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By email to PACMatters@ISO-NE.com

Peter Bernard
Chair, Planning Advisory Committee
ISO New England Inc.
One Sullivan Road
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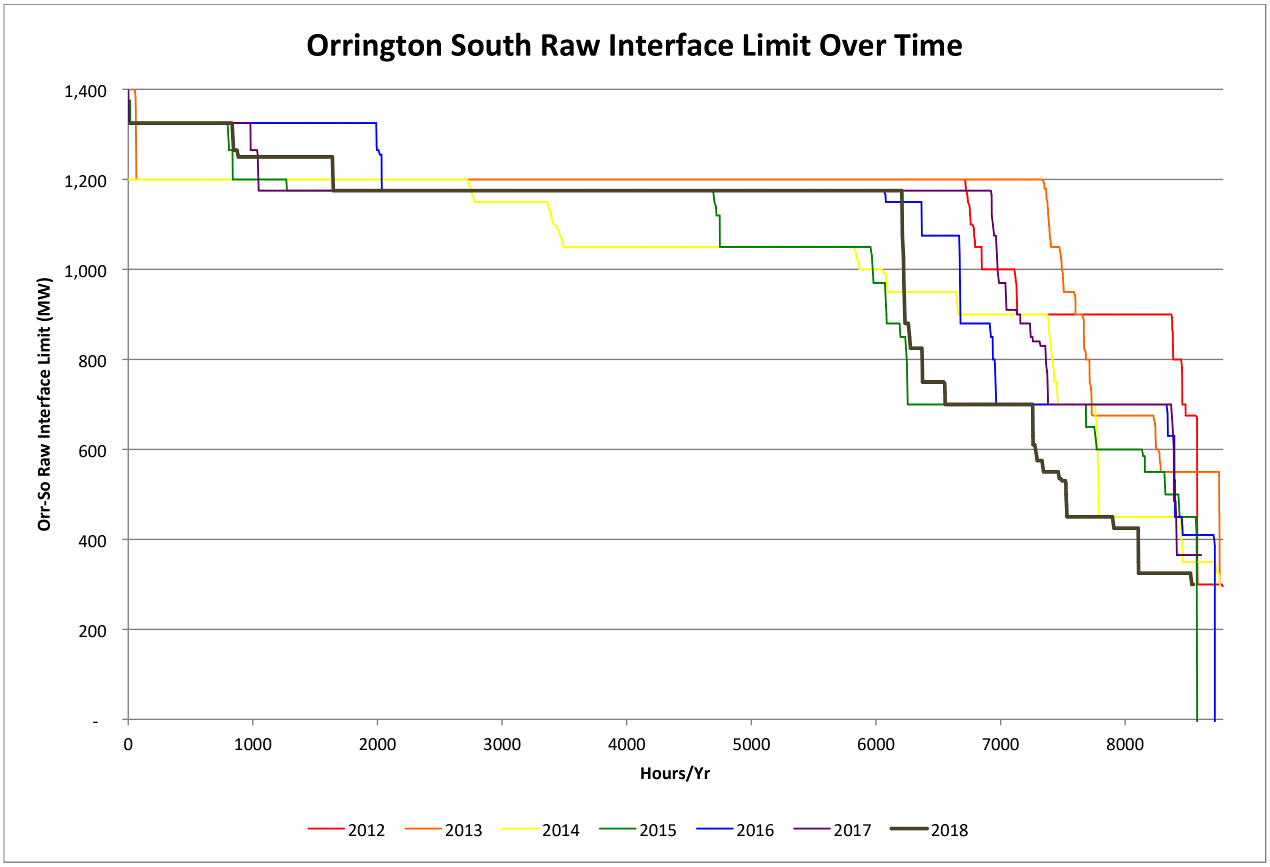
Subject: 2019 Economic Study Request: Economic Impact of Targeted Upgrades to the Orrington-South Interface Limit

Mr. Bernard:

RENEW Northeast, Inc. ("RENEW") requests, pursuant to Attachment K of the Open Access Transmission Tariff, that ISO New England ("ISO-NE") conduct an economic study evaluating the economic impact of two conceptual alternate transmission upgrades that would increase the hourly operating limits of the Orrington South interface in Maine. If the results of this study show that the expected production cost savings from one of the scenarios exceeds the expected cost of the upgrade needed to achieve these results, we would request that ISO-NE identify this upgrade as a possible Market Efficiency Transmission Upgrade pursuant to Attachment N of the Open Access Transmission Tariff.

I. Background on Orrington South Interface Limit

ISO-NE has a planning limit that sets the upper bound on operational limits for the defined transmission interfaces. Based on real-time system conditions, taking into account such things as transmission element outages and generator dispatch, ISO sets real-time operating limits that are capped by the planning limit. In the case of the Orrington-South interface, the planning limit is 1,325 MW, though the raw hourly operating limit is below this level the vast majority of the time, sometimes significantly so. The amount of time this interface has spent at different real time operating limits is shown in the following figure created from data provided to the PAC by ISO.[1]



The data in this figure shows, for example, that the Orrington South interface limit was 1,325 MW in only 11% of the hours in 2017. The interface limit was 1,175 MW for the majority of the year, and spent a significant portion of the year at or below 700 MW. It is during these periods of time, when the interface limit is reduced below the planning limit, that we believe the majority of congestion occurs.

