DAM) this gap could similarly result in instances where a market participant receives a day-ahead schedule that may not be operationally possible. The financially binding two- settlement of the DAM could result in the market participant potentially having a balancing amount to account for differences in real-time quantities delivered. The uncertainty and possible financial risk associated with these balancing amounts due to infeasible schedules could impede efficient market participation from these resources.

In response to these concerns, the IESO met with market participants on November 14, 2019 to discuss five hydroelectric operating constraints: minimum hourly output, multiple daily energy limits, maximum starts per day, forbidden regions, and intertemporal dependencies on a cascade river system.[1] For the first four constraints, the IESO and market participants had a detailed discussion on how the IESO's proposed design can be refined to better reflect each constraint in the optimization engines. The feedback received will be considered in the draft detailed design documents. For the fifth constraint – intertemporal dependencies on a cascade river system – the IESO sought stakeholder input on the constraint in order to inform a proposed design for discussion with stakeholders on February 6, 2020.

Following the session, stakeholders submitted additional input on cascade river systems, including examples. The IESO has used the input provided by stakeholders during and following the November session to inform the requirements and proposed design contained in these materials.

[1] Meeting materials and a meeting summary are available on the Energy Detailed Design Engagement webpage.

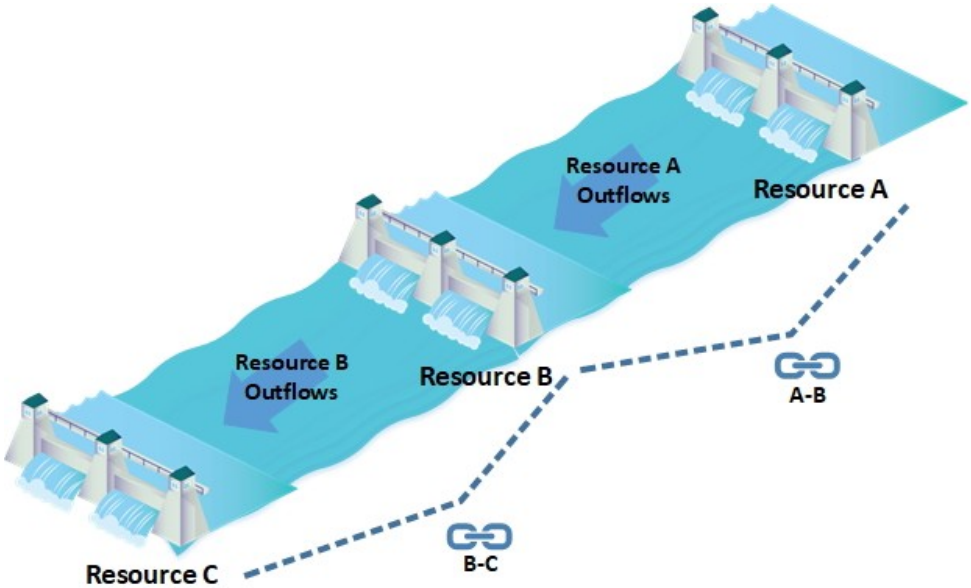
3. Market Participant Requirements for Cascade Resources

Hydroelectric station operators are required to manage their water in accordance with safety, regulatory, and environmental requirements. These requirements are typically reflected in specific water management plans, which dictate how the hydroelectric stations must operate with respect to water levels and flows.

For cascade hydroelectric resources, water management plans can impact how multiple stations on the same river system must operate to meet safety, regulatory and environmental requirements. For example, the water management plan may require a certain amount of water to be discharged from one end of the cascade to the other by the end of the day. The stations along the cascade must pass this water by either generating or spilling. These requirements create unique operating constraints for cascade hydroelectric resources that do not exist for non-cascade resources. The constraints relate to how water flows from one station to the next, and therefore how electricity production from station can impact electricity production at the next station.

As illustrated in **Figure 2**, water released from a reservoir or upstream resource can impact the amount of energy that can be generated by a downstream resource since the water released upstream becomes the input fuel for a downstream resource. Resource B is dependent on Resource A and Resource C is dependent on Resource B.

Figure 2 – Example of Dependencies Between Cascade Hydroelectric Resources



These dependencies create unique constraints for energy production between adjacent resources on a cascade river system. Stakeholders identified that energy scheduling constraints exist between resources on a cascade river system where short travel times between resources are coupled with minimal storage capabilities at downstream resources. In this situation, energy produced by the upstream resource requires energy to be produced by the downstream resource in order to pass the water it receives from the upstream resource within a certain amount of time.

