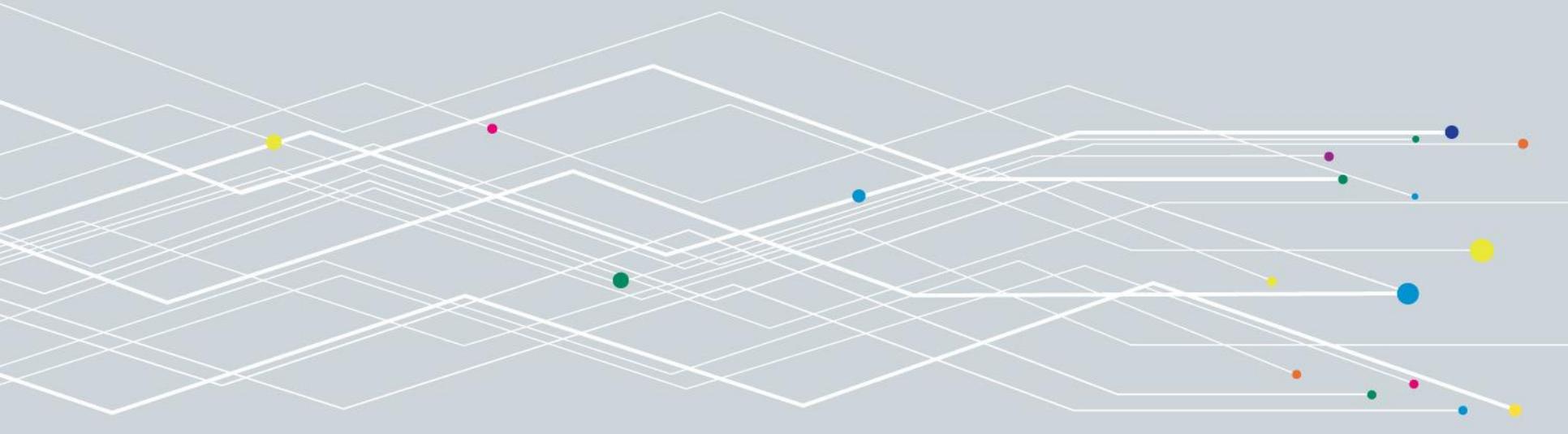


Powerex's EIM Participation

October 3, 2017



Overview Of Powerex's EIM Participation

- **Powerex's participation is consistent with a Balancing Authority based implementation**
- **Powerex will participate in the EIM with the same "trifecta" as other EIM Entities:**
 1. **Flexible Generation** - voluntary bids and offers from residual BC Hydro flexible generation
 2. **Generation and Load Imbalances** - deviations from hourly base schedules
 3. **Transmission rights** - set aside ahead of the hour to support EIM transfers, anticipating:
 - 150 MW to and from Puget Sound Energy at BC-US Border
 - 150 MW to and from CAISO at Malin
 - Will include dynamic transfer capability (subject to availability)
- **CAISO's full network model will include information on BC Hydro Balancing Authority Area**
 - Data on generation, transmission, load, interchange, base schedules, etc.
 - Telemetry and Settlement Quality Meter Data*
 - CAISO will thus have full visibility, consistent with an EIM BA-based implementation
- **Powerex will be subject to CAISO's EIM requirements:**
 - Base schedule submission
 - Resource sufficiency
 - Local market power mitigation
 - GHG treatment
 - Settlement of energy imbalances, uplift allocations, etc.
 - Powerex will pay:
 - EIM Implementation Fee, estimated at \$1.9 million
 - EIM Administrative Fees, currently \$0.19/MWh
 - Will not apply to BC-Alberta transactions

* Information may be aggregated for some non-participating generation and/or load owned and/or operated by third parties