One further caveat that we believe is important to note is that the real time operating limits provided by ISO and shown in the above figure are "raw" limits, not the actual limits used in the economic dispatch process that determines dispatch and curtailment levels as well as congestion pricing. Because there is some uncertainty about how closely the ISO's dispatch instructions will be followed, and due to the need to ensure that the raw operating limits are not exceeded, ISO applies a buffer to these raw operational limits when setting the limits used in the economic dispatch process. These buffers, or rather, the actual limits used in the dispatch process, are not published publicly by ISO-NE. However, it is our understanding that a 50 MW buffer is fairly

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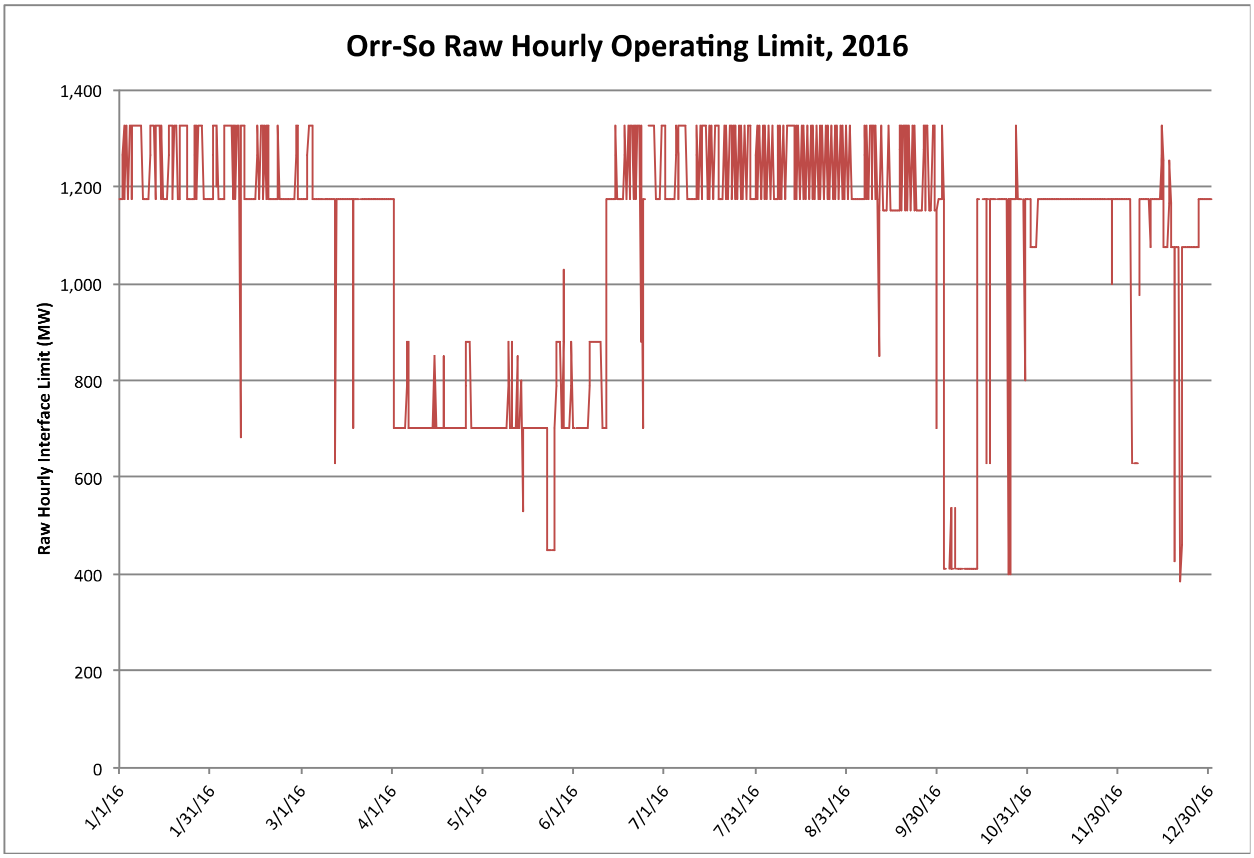
[1] https://www.iso-ne.com/isoexpress/web/reports/load-and-demand/-/tree/historical-hourly-flows-and-limits

typical for this particular interface. As such, when the raw operational limit was 1,175 MW, the limit used in the dispatch process was likely around 1,125 MW.

In the past, Economic Studies of transmission upgrades to this part of the system have assumed that the interface limit has been equal to the planning limit in all hours. It has not taken into consideration that the interface is often limited below this level due to real time operating conditions, nor has it taken into account the buffer used in the economic dispatch process. The results of these studies have historically shown low levels of congestion, and low levels of "bottled in" clean energy as a result. We believe that the levels of congestion and "bottled in" energy in these studies has been lower than actual observed levels due in large part to this mismatch between the interface limit assumption and the reality of lower interface limits in actual operations.

