DRAFT 2016/17 Maine Resource Integration Study

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NOVEMBER, 2017

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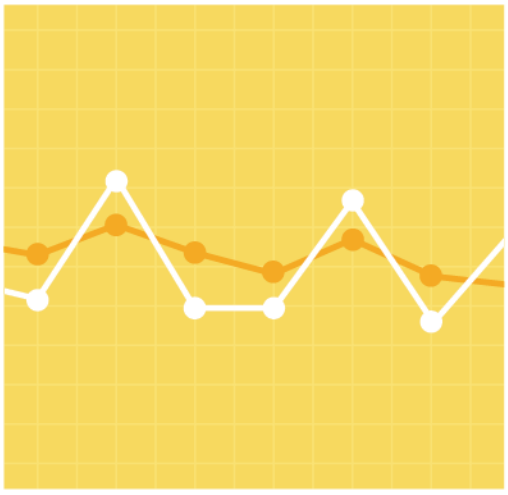

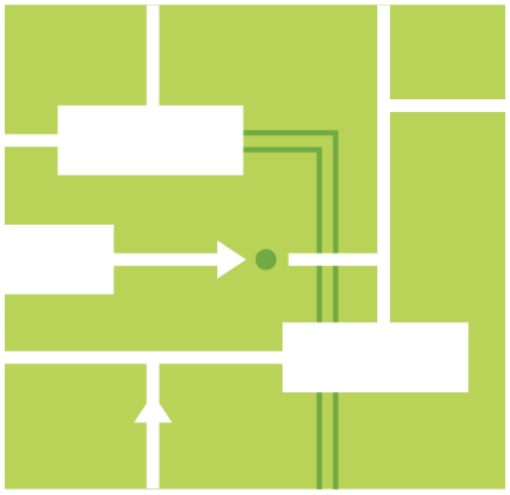

Contents

Figures

Tables

1 Executive Summary

The 2016/17 Maine Resource Integration Study (MRIS) was conducted to identify the transmission upgrades that would be necessary to enable the interconnection of proposed new resources in Northern and Western Maine. This MRIS was conducted pursuant to Attachment K of the Open Access Transmission Tariff (OATT), which is Section II of the ISO New England Inc. (ISO) Transmission, Markets and Services Tariff (Tariff), in consultation with the Planning Advisory Committee (PAC).

This study effort was performed in parallel with the development of an approach to clustering Interconnection Requests in the ISO-administered interconnection queue, which was approved by the Federal Energy Regulatory Commission (Commission) in an order issued on October 31, 2017, in Docket No. ER17-2421-000.[1] The clustering approach reflected in the Commission-approved rules uses a two-phased study methodology for expediting the consideration of two or more Interconnection Requests and allocating interconnection upgrade costs among Interconnection Customers on a cluster basis, in certain circumstances.

The first phase of the clustering process consists of a transmission planning study performed under the Regional System Planning Process in Attachment K of the OATT to identify the transmission infrastructure, called "Cluster Enabling Transmission Upgrades" (CETU), and associated system upgrades that will be necessary to enable the interconnection of potentially all of the proposed resources in the interconnection queue. This first phase is referred to as the "Cluster Enabling Transmission Upgrade Regional Planning Study" (CRPS). The second phase consists of a Cluster Interconnection System Impact Study (CSIS) and a Cluster Interconnection Facilities Study (CFAC) performed under the Interconnection Procedures contained in Schedules 22, 23 and 25 of the OATT to identify the specific facilities required to interconnect the resources that elect to move toward interconnection, and meet the associated second-phase entry requirements.

This MRIS constitutes the first CRPS pursuant to Section 15.4 of Attachment K, and forms the basis for the first CSIS to be conducted in accordance with Section 4.2.3 of Schedule 22, Section 1.5.3.3 of Schedule 23, and Section 4.2.3 of Schedule 25 to the OATT. The study identifies the Interconnection Requests, by Queue Position, that are eligible to be included in the second-phase study, the transmission upgrades (i.e., CETUs and associated system upgrades) required to enable interconnection and the cost allocation for eligible projects if they elect to proceed to the second phase of the clustering process.

The posting, consistent with Section 2.4 (d) of Attachment K, of the final CRPS report on the ISO website will trigger the Cluster Interconnection System Impact Study Entry Deadline (CSIS Entry Deadline) specified in Section 4.2.3.1 of Schedule 22, Section 1.5.3.3.1 of Schedule 23, and Section 4.2.3.1 of Schedule 25 to the OATT. The associated CSIS Entry Deadline is 30 days from the posting of the final CRPS report.

1.1 Eligible Queue Positions

The Interconnection Procedures provide for Interconnection Requests to be considered on a cluster basis when: (a) there are two or more Interconnection Requests without completed Interconnection System Impact Studies in the same electrical part of the New England Control Area based on the requested Point of Interconnection, and (b) the System Operator determined that

[1] *See ISO New England Inc.*, 16 FERC ¶ 61,123 (2017).

none of the Interconnection Requests identified in (a) will be able to interconnect, either individually or on a cluster basis, without the use of common significant new transmission line infrastructure rated at or above 115 kV AC or HVDC.

In accordance with Section 5.1.1.2 of Schedule 22, Section 1.6.1.2 of Schedule 23, and Section 5.2.1.2 of Schedule 25 to the OATT, Interconnection Requests seeking to interconnect into the Northern and Western Maine parts of the New England Control Area that do not have a completed Interconnection System Impact Study by November 1, 2017 shall be included in the MRIS. The following list of the Interconnection Requests, referenced by Queue Position, are identified by the ISO as eligible to participate in the second-phase cluster studies that will be conducted by the ISO in accordance with Section 4.2.3 of Schedule 22, Section 1.5.3.3 of Schedule 23, and Section 4.2.3 of Schedule 25 to the OATT:

Northern Maine Cluster Queue Positions

QP458	QP462	QP626
QP459	QP470	
QP460	QP471	
QP461	QP590	

Western Maine Cluster Queue Positions

QP571	QP591	QP661
QP572	QP593	QP662
QP573	QP594	QP663
QP574	QP621	QP664
QP576	QP639	QP665
QP577	QP652	QP666
QP578	QP658	QP667
QP589	QP659	

1.2 Description of the Clusters, Cluster Enabling Transmission Upgrades and Associated Upgrades

This MRIS provides a planning level description of the CETU(s) and associated system upgrades. It also provides the approximate megawatt quantity (or quantities if more than one level of megawatt injection was studied in the CRPS) of resources that could be interconnected in a manner that meets the Network Capability Interconnection Standard and the Capacity Capability Interconnection Standard in accordance with Schedules 22, 23 and 25 of the OATT.

