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

- 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

<table>
<thead>
<tr>
<th>Physical Capacity* (MW)</th>
<th>2016 AGC Response (% of hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>G.M. Shrum</td>
<td>2,730</td>
</tr>
<tr>
<td>Peace Canyon</td>
<td>694</td>
</tr>
<tr>
<td>Mica</td>
<td>2,746</td>
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<tr>
<td>Revelstoke</td>
<td>2,480</td>
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<tr>
<td>Seven Mile</td>
<td>805</td>
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<tr>
<td>Kootenay Canal</td>
<td>583</td>
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<tr>
<td>Bridge River</td>
<td>478</td>
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<tr>
<td>Cheakamus</td>
<td>158</td>
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</tbody>
</table>

* Maximum sustained generating capacity from “BC Hydro Quick Facts” for year ending March 31, 2017.

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

- 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

Note: Excludes (as de minimis) any plant that was identified as on AGC but with a participation factor of 1% or less of overall AGC response.
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