We believe that in order to perform a study of the congestion on this part of the system that comes closer to approximating actual system operations, the typical range of hourly operating limits must be assumed rather than a fixed upper planning limit. We believe this can best be done by utilizing a prior year of actual operational limit data that is representative of typical system operations for use in the base case of any study. Looking at the years 2012 through 2018 for which we have data, we believe that 2016 is the most representative year. The MPRP project was substantially completed in 2015. This caused significant reductions to the operating limits due to outages that were required during the multi-year construction effort, and when completed resulted in changes to the interface limits in Maine. In late 2017 and throughout 2018, the MEPCO lines underwent major asset condition upgrades that required lengthy outages with significant impact to the Orrington-South operating limit. Given that the construction outages required for MPRP and the MEPCO asset condition upgrades are atypical, we felt that the year between these, 2016, in which major transmission construction was not being performed, provided a more typical baseline for analysis.

The 2016 raw hourly operating limit for the Orrington South interface limit (prior to a buffer being applied in the economic dispatch process) is shown chronologically in the following figure.



Because ISO-NE, due to the Information Policy, does not share specific details about the impact of different operating conditions, some amount of guesswork must unfortunately be used in trying to determine what the effect of possible upgrades would be for use in this study. By comparing the chronological Orrington-South limit data shown in the above figure to ISO's public transmission outage reports and other publicly available information, a number of conclusions can be inferred regarding the causes of the fluctuating limits on this interface. In turn, these can inform assumptions about how these limits might change as a result of the area upgrades proposed in this study request.

For example, the daily fluctuations between 1,175 MW and 1,325 MW appear to be the result of generator dispatch during all-lines-in conditions. There is a large, synchronous generator located close to the Orrington-South interface. When this generator is dispatched to run, it provides significant stability and voltage contributions to the area and as such is most likely the cause of these fluctuations.

If a non-generator device that provided similar stability and voltage support were added to the system, it would be reasonable to expect that the system could achieve the higher interface limit, regardless of whether this synchronous generator was dispatched.

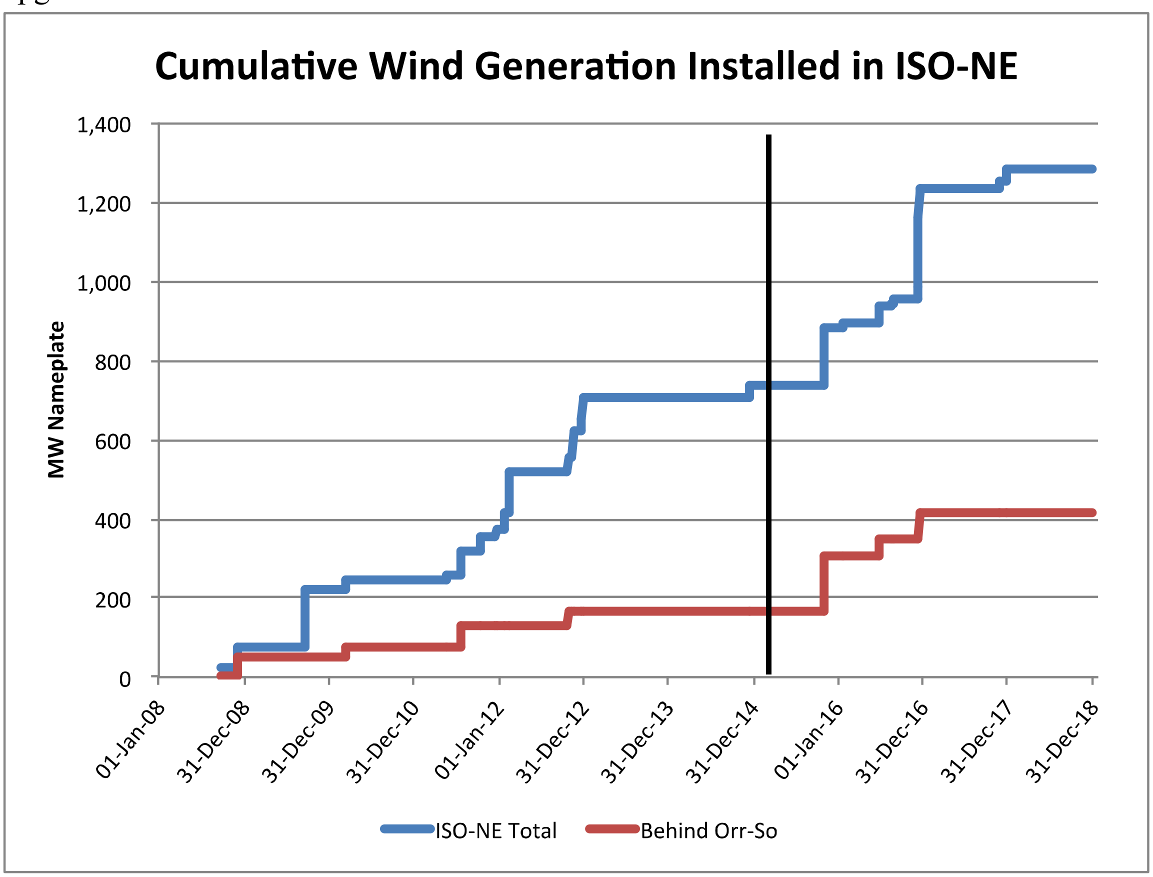
The 475 MW decrease in the interface limit from April 1 through June 12 coincided with the annual spring maintenance outage of the Point Lepreau nuclear generation station in New Brunswick. When 345kV line section 3023 from Orrington to Albion Road was out of service from May 23 through May 25, the interface limit dropped a further 250 MW. In the fall, from October 3 through 14, the outage of 345 kV line Section 388 from Orrington to Coopers Mills was accompanied by an interface limit reduction of 765 MW. Later in the year, from December 15 through 27, the series compensator on Section 388 was out of service, coinciding with a 100 MW reduction to the interface limit.