The following Figure 1-1 presents a one-line network diagram representation of the cluster upgrades. The location and sizes of the dynamic reactive devices are also shown.

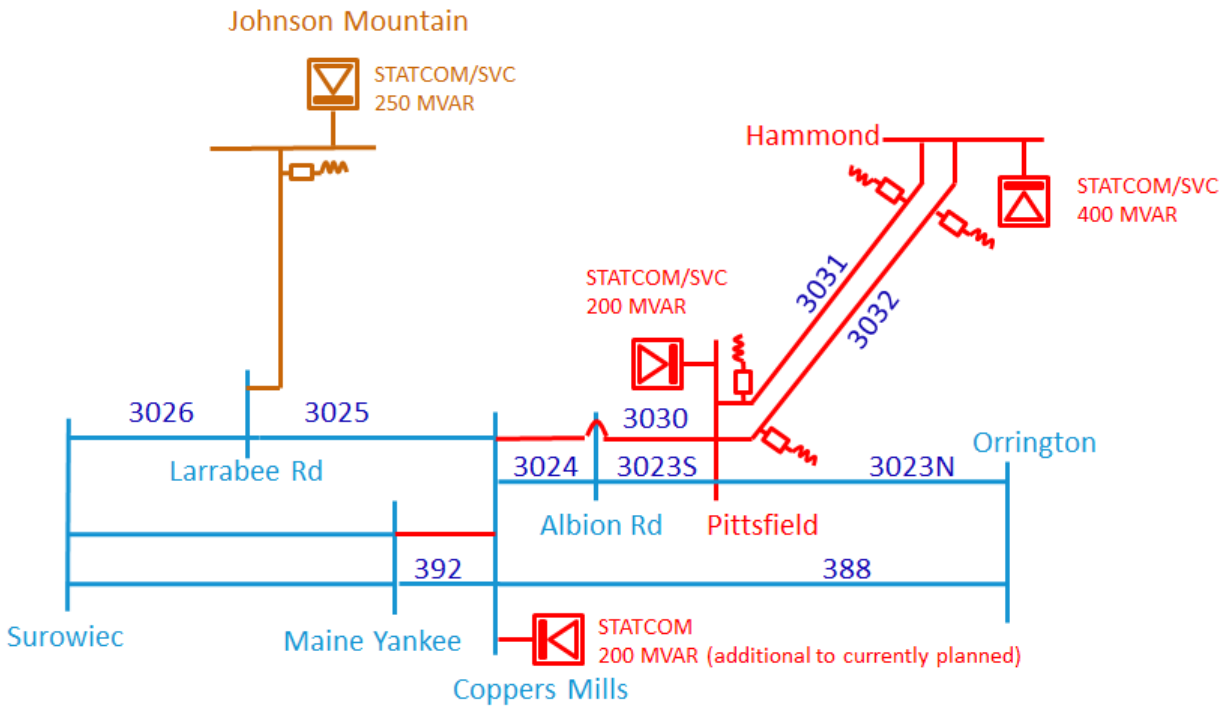

Figure 1-1: One-Line Representation of the Cluster Enabling Upgrades

The MRIS identifies two clusters: a northern Maine cluster and a Western Maine cluster. To interconnect proposed resources in the Aroostook County area of northern Maine, a new 345 kV double circuit tower line will extend from a new substation in the vicinity of Hammond to a new substation on the existing 345 kV Orrington to Albion 3023 line in the vicinity of Pittsfield. To interconnect resources in Western Maine a new 345 kV line will extend from a new substation in the vicinity of Johnson Mountain to the existing 345 kV substation at Larrabee Road. The northern and Western Maine clusters share the requirement to add a second 345 kV Coopers Mills to Maine Yankee 392 line. Figure 1-1 also shows the location and size of the required dynamic reactive devices for the interconnections.

For both the northern and western clusters, a combined total of approximately 1,800 MW is expected to be able to interconnect in a manner that meets the Network Capability Interconnection Standard. As described further in this report, this total could include up-to 1,200 MW from either the western or the northern cluster.

1.3 Elective Transmission Upgrades That Can Serve As Cluster Enabling Transmission Upgrades

Pursuant to Section 4.2.1 of Schedule 25 of the OATT, there are Interconnection Requests for Internal Elective Transmission Upgrades (ETU) in the ISO-administered interconnection queue that are eligible to participate in the second-phase cluster studies as potentially eligible to take the place of CETUs. Specifically, QP590 is eligible to take the place of the CETU from Hammond to Pittsfield. QP571, QP652, QP658, QP659 or QP661 are eligible to take the place of the CETU from Johnson Mountain to Larrabee Road.

1.4 Cost Estimates and Cost Allocation

Table 1-1, below, provides a non-binding good faith order-of magnitude estimate, developed by the applicable Transmission Owner(s), of the costs for the CETU(s). The list also includes other facilities that may be needed in addition to the CETU(s) and a non-binding good faith order-of-magnitude estimate, developed by the applicable Transmission Owner(s), of the costs for those facilities. The MRIS does not provide descriptions of expected Interconnection Facilities for specific Interconnection Requests in the cases where the Interconnection Facilities cannot be finalized until the actual Interconnection Requests that will be moving forward in the cluster are known. Finally, the list reflected in Table 1-1 also provides the expected cost allocation for the eligible Interconnection Requests, calculated in accordance with Schedule 11 of the OATT.