For cascade hydroelectric resources, the IESO has noted the following scheduling constraints:

- A market participant must be able to define which pair of their own upstream and downstream resources, if economic, must be scheduled together; and
- A time lag must be respected for each pair of upstream and downstream resources that must be scheduled together.

4. Proposed Dispatch Data Design for Cascade Resources

The IESO proposes to introduce two new dispatch data parameters that would be used to reflect scheduling constraints between cascade resources owned by the same market participant. The following sections describe each parameter, their submission requirements, and how the DAM and pre-dispatch (PD) calculation engines would schedule resources and respect the proposed dispatch parameters submitted by the market participant.

4.1 Cascade Dependent Resources

During facility registration market participants will be required to register which of the upstream resources they own share a cascade dependency with other downstream resources that they own on the same cascade river system. This will determine which resources the registered market participant will be eligible to submit dependencies for as dispatch data.

During dispatch data submission, market participants will be able to select (link) which upstream and downstream resource pair must be jointly scheduled in respect of their cascade dependencies on a specific dispatch day. This selection will inform the DAM and PD calculation engines that the offer quantities corresponding to each pair of upstream and downstream resources need to be jointly evaluated in respect of a 'time lag' value (described in Section 4.2). By linking a pair of upstream and downstream resources, the market participant in effect establishes an energy scheduling dependency for the pair. An energy scheduling dependency means that a pair of linked resources must have their offer quantities and prices evaluated together. Section 4.3 provides examples of scheduling outcomes for resources with linked offers.

4.2 Timelag

Once a market participant establishes a link between two or more of its resources, a single 'time lag' value must be submitted by the market participant for each pair of upstream and downstream resources in the link. If Resource A is linked to B and B is linked to C then a time

lag value must be provided for each link. Market participants would submit a time lag value of zero to indicate that the resources must be scheduled within the same hour, or a value of one or more to indicate that the resources must be scheduled with a delay between them.

The single time lag value, in hours, reflects a fixed amount of time that must pass before a downstream resource can receive an energy schedule if the upstream resource receives an energy schedule. The DAM and PD calculation engines will respect this time lag such that schedules for each set of linked resources are staggered by the value submitted.

4.3 Cascade Resource Scheduling in Day-Ahead and Pre-Dispatch

The following section uses a scheduling example to describe how the proposed dispatch data parameters for cascade hydroelectric resources will be used in the DAM and PD scheduling processes.

4.3.1 Scheduling Example

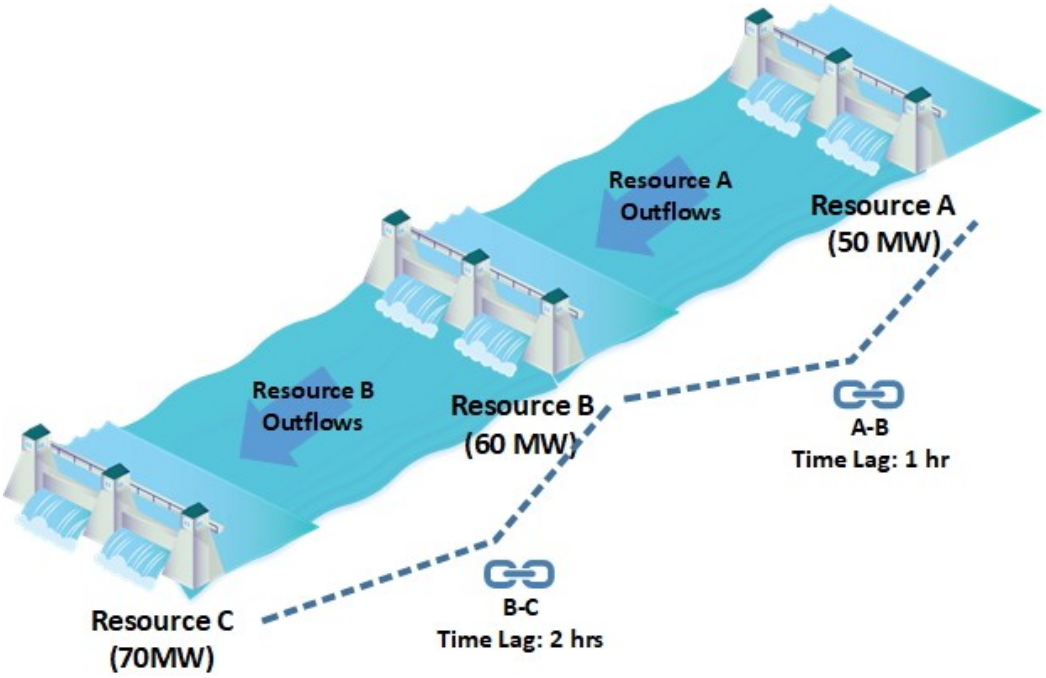
The following section uses a scheduling example to describe how the proposed dispatch data parameters for cascade hydroelectric resources will be used in the DAM and PD scheduling processes.