When either Section 388 or Section 3023 are taken out of service, only one 345kV transmission path remains connecting Orrington to the rest of Maine. If a third 345 kV transmission path from Orrington to Maine Yankee were added, it would be reasonable to assume that when either Section 388 or Section 3023 were out of service (i.e., when only two 345 kV transmission paths remain connecting Orrington to the south), the system limits would be similar to what they have historically been when both of these lines are in service.

II. Review of Past Economic Studies

In 2015 RENEW requested an economic study to evaluate the impact of a number of Maine transmission upgrades, as identified by ISO in their Strategic Transmission Analysis for Wind Integration. That study showed very low levels of congestion and curtailment from the Orrington-South interface, and therefor little benefit to upgrading the interface. We believe it is possible that a new, more focused study, may come to different conclusions. First, we believe that a large part of the reason for this finding was the use of the raw planning limit for the interface, as described above, rather than more realistic hourly operating limits as requested in this study. Second, the amount of generation located behind the interface has increased since the 2015 study request.

The next figure shows the cumulative wind generation installed in ISO-NE over time (blue) and the portion of this that has been installed behind the Orrington-South interface (red). At the time that the assumptions for the resource mix to be used in the 2015 economic study were set (shown as the black vertical line), only 166 MW of wind was operating behind the interface. Today, 418 MW of wind is operating behind the interface, a 252% increase. Though the total MW numbers here are rather modest, the impact of this additional generation on the interface has been considerable. As such, we believe it is appropriate to re-visit the impact of making targeted upgrades to this interface.



III. RENEW's Request of Scenarios to Be Studied

We request ISO-NE evaluate the economic impact metrics of two alternate upgrades targeting the Orrington-South interface.

0 – The base case would use the actual, raw hourly operating limits reported for 2016, modified to approximate the addition of the Coopers Mills STATCOM (CMS) which was added to the system in November 2018.

1 – Scenario 1 would evaluate the impact of adding a transmission device with an equivalent impact on the Orrington-South interface as the dispatch of a nearby, large synchronous generator.

2 – Scenario 2 would evaluate the impact of adding a new 345 kV transmission path from Orrington to Maine Yankee.

To create each of these scenarios, the 2016 Orrington South interface limits would be modified as follows:

Base Case: Use 2016 raw hourly limits, modified to approximate addition of Coopers Mills STATCOM (CMS) added in Nov 2018

- In hours when limit is 1325 MW, no change
    - Assumes no change to max planning limit
- In hours when limit is 1175 MW, increase to 1250 MW
    - Assumes CMS increases all-lines in limit, without nearby synchronous generator dispatched, by 75 MW from normal value of 1175 MW
- In hours when limit is 1150MW, increase to 1225 MW
    - Assumes CMS increases this limit, without nearby synchronous generator dispatched, by 75 MW
- In hours when limit is 700 MW, increase to 750 MW
    - During Pt Lepreau outage, assumes CMS increases limit by 50 MW (This is a guess. In early April can check what actual limit is for outage, which is planned to start 4/5/19.)
- In hours when limit is 880 MW, increase to 930 MW
    - During Pt Lepreau outage, during hours when nearby synchronous generator is dispatched, assumes CMS has additional benefit equal to 50 MW (This is a guess. Can check for actual limit during this spring's outage if the synchronous generator gets dispatched.)
- In hours when limit is 450 MW, increase to 535 MW
    - During overlapping Pt Lepreau and S3023 outage, assumes CMS increases limit by 85 MW (same increase seen on 11/8 when we think CMS went into service during S3023 outage)

- In hours when limit is 410 MW, increase to 425 MW
  - During S388 outage, assumes CMS increases limit to 425 MW (limit observed in Dec 2018 during S388 outage)
- In hours when limit is 1075 MW, increase to 1125 MW
  - During 388-SC outage, assumes CMS increases limit by 50 MW (A guess)

Scenario 1: Device with Orr-S limit impact equivalent to dispatch of nearby synchronous generator

- In hours when limit is 1325 MW, no change
  - Assumes no change to max planning limit
- In hours when limit is 1175 MW or 1150MW, increase to 1325
  - Assumes device has equivalent impact as nearby synchronous generator being dispatched
- In hours when limit is 700 MW, increase to 920 MW
  - During Pt Lepreau outage, assumes device has equivalent impact as nearby synchronous generator being dispatched (180 MW) plus 50 MW for CMS, less 10 MW for diminishing returns
- In hours when limit is 880 MW, increase to 1020 MW
  - During Pt Lepreau outage, during hours when nearby synchronous generator is dispatched, add 50 MW for CMS and then assume device has additional benefit equal to half the impact of the synchronous generator (90 MW) for diminishing returns
- In hours when limit is 450 MW, increase to 575 MW
  - During Pt Lepreau and S3023 outage, assumes device increases limit to level observed on 11/9 when we believe CMS and nearby synchronous generator were online during S3023 outage
- In hours when limit is 410 MW, increase to 550 MW
  - During S388 outage, assumes device increases limit by 150 MW beyond the 425 MW observed with CMS in service, less 10 MW for diminishing returns.
- In hours when limit is 1075 MW, increase to 1265
  - During 388-SC outage, assumes device increases limit by 150 MW, CMS increases by 50 MW, less 10 MW for diminishing returns