Based on the expected cost allocation for each Interconnection Request, Table 1-1 shows the Cluster Participation Deposit (CPD) that would be required from each resource that choses to enter the CSIS. $1 Million is listed as the CPD for internal ETUs. For an Internal ETU, the CPD will be the lesser of $1,000,000 or five (5) percent of the Interconnection Customer's estimated costs for the Internal ETU as of the time the initial Cluster Participation Deposit is due.

Cost Allocation		New 345 kV AC Transmission Line from Hammond S/S to Pittsfield (DCT)	New 345 kV AC Transmission Line from Pittsfield - Coopers Mills	New 345 kV AC Transmission Line from Coopers Mills to Maine Yankee	New 345 kV AC Transmission Line from Johnson Mtn to Larrabee	New Hammond 345 kV Switching Station	New Pittsfield 345 kV Switching Station	New Johnson Mtn 345 kV Switching Station	Larrabee Road 345 kV terminal upgrades	Statcom/SVC at the Hammond S/S	Statcom/SVC at the Pittsfield Switching Station	Additional statcom at the Coopers Mills S/S	Statcom/SVC at Johnson Mtn		
	Cost $ M	$820	$153	$108	$353	$ 35	$ 44	$ 44	$ 4	$105	$ 55	$ 43	$ 66	Cost	Cluster
Queue Position	MW													Allocation	Participation
Northern Total	1118	$820	$153	$ 90	-	$ 35	$ 44	-	-	$105	$ 55	$ 43	-	$ 1,346	Deposit $ M
458	104	$ 76	$ 14	$ 8	-	$ 3	$ 4	-	-	$ 10	$ 5	$ 4	-	$ 125	$ 6.26
459	104	$ 76	$ 14	$ 8	-	$ 3	$ 4	-	-	$ 10	$ 5	$ 4	-	$ 125	$ 6.26
460	104	$ 76	$ 14	$ 8	-	$ 3	$ 4	-	-	$ 10	$ 5	$ 4	-	$ 125	$ 6.26
461	104	$ 76	$ 14	$ 8	-	$ 3	$ 4	-	-	$ 10	$ 5	$ 4	-	$ 125	$ 6.26
462	104	$ 76	$ 14	$ 8	-	$ 3	$ 4	-	-	$ 10	$ 5	$ 4	-	$ 125	$ 6.26
470	600.6	$440	$ 82	$ 48	-	$ 19	$ 24	-	-	$ 57	$ 29	$ 23	-	$ 723	$ 36.14
471	600.6	$440	$ 82	$ 48	-	$ 19	$ 24	-	-	$ 57	$ 29	$ 23	-	$ 723	$ 36.14
590	ETU	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ 1.00
626	376.2	$276	$ 51	$ 30	-	$ 12	$ 15	-	-	$ 35	$ 18	$ 14	-	$ 453	$ 22.64
Western Total	777	-	-	$ 18	$353	-	-	$ 44	$ 4	-	-	-	$ 66	$ 485	
571	ETU	-	-	-	-	-	-			-	-	-	-	$ -	$ 1.00
572	113.88	-	-	$ 3	$ 52	-	-	$ 7	$ 1	-	-	-	$ 10	$ 71	$ 3.56
573/594/663	245.38	-	-	$ 6	$112	-	-	$ 14	$ 1	-	-	-	$ 21	$ 153	$ 7.66
574/593/664	216.41	-	-	$ 5	$ 98	-	-	$ 12	$ 1	-	-	-	$ 18	$ 135	$ 6.76
576/666	52.26	-	-	$ 1	$ 24	-	-	$ 3	$ 0	-	-	-	$ 4	$ 33	$ 1.63
577/665	25.08	-	-	$ 1	$ 11	-	-	$ 1	$ 0	-	-	-	$ 2	$ 16	$ 0.78
578/667	152	-	-	$ 4	$ 69	-	-	$ 9	$ 1	-	-	-	$ 13	$ 95	$ 4.75
589	ETU	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ 1.00
591	ETU	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ 1.00
621	93.6	-	-	$ 2	$ 43	-	-	$ 5	$ 0	-	-	-	$ 8	$ 58	$ 2.92
639	1200	-	-	$ 28	-	-	-	-	$ 4	-	-	-	-	$ 32	$ 1.59
652	ETU	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ 1.00
658	ETU	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ 1.00
659	ETU	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ 1.00
661	ETU	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ 1.00
662	150	-	-	$ 3	$ 68	-	-	$ 9	$ 1	-	-	-	$ 13	$ 94	$ 4.68

Table 1-1: Cost Allocation for the Cluster Upgrades

The posting, consistent with Section 2.4 (d) of Attachment K, of the final CRPS report on the ISO website will trigger the CSIS Entry Deadline specified in Section 4.2.3.1 of Schedule 22, Section 1.5.3.3.1 of Schedule 23, and Section 4.2.3.1 of Schedule 25 to the OATT. The CSIS Entry Deadline shall be 30 days from the posting of the final CRPS report. The initial Cluster Participation Deposits for each Interconnection Request are also provided in Table 1-1.

2 Introduction

2.1 Background to the 2016/17 Maine Resource Integration Study

The Northern and Western Maine areas of the system are comprised of a transmission network that was built to serve low levels of area load, and there are already a number of generators connected, leaving this part of the transmission system at its performance limit with no remaining margin. Despite the limited infrastructure in the area, the ISO's interconnection queue contains requests for more than 5,800 MW (as of September 2017, including duplicate requests) of proposed new resources (mostly wind) seeking to interconnect in the area.

