Northwest **Power** and
Conservation Council

January 7, 2021

MEMORANDUM

TO: **Power Committee**

FROM: **Ben Kujala**

SUBJECT: **How RPM Simulates Imports and Exports**

BACKGROUND:

Presenters: Ben Kujala, John Ollis

Summary: The Regional Portfolio Model (RPM) deals with imports and exports to and from the region differently than the other power system models, AURORA and GENESYS. RPM, being largely based on economic commodity pricing theory, iterates the quarterly electricity price up and down and then looks at the implied regional generation based on the simulated electricity price. RPM does this until it finds a balance of generation and load within a range set by import and export limits. Energy efficiency that is acquired is netted out of the load when making this calculation.

In this presentation we will walk through an example of how the model iterates on price and subsequently adjusts generation to find a regional balance.

Also included are the slides from the first look presentation at the December Power Committee meeting. Because this material raised questions among the committee on how RPM modeled imports and exports, these slides are included for reference and discussion.

More Info: [Presentation on the First Look at Baseline Conditions (December 2020)]

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How RPM Simulates Imports and Exports

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Imports and Exports Start with Electricity Price

- RPM is largely based on economic commodity pricing theory
- RPM incorporates simulated "futures" based on the range of prices from AURORA and adjusted for relationship between electricity price, load, natural gas price, and hydro generation

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Example Q4 2021 Single Future

- Simulated future unadjusted peak electricity price Q4 2021 (period 1 of the study) - $118.10
- Adjusted based on load, natural gas price, and hydro to $92.94
  - Simulated hydro generation 15393 aMW > average hydro generation 13486 aMW
  - Simulated natural gas price $2.87 > average natural gas price $2.79
  - Simulated on-peak load 26,469 aMW > average on-peak load 26,027 aMW

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Dispatch of Generating Resources Based on Price

- Transform quarterly price into hourly price distribution
- Calculate total generation (both existing and new generating resources) based on hourly prices:
  - If generation is must-run, assume full dispatch (CGS, hydro, small PURPA resources, etc.)
  - If generation is dispatchable, calculate number of hours revenue exceeds costs
- Add generation and compare to net load

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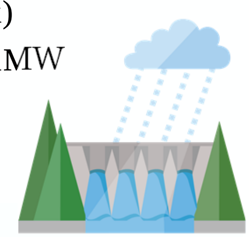
Example Q4 2021 Single Future

- Based on electricity price of $92.94 close to full dispatch of non-hydro existing system (approx. 16,000 aMW on-peak)
- Hydro generation is must-run and based on climate change data (approx. 17,500 aMW on-peak)
- Total generation is approximately 33,500 aMW



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Load is net of EE

- EE impacts the net load for the calculation
- Known contracts for import or export are included in the net load

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Example Q4 2021 Single Future

- Net load on-peak is 26,761 aMW
- Thus surplus generation is 33,500 aMW – 26,761 aMW = 6,739 aMW export

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Import / Export Limits Create a Generation Range

- Maximum export limits by quarter are used for balancing
- Based on joint export Available Transfer Capability (ATC) with 95% exceedance – i.e. 95% of the time you can export more than the limiting amount

Q1	Q2	Q3	Q4
6789	6850	7097	5850

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Example Q4 2021 Single Future

- Since surplus 6789 aMW > 5850 export limit price is adjusted down to reduce generation
- Price is adjusted by a factor k (current set to .5) that narrows a price range with each iteration by changing a top or bottom price depending on if the implied surplus or deficit of generation is within the import and export limit range:
  - Formula is $(1-k) * Top\ Price + k * Bottom\ Price$
- For the example the price is iterated 5 times:
  1. .5 * $92.94 + .5 * -$50 = $21.47 (not enough generation)
  2. .5 * $92.94+ .5 * *$21.47* = $57.20 (too much generation)
  3. .5 * *$57.20* + .5 * $21.47 = $39.34 (not enough generation)
  4. .5 * $57.20 + .5 * *$39.34* = $48.27 (too much generation)
  5. .5 * *$48.27* + .5 * $39.34 = $43.81 (final price)