Scenario 2: New 345kV transmission line from Orrington to Maine Yankee

- In hours when limit is 1325 MW, increase to 1425 MW
  - Assumes 100 MW increase to max planning limit resulting from new 345kV line from Orr to ME Yankee (reference: MPRP limit increase when 2nd 345kV line was added was 125 MW)
- In hours when limit is 1175 MW or 1150MW, increase to 1350
  - Assumes 75 MW decrease from max planning limit when nearby synchronous generator not dispatched as observed following CMS in service date
- In hours when limit is 700 MW, increase to 1025 MW
  - During Pt Lepreau outage, assume 450 MW decrease from max planning limit (same as NB-NE limit decrease during Pt Lepreau outage) plus 50 MW increase for CMS

- In hours when limit is 880 MW, increase to 1,205
    - During Pt Lepreau outage, during hours when nearby synchronous generator is dispatched, assumes new line and CMS in combination have same increase as when the synchronous generator is not dispatched (325 MW)
- In hours when limit is 450 MW, increase to 750 MW
    - During Pt Lepreau and S3023 outage, assumes device increases limit to what it is (with CMS) during just Pt Lepreau outage without S3023 outage
- In hours when limit is 410 MW, increase to 1250 MW
    - During S388 outage, assumes new line increases limit to what it is now during all lines in conditions, with CMS in service, without nearby synchronous generator being dispatched
- In hours when limit is 1075 MW, increase to 1325
    - During 388-SC outage, when nearby synchronous generator is not dispatched, assumes new line increases limit to 100 MW below the max planning limit.

For all three scenarios

- All limits described above are raw. Put buffer of 50 MW on the above limits in all hours to approximate actual dispatch limits (e.g., where the limit is listed at 1075 MW above, use a limit of 1025 after application of the buffer).
- Where 2016 limit was reported as -99999 or missing, replace with persistence values

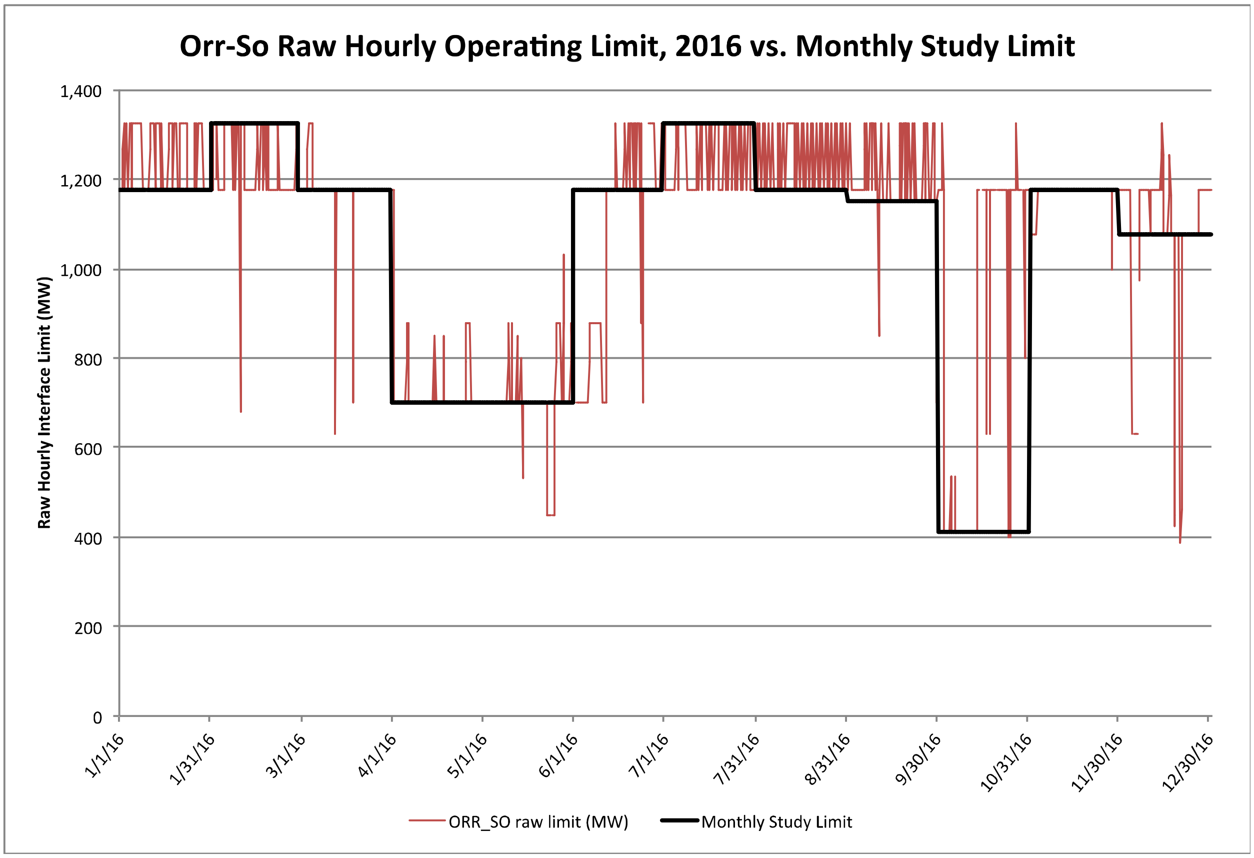
IV. Alternate Methodology Using Monthly Interface Limits to Approximate Hourly Limits