Significant new transmission infrastructure is required to interconnect the quantity of proposed resources in Northern and Western Maine. This identified need for significant transmission infrastructure is common to all of the resources seeking to interconnect in these areas of the system. Individually, each Interconnection Request would involve complex, lengthy engineering studies to identify the significant transmission infrastructure needed to accommodate the proposed resource, and individual interconnection projects are not able or willing, on an individual basis, to make the necessary system upgrade investments. This combination of circumstances led to the development of a clustering solution to move the situation forward.

Revisions to the Tariff were developed to incorporate a clustering approach (Clustering Rules). The Clustering Rules were filed with the Commission on September 1, 2017 in Docket No. ER17-2421-000, and approved by the Commission in an order issued on October 31, 2017. The Clustering Rules provide the process to resolve the queue backlog in Northern and Western Maine and, in the future, elsewhere on the New England Transmission System, should similar conditions arise. More specifically, the rules establish a two-phased study methodology for expediting the consideration of two or more Interconnection Requests and allocating interconnection upgrade costs among Interconnection Customers on a cluster basis in certain circumstances.

In parallel with the Tariff changes, the ISO also initiated a strategic infrastructure study – this MRIS – to identify the transmission upgrades that will be necessary to enable the interconnection of potentially all of the proposed resources in Northern and Western Maine. This work not only informed the development of the clustering approach reflected in the Commission-approved Clustering Rules, but is also the first CRPS and will be the basis for the first CSIS.

2.2 Summary of the Study Approach

The purpose of a CRPS is to identify the new transmission infrastructure and any associated system upgrades to enable the interconnection of potentially all of the resources proposed in the Interconnection Requests for which it has been identified that significant common new infrastructure is required to interconnect.

In the case of the MRIS, the ISO prepared and posted on its website, a proposed scope of study along with the associated parameters and assumptions. The scope was discussed at the meeting of the Planning Advisory Committee (PAC) held on March 28, 2016,[2] in order to solicit stakeholder input for consideration by the ISO on the CRPS's scope, parameters and assumptions, consistent with the responsibilities of the PAC.

[2] *Maine Resource Integration Study – Scope of Work*, PAC presentation (March 28, 2016), https://www.iso-ne.com/static-assets/documents/2016/03/a2_maine_resource_integration_study_scope_of_work.pdf.

As part of the scope, the ISO identified:

- A summary of the Interconnection Requests that gave rise to the need to consider major new transmission line infrastructure, and
- The preliminary transmission upgrade concepts proposed to be considered in the study.

The preliminary transmission upgrade concepts that were developed in the MRIS accounted for previously conducted transmission reinforcement studies and previously identified concepts for transmission upgrades in the relevant electrical area, including ETUs with Interconnection Requests pending in the interconnection queue prior to the initiation of the study.

At the September 2016 PAC meeting[3] and at the November 2016 PAC meeting,[4] the ISO presented steady-state results comparing the performance of four alternative transmission configurations to interconnect northern Maine resources and four alternatives for Western Maine resources. The November 2016 presentation also discussed the various difficulties associated with interconnecting major new infrastructure north of the Orrington-South interface in Northern Maine. The results of these alternative evaluations are discussed in Section 3 of this report.

Preliminary stability testing results that supported the identification of a preferred upgrade configuration were discussed at the February 2017 PAC meeting.[5] The preferred upgrade configuration was tested with the following detailed analyses:

- Steady state thermal
- Steady state voltage
- Stability
- PSCAD (electromagnetic transient)

The results of the detailed testing were presented at the May 2017 PAC meeting,[6] and are discussed in Section 4 of this report.

2.3 Megawatt Sensitivities and Scenario Analyses

One of the deliverables of the CRPS is to identify the approximate megawatt quantity (or quantities if more than one level of megawatt injection was studied in the CRPS) of resources that could be interconnected in a manner that meets the Network Capability Interconnection Standard and the Capacity Capability Interconnection Standard in accordance with Schedules 22, 23 and 25 of the OATT. Several levels of megawatt injections were studied in the MRIS. The scenario analyses were discussed at the August 2017 PAC.[7] Section 5 of this report contains the results of the megawatt sensitivities.

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[3] *Maine Resource Integration Study – Initial Steady State Results*, PAC presentation (September 21, 2016), https://smd.iso-ne.com/operations-services/ceii/pac/2016/09/a3_maine_resource_integration_study.pdf.

[4] *Maine Resource Integration Study – Additional Steady State Results*, PAC presentation (November 16, 2016), https://smd.iso-ne.com/operations-services/ceii/pac/2016/11/a3_maine_resource_integration_additional_steady_state_resultys.pdf.

[5] *Maine Resource Integration Study – Status Update*, PAC presentation (February 9, 2017), https://smd.iso-ne.com/operations-services/ceii/pac/2017/02/a6_maine_resource_integration_study.pdf.

[6] *Maine Resource Integration Study – Study Results*, PAC presentation (May 24, 2017), https://smd.iso-ne.com/operations-services/ceii/pac/2017/05/a2_maine_resource_integration_study_results.pdf.

[7] *Maine Resource Integration Study – Scenarios and Cost Estimates*, PAC presentation (August 3, 2017), https://www.iso-ne.com/static-assets/documents/2017/07/a3_maine_resource_integration_study_scenarios_and_cost_estimated.pdf.

2.4 Cost Estimates and Cost Allocation

Cost estimates for the preferred upgrade configuration were developed by the Interconnecting Transmission Owners: Central Maine Power (Avangrid) and Emera Maine. The cost estimates were discussed at the August 2017 PAC and at the September 2017 PAC.[8] Section 6 of this report contains the cost estimates and projected cost allocations for the required upgrades.

[8] *Maine Resource Integration Study – Additional Scenarios and Cluster Formation*, PAC presentation (August 3, 2017), https://www.iso-ne.com/static-assets/documents/2017/09/a3_maine_resource_integration_study.pdf.

3 Evaluation of Alternative Upgrade Concepts

Information from this Section is not included in this redacted non-critical energy infrastructure information version of this report.

4 Detailed Testing of Preferred Upgrades

Information from this Section is not included in this redacted non-critical energy infrastructure information version of this report.