Overview Of Powerex's EIM Participation

- **Powerex's implementation framework reflects Powerex's unique participation with resources and load located in Canada:**
 1. **Powerex's participation in US wholesale electricity markets respects the mutually exclusive legal and regulatory jurisdictions of the BCUC and FERC**
 - Powerex is subject to FERC jurisdiction
 - BC Hydro is subject to BCUC jurisdiction
 - Powerex is the entity that participates in markets **outside** the Province of BC, with BC Hydro residual capability
 - BC Hydro operates **inside** the Province of BC
 - Title transfers between Powerex and BC Hydro at the BC border
 - Powerex's EIM participation must be consistent with this established framework
 2. **EIM Area will not extend into Canada**
 - EIM Area will remain subject to FERC's exclusive jurisdiction
 - Powerex's EIM transactions defined to occur at BC-US Border
 - CAISO will not publish market prices inside BC
 - CAISO will not manage congestion inside BC
 - CAISO will model power flows inside BC
 - CAISO will also inform BC Hydro of any resulting modelled congestion inside BC
 3. **BC Hydro continues to maintain legal, regulatory, operational autonomy**
 - Continues to be subject to BCUC jurisdiction
 - Continues to operate generation and transmission systems, serve load
 - Continues to manage transmission congestion in BC
 - Continues to settle tariff services independent of EIM, including Energy Imbalance Service

Overview Of Powerex's EIM Participation

- **Powerex's implementation framework reflects Powerex's unique participation with resources and load located in Canada:**
 1. **Powerex, not BC Hydro, will join and participate in the EIM**
 - Powerex will be subject to CAISO tariff
 - Powerex will settle EIM transactions with CAISO
 - BC Hydro will enter into a data-sharing agreement with CAISO to support Powerex's EIM participation
 2. **Powerex's EIM participation will adhere to Standards of Conduct**
 - BC Hydro will communicate necessary information covered under the Standards of Conduct directly to CAISO
 - CAISO will not provide Powerex access to Transmission Function Information (including through CAISO software interfaces)
 3. **No load biasing will be used for the BC Hydro BAA**
 - BC Hydro's load forecast will be communicated by BC Hydro directly to the CAISO, and used for Powerex's EIM participation
 - BC Hydro forecasted load will be distributed to load nodes within BC Hydro BAA using load distribution factors the same as for EIM Entities
 - Like with any EIM Entity, the EIM algorithm will balance any deviations between 15- and 5-minute load forecasts and Powerex's hourly base schedules
 - Like with any EIM Entity, Powerex will settle any load deviations from Powerex's hourly base schedules

Powerex's EIM Participation Using Aggregate Resources

- Powerex's participation will use CAISO's existing framework for aggregation of electrically-similar resources in the BC Hydro BAA:

Aggregate Participating Resource

1. **Aggregate Participating Resource for 8 large hydro AGC facilities**
 - BC Hydro dispatches large hydro generation on AGC to respond to intra-hour changes in generation, load and interchange

Aggregate Non-Participating Resources

1. **Aggregate Non-Participating Resource for 8 large hydro AGC facilities**
2. **Aggregate Non-Participating VER Resources**
3. **Aggregate Non-Participating Resources for other Non-VER generation facilities**
4. **Aggregate Load**