It is our understanding that ISO-NE's modeling software used in the economic study analysis may not be able to vary interface limits on an hourly basis but would be able to vary the limits on a monthly basis. Though our strong preference would be that the study use hourly limits to provide for a better comparison with actual operating experience, we believe that a reasonable approximation could be made by using monthly limits.

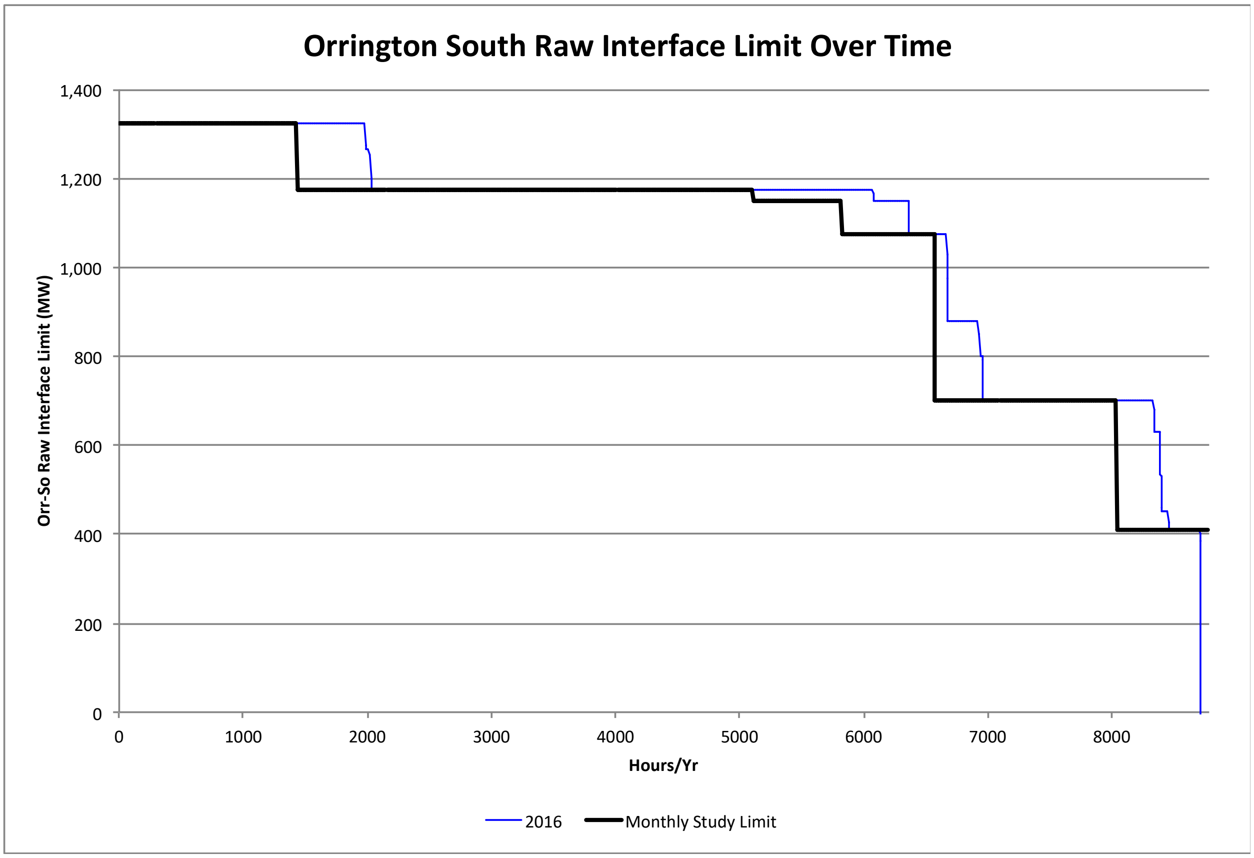
If monthly interface limits must be used, we suggest the following monthly limits in order to approximate the 2016 hourly limits:

Month	2016 Raw Limit Approximation (MW)
Jan	1175
Feb	1325
Mar	1175
Apr	700
May	700
Jun	1175
Jul	1325
Aug	1175
Sep	1150
Oct	410
Nov	1175
Dec	1075

These monthly limits are shown graphically in the following figure in black, in comparison to the actual raw hourly operating limits in 2016.



The next figure shows the limit duration curve for the actual raw hourly operating limits in 2016 and the monthly limit approximations. Though they are not identical, we believe the monthly limits come sufficiently close to the hourly limits that they can be used as a reasonable approximation in this study.