5 Megawatt Sensitivities and Scenario Analyses

As described in Section 4 of this report, the detailed testing for the MRIS was conducted with the assumption of 1,118 MW of Northern resources and 777 MW of Western resources. Additional sensitivities and scenarios were analyzed to estimate the upgrades that would be needed for different levels of megawatt participation in the cluster.

5.1 Northern-Only and Western-Only Scenarios

The following scenarios were analyzed:

- 1,118 MW in the Northern area and no resources in the Western area
- 559 MW in the Northern area and no resources in the Western area
- 777 MW in the Western area and no resources in the Northern area

The following Table 5-1 describes the upgrades needed in each of these scenarios compared with the base scenario.

Facilities		1,118 MW North	559 MW North	777 MW West	1,118 MW North & 777 MW West
New 345kV lines	Coopers Mills – Maine Yankee	X	X	X	X
	Pittsfield – Coopers Mills	X	X		X
	Pittsfield – Hammond 1	X	X		X
	Pittsfield – Hammond 2	X			X
	Hammond - NNE	X	X		X
	NNE – Horse Mt	X	X		X
	Larrabee Rd – Johnson Mt			X	X
	Johnson Mt – Jim Pond			X	X
STATCOMs (MVAR)	@Hammond	2X200	2X100		2X200
	@Pittsfield	1X200	1X200		1X200
	@Coopers Mills	1x200			1X200
	@Johnson Mt			1X250	1X250
Reactors (MVAR)	@Pittsfield	2X65	1X65		2X65
	@Hammond	2X65	1X65		2X65
	@NNE	1X30	1X30		1X30
	@Horse Mt	1X30	1X30		1X30
	@Johnson Mt			2X35	2X35
	@Jim Pond			2X35	2X35
Upgrades of Existing System	Larrabee Rd Autotransformer			X	X
	Bath – ME Yankee Tap (207-2)	X			X

Table 5-1: Upgrades Needed for Northern-Only and Western Only Scenarios

5.2 Additional Northern Thresholds

Two additional megawatt thresholds were identified for the Northern resources.

The first threshold identifies the maximum amount of MW of Northern resources that can be interconnected to the New England system with the following upgrades:

- Only one new Pittsfield-Hammond 345 kV line (no DCT)
- No new 345 kV lines from Pittsfield–Coopers Mills or from Coopers Mills to Maine Yankee
- Reactive upgrades as needed

Approximately 325-350 MW can be interconnected with these upgrades. The interconnection limit is caused by N-1 and N-1-1 violations on lines south from Orrington. Approximately 100 MVAR Statcom in addition to synchronous condenser(s) would also be required for this megawatt level of injection. The exact MW and MVAR values would be determined by the exact set of resources that proceeded in this configuration. This scenario assumed that the Surowiec-South transfer limit remains at 1,600 MW.

The second threshold identifies the maximum amount of MW of Northern resources that can be interconnected to the New England system with the following upgrades:

- Only one new Pittsfield-Hammond 345 kV line (no DCT)
- One new Pittsfield-Coopers Mills 345 kV line
- One new Coopers Mills–Maine Yankee 345 kV line
- Reactive upgrades as needed

Approximately 675 MW can be interconnected with these upgrades. The interconnection limit is caused by instability of wind farm facilities for local normal contingency faults. Approximately 650 MVAR total Statcom in addition to synchronous condenser(s) would also be required for this megawatt level of injection. Exact MW and MVAR values would be determined by the exact set of resources that proceed in this configuration. This scenario assumed that the Surowiec-South transfer limit increased to 2,200 MW.

5.3 Megawatt quantity that could be interconnected in a manner that meets the Capacity Capability Interconnection Standard

This MRIS provides an approximate megawatt quantity of resources that could be interconnected in a manner that meets the Capacity Capability Interconnection Standard (CCIS) in accordance with Schedules 22, 23 and 25 of the OATT.

The availability of Capacity Network Resource Capability (CNRC) "headroom" on the Surowiec-South interface is a primary factor in the ability of the proposed resources to meet the CCIS. Before the addition of the cluster resources, the Surowiec-South interface already had approximately 200 MW of unused CNRC headroom. As described in this study, the proposed upgrades would allow the Surowiec-South interface to be increased by approximately 600 MW. Assuming no increase in the upstream Orrington-South interface, and assuming no local constraints other than Surowiec-South, this would result in room for approximately 800 MW of additional CNRC north of Surowiec-South.

Note that this analysis does not constitute the definitive determination of the ability to meet CCIS. Definitive evaluation takes place within the Capacity Network Resource (CNR) Group Study as part of Forward Capacity Market (FCM) qualification. Note that wind resources are qualified for the

Forward Capacity Market (FCM) as intermittent resources. The qualified capacity of intermittent resources is based on the output over specified (reliability) peak hours in each season. Typically, on-shore wind resources have qualified for the FCM with summer qualified capacity of approximately 15-20% of their nameplate capability.

6 Cluster Formation, Cost Estimates and Cost Allocation

The results of the sensitivity analysis in Section 5 identified that some of the new transmission facilities and dynamic reactive were directly attributable to one set of resources, either the Northern or Western resources, but not to the other set. For this reason, two clusters are proposed for inclusion in the MRIS: a Northern Maine cluster and a Western Maine cluster. The cost estimates of the associated infrastructure for each cluster and related assumptions are described in this section.