- Resource A offered for 50 MW;
- Resource B offered for 60 MW; and
- Resource C offered for 70 MW.

The market participant links the following resource offers and submits the following time lags as dispatch data (illustrated in **Figure 3**):

- Resource A offers are linked to Resource B offers with a time lag of 1 hour;
- Resource B offers are linked to Resource C offers with a time lag of 2 hours.

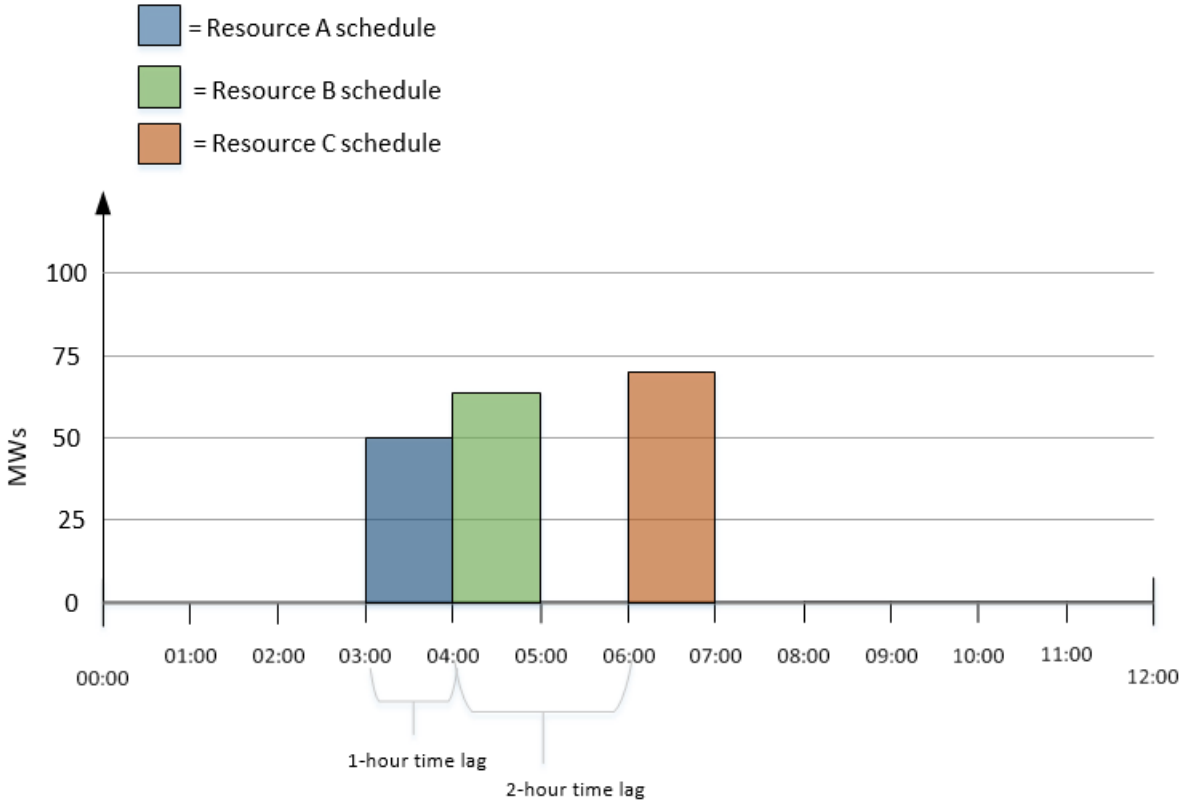
Figure 3 - Example: Hydroelectric Cascade Resources



The DAM and PD calculation engines will jointly evaluate all resource offers linked by the same market participant based on the submitted offer quantities, offer prices and time lag values. This means that Resource B cannot be scheduled unless Resource A is also scheduled and vice versa. Similarly, Resource C cannot be scheduled unless Resource B is scheduled. Since Resource B is linked to both Resource A and Resource C, the offers from all three resources are in effect linked to each other.