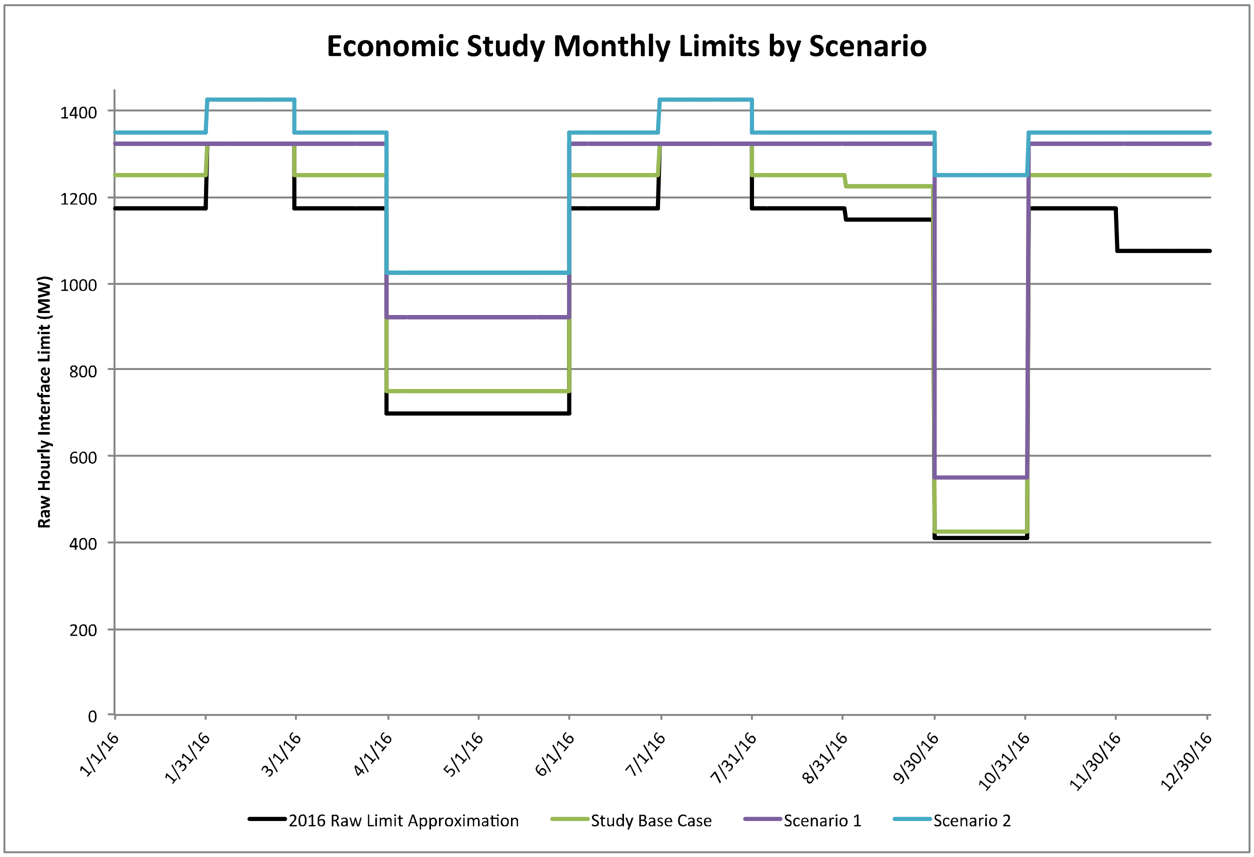


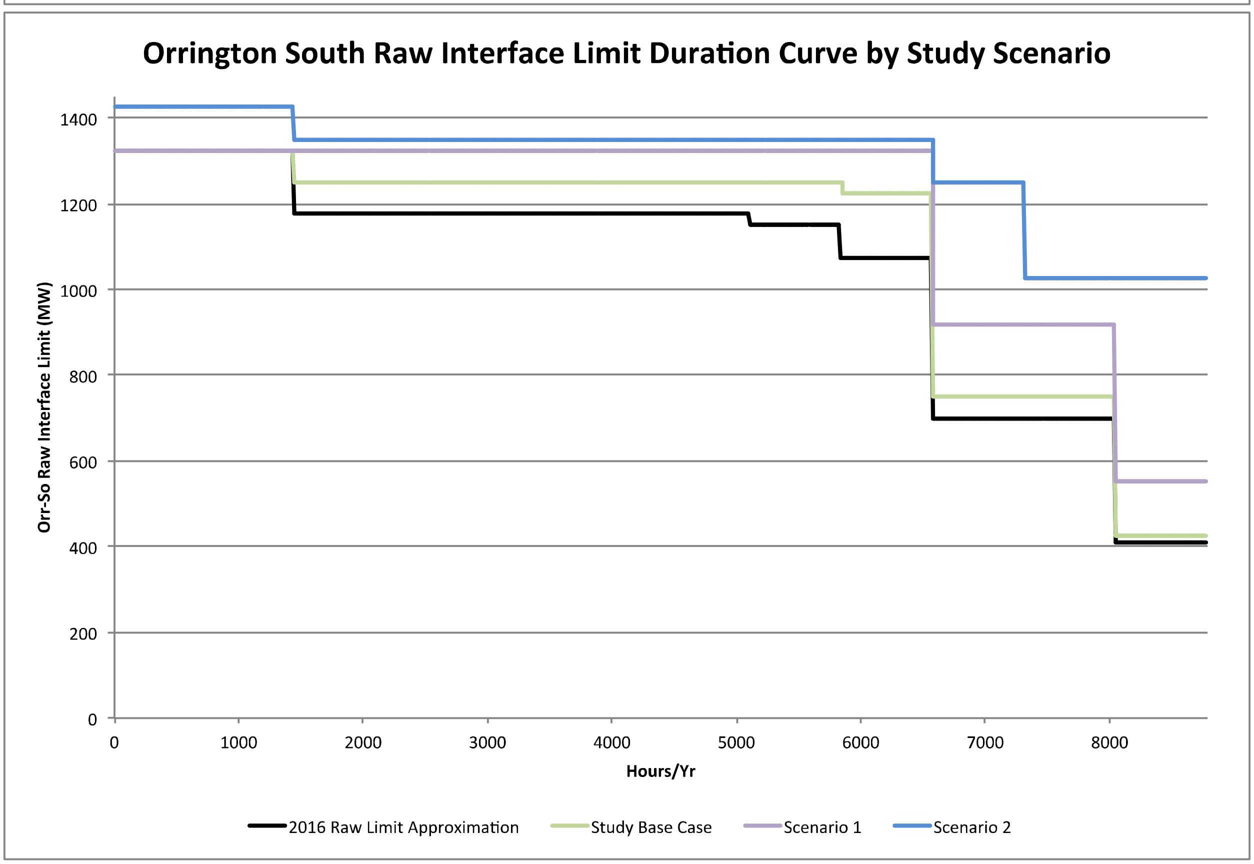
Using the above monthly limits values to approximate the 2016 raw hourly limit values, the base case and two scenarios would then be as shown in the following table and figure. To create the three study scenarios, the 2016 raw data has been adjusted using the same rules laid out in the earlier section which assumed hourly data would be used.

Month	2016 Raw Limit Approximation (MW)	Base Case Limit (MW)	Scenario 1 Limit (MW)	Scenario 2 Limit (MW)
Jan	1175	1250	1325	1350
Feb	1325	1325	1325	1425
Mar	1175	1250	1325	1350
Apr	700	750	920	1025
May	700	750	920	1025
Jun	1175	1250	1325	1350
Jul	1325	1325	1325	1425
Aug	1175	1250	1325	1350
Sep	1150	1225	1325	1350
Oct	410	425	550	1250
Nov	1175	1250	1325	1350
Dec	1075	1125	1265	1325

Note: All limits in the above table are raw. A buffer of 50 MW should be included in all hours to approximate actual dispatch limits (e.g., where the limit is listed at 1075 MW above, use a limit of 1025 after application of the buffer).

Graphically, the study scenarios shown in the above table would appear as shown in the following two figures.


Economic Study Monthly Limits by Scenario
Raw Hourly Interface Limit (MW)
0
200
400
600
800
1000
1200
1400
1/1/16
1/31/16
3/1/16
4/1/16
5/1/16
6/1/16
7/1/16
7/31/16
8/31/16
9/30/16
10/31/16
11/30/16
12/30/16
2016 Raw Limit Approximation
Study Base Case
Scenario 1
Scenario 2


Orrington South Raw Interface Limit Duration Curve by Study Scenario
Orr-So Raw Interface Limit (MW)
0
200
400
600
800
1000
1200
1400
0
1000
2000
3000
4000
5000
6000
7000
8000
Hours/Yr
2016 Raw Limit Approximation
Study Base Case
Scenario 1
Scenario 2

V. ISO Review and Input on Limit Assumptions Requested