6.1 Cost Estimates

	Transmission Facility Upgrades (1,118 MW Northern)	Miles/Size	Cost ($M)
Substation Upgrades	New Hammond 345 kV Switching Station		35.3
	New Pittsfield 345 kV Switching Station		44.4
Transmission Upgrades[1]	New 345 kV AC Transmission Line from Hammond S/S to Pittsfield (DCT)[5]	149	819.5
	New 345 kV AC Transmission Line from Pittsfield - Coopers Mills[5]	40	153.0
	New 345 kV AC Transmission Line from Coopers Mills to Maine Yankee[2]	27	108.1
Reactive Upgrades	Statcom/SVC at the Hammond S/S	2 x 200	105.4
	Statcom/SVC at the Pittsfield Switching Station	200	54.6
	Additional statcom at the Coopers Mills S/S	200	43.1
	Shunt reactors at Pittsfield	2 x 65	Note 3
	Shunt reactors at Hammond	2 x 65	Note 3
		Total	**1363.5**

Table 6-1: Cost Estimates for Upgrades for Northern Resources

1. Estimates assume bundled (2) 1590 ACSR conductor for all new 345 kV transmission lines
2. The second Coopers Mills – Maine Yankee line is common between both the northern and western Maine clusters and substation terminal upgrade costs are included in the provided estimate. Estimate assumes that work is required at Coopers Mills for both North and Western clusters. The $108.1 million cost to build the new line is duplicated in the Northern and Western cost estimate presentations, but if both clusters proceed, this cost would be shared by Northern and Western resources according to the distribution factor cost allocation methodology.
3. Hammond/Pittsfield shunt reactor costs included in substation costs
4. Assumed two 345kV generator terminals at Hammond, in the event more terminations are required this cost will increase
5. Substation terminal costs are included in the pricing above
6. Estimate provided above is a good faith non-binding order of magnitude estimate per ISO-NE PP4 Appendix D with an assumed accuracy of -50% to +200%
7. Assumed Contingency= 30%
8. Billing Adder= 16%
9. AFUDC= 0% (Assumed developers will supply capital for the project)
10. Escalation= 8.3% (Assumed 4 years of escalation and that construction will occur in year 2021)
11. In general MEPCO provided estimate based on breaker configuration identified in the ISO-NE MRIS results presentation. Breaker configurations will be finalized in the CSIS.

	Transmission Facility Upgrades (777 MW Western)	Miles/Size	Cost ($M)
Substation Upgrades	New Johnson Mtn 345 kV Switching Station[4]		44.5
	Larrabee Road 345 kV terminal upgrades		4.1
Transmission Upgrades[1]	New 345 kV AC Transmission Line from Johnson Mtn to Larrabee	100.8	353.2
	New 345 kV AC Transmission Line from Cooper Mills to Maine Yankee[2]	27	108.1
Reactive Upgrades	Statcom/SVC at Johnson Mtn	250	65.7
	Shunt reactor at Johnson Mtn	2 x 35	Note 3
		Total	**575.5**

Table 6-2: Cost Estimates for Upgrades for Western Resources

1. Estimates assume bundled (2) 1590 ACSR conductor for all new 345 kV transmission lines
2. The second Coopers Mills – Maine Yankee line is common between both the northern and western Maine clusters and substation terminal upgrade costs are included in the provided estimate. Estimate assumes that work is required at Coopers Mills for both North and Western clusters. The $108.1 million cost to build the new line is duplicated in the Northern and Western cost estimate presentations, but if both clusters proceed, this cost would be shared by Northern and Western resources according to the distribution factor cost allocation methodology.
3. Johnson Mountain shunt reactor costs included in substation costs
4. Assumed two 345kV generator terminals at Johnson Mountain as shown in the ISO-NE diagram, in the event more terminations are required this cost will increase
5. Estimate provided above is a good faith non-binding order of magnitude estimate per ISO-NE PP4 Appendix D with an assumed accuracy of -50% to +200%
6. Assumed Contingency= 30%
7. Billing Adder= 16%
8. AFUDC= 0% (Assumed developers will supply capital for the project)
9. Escalation= 8.3% (Assumed 4 years of escalation and that construction will occur in year 2021)
10. In general CMP provided estimate based on breaker configuration identified in the ISO-NE MRIS results presentation. Breaker configurations will be finalized in the CSIS.

6.2 Cost Allocation Calculations

In accordance with Schedule 11 of the OATT, if a Generator or ETU Interconnection Related Upgrade (Upgrade) consists of Interconnecting Transmission Owner's Interconnection Facilities, Network Upgrades, or Distribution Upgrades, including a Cluster Enabling Transmission Upgrade, that were identified under Clustering and are not included in Direct Interconnection Transmission Costs, then the costs to be paid by each Generator Owner or ETU IC (that is not the ETU IC for an ETU that is taking the place of a CETU, or portion thereof, pursuant to Section 4.2.3.4 of Schedule 22, Section 1.5.3.3.3.4 of Schedule 23, or Section 4.2.3.4 of Schedule 25, Section II of the Tariff) with an Interconnection Request included in the cluster shall be the total costs of such Upgrade multiplied by the ratio of the Generator Owner or ETU IC's respective distribution impact divided by the total distribution impact of the entire cluster based on the following distribution factor cost allocation methodology.

The distribution factor is the measure of responsiveness or change in electrical loading on system facilities due to a change in electric power transfer from one part of the electric system to another, expressed in percent of the change in power transfer. The calculation of the distribution factor for each of the eligible Upgrades shall: (i) use the final CSIS Study Case for summer peak load conditions; (ii) use the pre-contingency condition (i.e., no contingencies will be modeled); and, (iii) be conducted using a transfer from the injection point associated with the respective Generator Owner or ETU IC's facility to New England Control Area load. The distribution impact of each Generator Owner or ETU IC with an Interconnection Request included in the cluster shall be determined by multiplying the Generator Owner or ETU IC's respective distribution factor, as calculated above, by the Summer Network Resource Capability in the case of a Generating Facility or the absolute value of the higher of the requested bidirectional capability that results in a positive distribution factor in the case of an Elective Transmission Upgrade. The total distribution impact of the entire cluster shall be the sum of all of the individual distribution impacts for the Generator Owners and ETU ICs with Interconnection Requests included in the cluster.