Powerex's EIM Participation Using Aggregate Resources

Illustrative hour with G.M. Shrum and Mica providing AGC response

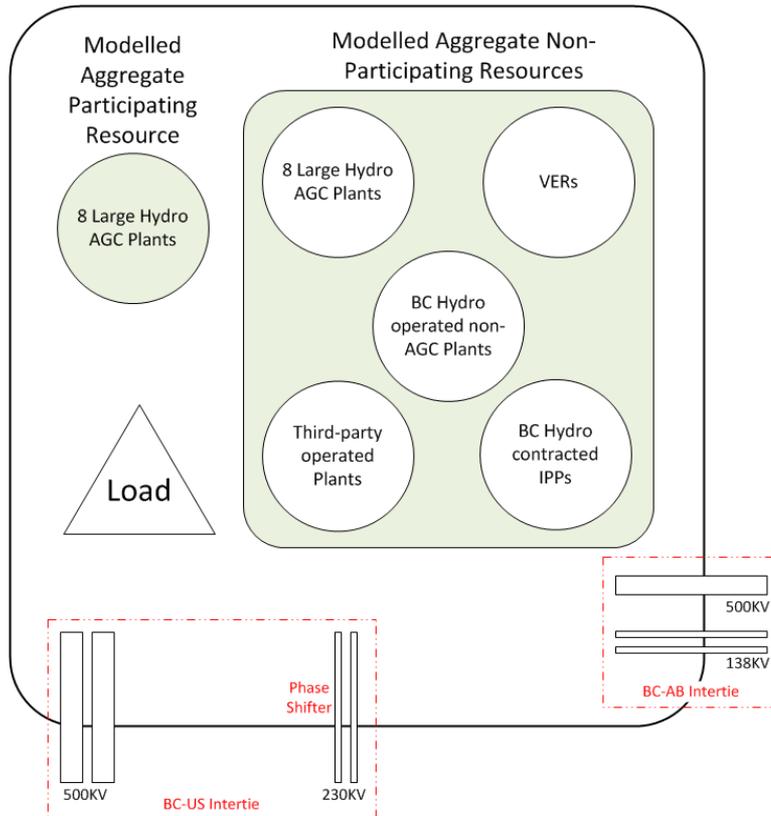
	Physical Capacity* (MW)	2016 AGC Response (% of hours)
G.M. Shrum	2,730	39%
Peace Canyon	694	0%
Mica	2,746	31%
Revelstoke	2,480	35%
Seven Mile	805	1%
Kootenay Canal	583	0%
Bridge River	478	0%
Cheakamus	158	0%

- These 8 large hydro facilities total 10,674 MW
- Base schedules, bids/offers and market dispatch for APR and ANPR will be within physical resource capabilities
- Modelled as:
 - Aggregate Participating Resource (APR), and
 - Aggregate Non-participating Resource (ANPR)
- Similar aggregation of large hydro generation occurs today for Mid-C resources in the EIM
- BC Hydro will determine GDFs for each upcoming hour, which will be communicated to CAISO
- These GDFs enable CAISO to more accurately model power flows from individual plants / units
 - Submission of hourly GDFs is an improvement from current aggregation approach
- Separating 8 large hydro AGC plants between APR and ANPR enables more accurate GDFs
 - Different GDFs for base schedules vs intra-hour EIM dispatch

* Maximum sustained generating capacity from "BC Hydro Quick Facts" for year ending March 31, 2017. <https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/corporate/accountability-reports/financial-reports/annual-reports/bchydro-quick-facts-june-2017.pdf>

Powerex's EIM Participation with Aggregate Resources is Consistent with the EIM Design