As illustrated in **Figure 4**, if the calculation engine determines all three resources are collectively optimal to schedule, Resources A, B and C will all receive non-zero energy schedules in respect of their time lags.

Figure 4 - Example Hydroelectric Cascade Resource Schedule



The linked resources may also be scheduled multiple times throughout the day as long as the time lags are respected and the maximum daily energy limits for the resources are not exceeded.

Conversely, if the calculation engine determines all three resources are collectively not optimal to schedule in any of the hours across a dispatch day, resources A, B and C would not be scheduled. The ability for market participants to link resource offers together therefore creates an 'all or none' scheduling dependency between the linked resources. Either all of the linked resources will be scheduled for energy or none of the linked resources will be scheduled for any energy.

The IESO has yet to determine under what conditions the market participant will be permitted to remove linked resource offers or revise the selection of linked resource offers to reflect changing conditions after the day-ahead market clears and during the pre-dispatch timeframe.

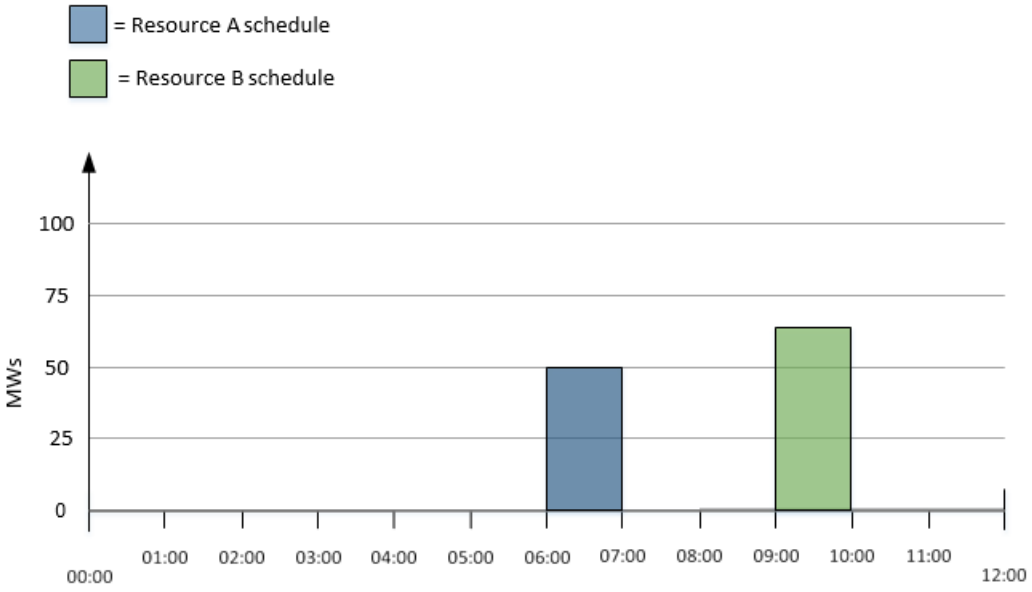
5. Rationale

In today's DACP, market participants attempt to account for cascade scheduling constraints using their offer prices. The market participant may attempt to achieve schedules that account for time

lag by offering lower prices in hours where they would like the upstream and downstream resources to be scheduled and higher prices in hours where the upstream and downstream resources are unable to be scheduled because they do not have water yet.

For example, consider that a three hour time lag exists between Resource A and Resource B. The market participant may expect market prices to clear higher in the morning hours, so they offer lower prices for Resource A in HE07 and for Resource B three hours later in HE10. To avoid receiving a schedule on Resource B during the 3 hour time lag, the market participant offers higher prices on Resource B in HE08 and HE09. The market participant's target schedule is shown in **Figure 5**.

Figure 5 - Example: Target Schedules for Resource A and Resource B



Despite the market participant's efforts, the DACP engine could schedule Resource B in HE09 rather than HE10 as the market participant had initially hoped. This schedule is technically infeasible since Resource B is unable to generate until HE10 if Resource A is scheduled in HE07. The market participant is afforded another opportunity to adjust their offers prices to drive a correct time lag schedule through the DACP resubmission window before final schedules are produced.

Market participants use today's DACP resubmission window to correct for infeasible cascade day-ahead schedules. In the future DAM, the proposed dispatch data will provide the calculation engine with the ability to produce feasible cascade schedules. As a result, market participants need not rely on adjusting their offer prices to manage their cascade dependencies

6. Conclusion

In preparation for the engagement session, stakeholders are encouraged to submit any questions or requests for clarification in advance of the interactive session.