Where cost allocation for an Upgrade identified under Clustering cannot be determined using the distribution factor cost allocation methodology (e.g., a dynamic reactive device), each Generator Owner or ETU IC with an Interconnection Request included in the cluster shall be obligated to pay the costs of such Upgrade based upon its pro rata megawatt share of the Interconnection Requests included in the cluster study to be determined using the Summer Network Resource Capability in the case of a Generating Facility and the absolute value of the higher of the requested bidirectional capability in the case of an Elective Transmission Upgrade.

Table 6-3 contains the distribution factors for the cluster upgrades. Table 6-4 contains the distribution impacts for the cluster upgrades. Table 6-5 contains the impact shares for the cluster upgrades and Table 6-6 contains the cost allocation for the cluster upgrades.

Distribution Factors		New 345 kV AC Transmission Line from Hammond S/S to Pittsfield (DCT)	New 345 kV AC Transmission Line from Pittsfield - Coopers Mills	New 345 kV AC Transmission Line from Coopers Mills to Maine Yankee	New 345 kV AC Transmission Line from Johnson Mtn to Larrabee	New Hammond 345 kV Switching Station	New Pittsfield 345 kV Switching Station	New Johnson Mtn 345 kV Switching Station	Larrabee Road 345 kV terminal upgrades	Statcom/SVC at the Hammond S/S	Statcom/SVC at the Pittsfield Switching Station	Additional statcom at the Coopers Mills S/S	Statcom/SVC at Johnson Mtn
	Cost $ M	$820	$153	$108	$353	$ 35	$ 44	$ 44	$ 4	$105	$ 55	$ 43	$ 66
Queue Position	MW												
Northern Total	1118	100%	29%	28%	-								
458	104	100%	29%	28%	-								
459	104	100%	29%	28%	-								
460	104	100%	29%	28%	-								
461	104	100%	29%	28%	-								
462	104	100%	29%	28%	-								
470	600.6	100%	29%	28%	-								
471	600.6	100%	29%	28%	-								
590	ETU	-	-	-	-								
626	376.2	100%	29%	28%	-								
Western Total	777	-	-	8%	100%								
571	ETU	-	-	-	-								
572	113.88	-	-	8%	100%								
573/594/663	245.38	-	-	8%	100%								
574/593/664	216.41	-	-	8%	100%								
576/666	52.26	-	-	8%	100%								
577/665	25.08	-	-	8%	100%								
578/667	152	-	-	8%	100%								
589	ETU	-	-	-	-								
591	ETU	-	-	-	-								
621	93.6	-	-	8%	100%								
639	1200	-	-	8%	-								
652	ETU	-	-	-	-								
658	ETU	-	-	-	-								
659	ETU	-	-	-	-								
661	ETU	-	-	-	-								
662	150	-	-	8%	100%								

Table 6-3: Distribution Factors for the Cluster Upgrades

Distribution Impact		New 345 kV AC Transmission Line from Hammond S/S to Pittsfield (DCT)	New 345 kV AC Transmission Line from Pittsfield - Coopers Mills	New 345 kV AC Transmission Line from Coopers Mills to Maine Yankee	New 345 kV AC Transmission Line from Johnson Mtn to Larrabee	New Hammond 345 kV Switching Station	New Pittsfield 345 kV Switching Station	New Johnson Mtn 345 kV Switching Station	Larrabee Road 345 kV terminal upgrades	Statcom/SVC at the Hammond S/S	Statcom/SVC at the Pittsfield Switching Station	Additional statcom at the Coopers Mills S/S	Statcom/SVC at Johnson Mtn
	Cost $ M	$820	$153	$108	$353	$ 35	$ 44	$ 44	$ 4	$105	$ 55	$ 43	$ 66
Queue Position	MW												
Northern Total	1118	1118	324.2	311.9	-								
458	104	104	30.16	29.02	-								
459	104	104	30.16	29.02	-								
460	104	104	30.16	29.02	-								
461	104	104	30.16	29.02	-								
462	104	104	30.16	29.02	-								
470	600.6	600.6	174.2	167.6	-								
471	600.6	600.6	174.2	167.6	-								
590	ETU	-	-	-	-								
626	376.2	376.2	109.1	105	-								
Western Total	777	-	-	62.16	777								
571	ETU	-	-	-	-								
572	113.88	-	-	9.11	113.9								
573/594/663	245.38	-	-	19.63	245.4								
574/593/664	216.41	-	-	17.31	216.4								
576/666	52.26	-	-	4.181	52.26								
577/665	25.08	-	-	2.006	25.08								
578/667	152	-	-	12.16	152								
589	ETU	-	-	-	-								
591	ETU	-	-	-	-								
621	93.6	-	-	7.488	93.6								
639	1200	-	-	96	-								
652	ETU	-	-	-	-								
658	ETU	-	-	-	-								
659	ETU	-	-	-	-								
661	ETU	-	-	-	-								
662	150	-	-	12	150								