BC Hydro BAA

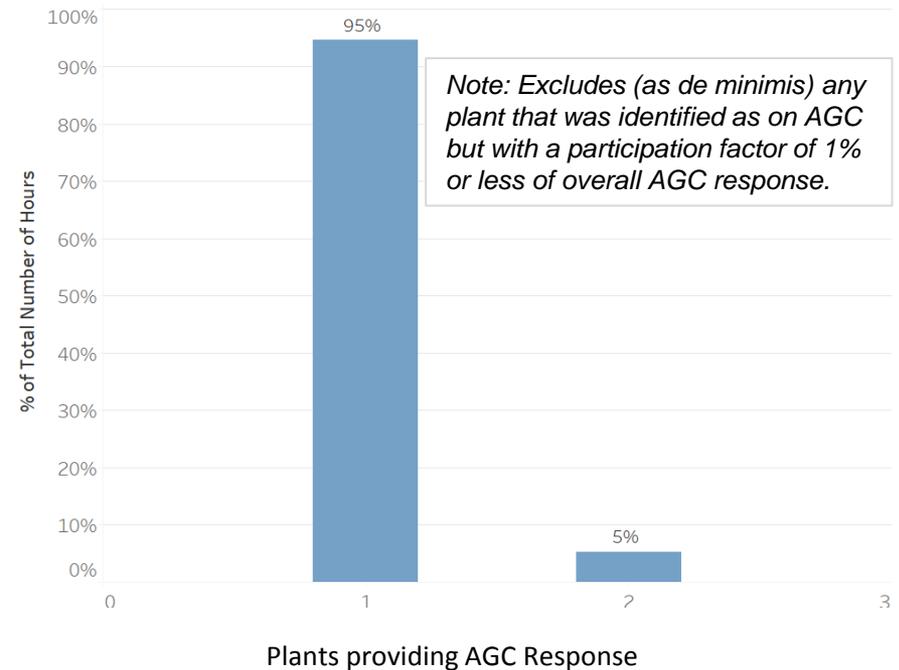


- **Powerex's resource aggregation meets the CAISO's existing requirements for aggregation of electrically-similar resources**
 - BC Hydro BAA is largely radial to the US (diagram)
 - Thus any potential rare departure from hourly GDFs will have limited impact on power flows in the EIM Area
 - Settlement of Powerex's aggregate resources will be consistent with the settlement of other EIM aggregate resources
- **CAISO will manage congestion within the EIM Area, including EIM transfers to and from BC**
 - BC Hydro will continue to manage congestion inside the BC Hydro BAA, and will not use CAISO's congestion management services
 - CAISO will inform BC Hydro of any resulting modelled congestion / infeasibilities in BC (if and when they arise)
 - CAISO will not enforce transmission limits within BC Hydro BAA
- **Powerex will be subject to the Resource Sufficiency tests**
 - CAISO will apply the balancing test, capacity test, flexible ramping sufficiency test and feasibility test
 - Powerex's base schedules and bids/offers are expected to continue to be fully feasible within the BC Hydro BAA

Transmission Congestion in the BC Hydro BAA

- BC Hydro has built out the transmission system to support winter peak demand under N-1 conditions including firm export commitments
- BC Hydro actively adjusts generation *prior to* the operating hour, considering transmission outages and congestion
- BC Hydro actively uses Generation RAS and Load Shedding RAS to ensure post-contingency states will respect reliability limits (instead of using generation re-dispatch)
- Thus, BC Hydro does not frequently re-dispatch generation intra-hour to resolve congestion
- In most hours, only one plant provides AGC response, and is known ahead of the hour, enabling accurate GDFs:
 - During 95% of the hours of 2016, only one plant was providing the AGC response
 - During the remaining 5% of the hours, only two plants were providing the AGC response
 - GDFs for APR may thus often be
 - 100% for one plant, or
 - 50%/50% for two plants

Number of Plants providing AGC Response each Hour - 2016



**Above data are provided to facilitate discussion.
Data is preliminary and subject to verification.**

Benefits of Powerex's EIM Participation

EIM Benefits to EIM Area

- 1. Powerex is bringing clean, fast-ramping, flexible hydro generation**
 - Increases supply options to meet generation and load imbalances
 - Supports integration of renewable resources
 - Reduces GHG emissions, through deployment of clean hydro energy
- 2. Powerex is bringing transmission rights**
 - Supports EIM transfers to/from BC and increases transfer capability between EIM Entities
 - Includes dynamic scheduling rights to/from CAISO, which is a frequent EIM limitation
- 3. Powerex is bringing additional diversity to the EIM**
 - Deviations in generation and load in BC included in EIM algorithm, and settled by Powerex
 - BC load and wind deviations are significantly diverse from NW load and wind deviations
 - Will reduce flexible capacity requirements for EIM Entities and CAISO
 - Flexible Ramping Sufficiency Test diversity credit

EIM Benefits to Powerex

- 1. Ability to use “stranded” balancing reserves**
 - Estimated at 300 MW of INC and 300 MW of DEC, on average
 - Does not displace non-EIM transactions
- 2. Ability to purchase during regional over-supply events, particularly spring season**
 - Additional voluntary DEC bids as opportunities arise
 - Requires additional transmission rights northbound be set aside
- 3. Leverages existing capability, in a more efficient way**
 - Powerex already participates in CAISO's 15-minute and 5-minute markets