RENEW understands that ISO will not conduct a transfer limit analysis as part of the economic study and, due to the Information Policy, is limited in sharing or confirming specific operating limits resulting from specific transmission conditions. For that reason, we have done our best to estimate what we believe the impact of the Coopers Mills STATCOM is for the base case, the impact of the dynamic reactive device for Scenario 1, and the impact of the new 345 kV transmission line for Scenario 2. We would, however, appreciate ISO's review of these assumptions and feedback as to whether these limit assumptions appear to be reasonable. If any of them appear unrealistic or not in the right ballpark for what would be expected, we would appreciate ISO notifying us of this and suggesting how they might be modified to make the assumptions more realistic. With ISO's review and input, we hope that this study will be as useful and informative as possible.

VI. RENEW Request of Metrics for the Study

We request ISO-NE evaluate the following economic impact metrics:

- Regional production costs
- Load Serving Entity (LSE) Energy Expense, broken down by zone
- Average zonal LMP
- Congestion, particularly on the Orrington-South interface
- Interface flow duration curves
- Generation energy production by fuel type as well as imports
    - Regionally as well as behind the Orrington South interface
- Gas, oil, and LNG consumption of electric generating units
- Air Emissions
    - CO_2
    - NOx
    - SO_2

Thank you for your consideration of RENEW's proposal for a 2019 economic study.

Respectfully submitted,

Francis E Pullaro

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Francis Pullaro
Executive Director

c: Abby Krich, Boreas Renewables