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Limits apply to aMW

- Export limits are based on transmission ATC but are applied to aMW of generation
- RPM does not check hourly transmission limits
  - I.e. we know average quarterly generation less than export limits but not that hourly implied generation is less than export limits

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Example Q4 2021 Single Future

- At the price of $17
  - 14,102 aMW on peak of non-hydro generation
  - 17,500 aMW Hydro generation does not change based on price
  - Total generation is 31,602 aMW
  - Net load remains 26,761 aMW
- Surplus generation is 4809 aMW
- Since surplus is less than 5850 aMW limit further iteration was not needed

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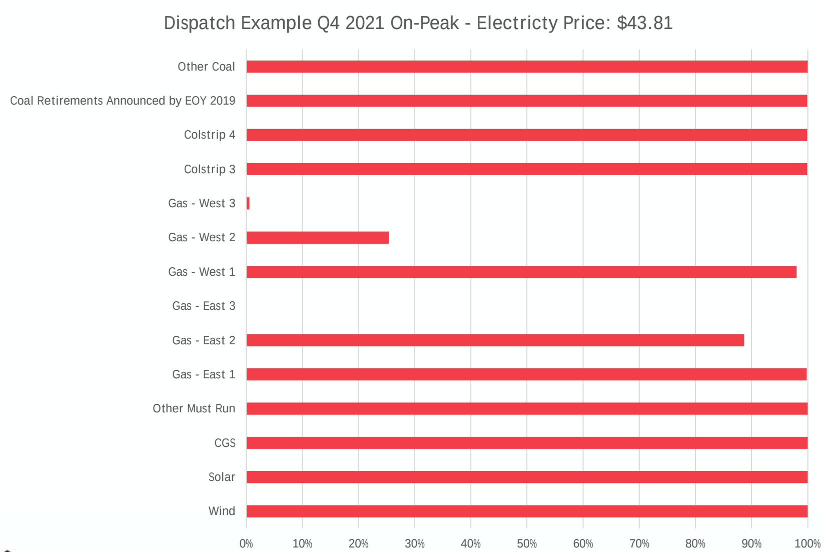

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Updating Import / Export Limits

Import / Export Limits

Import and export limits from the 7th plan:

Quarter	Import (MW)	Export (MW)
1	3,732	5,795
2	3,472	6,835
3	3,456	7,062
4	3,266	5,829

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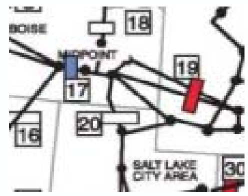
Potential Basis for Change

- Limits were previously based on fifth percentile of available transmission capacity on the COI and DC Intertie – this was a proxy for the market seen as predominantly California
- Staff tested adding in the ability to export on the BC Intertie and adding export capability for Path 20 (Southern Idaho to Utah)
- Updated data based on 15 minute ratings from BPA on COI + DC Intertie + BC Intertie ratings from 2016 to 2019
- For WECC Path 20, we didn't have 15 minute ratings so added 1000 MW based on WECC document



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Potential Update to Import / Export Limits

- With this approach the results would be:

Quarter	Import (MW)	Export (MW)
1	7,800	7,800
2	8,210	6,850
3	9,750	7,097
4	5,100	5,850

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Potential Change in Import / Export Limits

- For a difference of

Quarter	Import (MW)	Export (MW)
1	4,068	2,005
2	4,738	15
3	6,294	35
4	1,834	21

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What's with the imports?

- These imports are for economics only, the imports for adequacy are determined by GENESYS and the Adequacy Reserve Margin
- Updated data show higher import transmission ratings and adding BC and Path 20 imports results in significant increase to import limits
- In the first look RPM run, import limits were infrequently hit so generally we wouldn't expect increasing them to have much impact in this setup – it may matter for scenarios

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Why didn't that add more to exports?

- Updating to 2016 to 2019 reflects more recent operations which look to have lower ratings for available transmission
- Adding up single line ratings misses transmission system dynamics that impact multiple paths
- Fifth-percentile may be conservative but reasonable for imports but not reflect a reasonable assumption for exports

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