Table 6-4: Distribution Impacts for the Cluster Upgrades

Impact Share		New 345 kV AC Transmission Line from Hammond S/S to Pittsfield (DCT)	New 345 kV AC Transmission Line from Pittsfield - Coopers Mills	New 345 kV AC Transmission Line from Coopers Mills to Maine Yankee	New 345 kV AC Transmission Line from Johnson Mtn to Larrabee	New Hammond 345 kV Switching Station	New Pittsfield 345 kV Switching Station	New Johnson Mtn 345 kV Switching Station	Larrabee Road 345 kV terminal upgrades	Statcom/SVC at the Hammond S/S	Statcom/SVC at the Pittsfield Switching Station	Additional statcom at the Coopers Mills S/S	Statcom/SVC at Johnson Mtn
	Cost $ M	$820	$153	$108	$353	$ 35	$ 44	$ 44	$ 4	$105	$ 55	$ 43	$ 66
Queue Position	MW												
Northern Total	1118	1	1	0.834	-	1	1	-	-	1	1	1	-
458	104	0.093	0.093	0.078	-	0.093	0.093	-	-	0.093	0.093	0.093	-
459	104	0.093	0.093	0.078	-	0.093	0.093	-	-	0.093	0.093	0.093	-
460	104	0.093	0.093	0.078	-	0.093	0.093	-	-	0.093	0.093	0.093	-
461	104	0.093	0.093	0.078	-	0.093	0.093	-	-	0.093	0.093	0.093	-
462	104	0.093	0.093	0.078	-	0.093	0.093	-	-	0.093	0.093	0.093	-
470	600.6	0.537	0.537	0.448	-	0.537	0.537	-	-	0.537	0.537	0.537	-
471	600.6	0.537	0.537	0.448	-	0.537	0.537	-	-	0.537	0.537	0.537	-
590	ETU	-	-	-	-	-	-	-	-	-	-	-	-
626	376.2	0.336	0.336	0.281	-	0.336	0.336	-	-	0.336	0.336	0.336	-
Western Total	777	-	-	0.166	1	-	-	1	1	-	-	-	1
571	ETU	-	-	-	-	-	-			-	-	-	-
572	113.88	-	-	0.024	0.147	-	-	0.147	0.147	-	-	-	0.147
573/594/663	245.38	-	-	0.052	0.316	-	-	0.316	0.316	-	-	-	0.316
574/593/664	216.41	-	-	0.046	0.279	-	-	0.279	0.279	-	-	-	0.279
576/666	52.26	-	-	0.011	0.067	-	-	0.067	0.067	-	-	-	0.067
577/665	25.08	-	-	0.005	0.032	-	-	0.032	0.032	-	-	-	0.032
578/667	152	-	-	0.033	0.196	-	-	0.196	0.196	-	-	-	0.196
589	ETU	-	-	-	-	-	-	-	-	-	-	-	-
591	ETU	-	-	-	-	-	-	-	-	-	-	-	-
621	93.6	-	-	0.02	0.12	-	-	0.12	0.12	-	-	-	0.12
639	1200	-	-	0.257	-	-	-	-	1	-	-	-	-
652	ETU	-	-	-	-	-	-	-	-	-	-	-	-
658	ETU	-	-	-	-	-	-	-	-	-	-	-	-
659	ETU	-	-	-	-	-	-	-	-	-	-	-	-
661	ETU	-	-	-	-	-	-	-	-	-	-	-	-
662	150	-	-	0.032	0.193	-	-	0.193	0.193	-	-	-	0.193

Table 6-5: Impact Shares for the Cluster Upgrades

Cost Allocation		New 345 kV AC Transmission Line from Hammond S/S to Pittsfield (DCT)	New 345 kV AC Transmission Line from Pittsfield - Coopers Mills	New 345 kV AC Transmission Line from Coopers Mills to Maine Yankee	New 345 kV AC Transmission Line from Johnson Mtn to Larrabee	New Hammond 345 kV Switching Station	New Pittsfield 345 kV Switching Station	New Johnson Mtn 345 kV Switching Station	Larrabee Road 345 kV terminal upgrades	Statcom/SVC at the Hammond S/S	Statcom/SVC at the Pittsfield Switching Station	Additional statcom at the Coopers Mills S/S	Statcom/SVC at Johnson Mtn		
	Cost $ M	$820	$153	$108	$353	$ 35	$ 44	$ 44	$ 4	$105	$ 55	$ 43	$ 66	Cost	Cluster
Queue Position	MW													Allocation	Participation
Northern Total	1118	$820	$153	$ 90	-	$ 35	$ 44	-	-	$105	$ 55	$ 43	-	$ 1,346	Deposit $ M
458	104	$ 76	$ 14	$ 8	-	$ 3	$ 4	-	-	$ 10	$ 5	$ 4	-	$ 125	$ 6.26
459	104	$ 76	$ 14	$ 8	-	$ 3	$ 4	-	-	$ 10	$ 5	$ 4	-	$ 125	$ 6.26
460	104	$ 76	$ 14	$ 8	-	$ 3	$ 4	-	-	$ 10	$ 5	$ 4	-	$ 125	$ 6.26
461	104	$ 76	$ 14	$ 8	-	$ 3	$ 4	-	-	$ 10	$ 5	$ 4	-	$ 125	$ 6.26
462	104	$ 76	$ 14	$ 8	-	$ 3	$ 4	-	-	$ 10	$ 5	$ 4	-	$ 125	$ 6.26
470	600.6	$440	$ 82	$ 48	-	$ 19	$ 24	-	-	$ 57	$ 29	$ 23	-	$ 723	$ 36.14
471	600.6	$440	$ 82	$ 48	-	$ 19	$ 24	-	-	$ 57	$ 29	$ 23	-	$ 723	$ 36.14
590	ETU	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ 1.00
626	376.2	$276	$ 51	$ 30	-	$ 12	$ 15	-	-	$ 35	$ 18	$ 14	-	$ 453	$ 22.64
Western Total	777	-	-	$ 18	$353	-	-	$ 44	$ 4	-	-	-	$ 66	$ 485	
571	ETU	-	-	-	-	-	-			-	-	-	-	$ -	$ 1.00
572	113.88	-	-	$ 3	$ 52	-	-	$ 7	$ 1	-	-	-	$ 10	$ 71	$ 3.56
573/594/663	245.38	-	-	$ 6	$112	-	-	$ 14	$ 1	-	-	-	$ 21	$ 153	$ 7.66
574/593/664	216.41	-	-	$ 5	$ 98	-	-	$ 12	$ 1	-	-	-	$ 18	$ 135	$ 6.76
576/666	52.26	-	-	$ 1	$ 24	-	-	$ 3	$ 0	-	-	-	$ 4	$ 33	$ 1.63
577/665	25.08	-	-	$ 1	$ 11	-	-	$ 1	$ 0	-	-	-	$ 2	$ 16	$ 0.78
578/667	152	-	-	$ 4	$ 69	-	-	$ 9	$ 1	-	-	-	$ 13	$ 95	$ 4.75
589	ETU	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ 1.00
591	ETU	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ 1.00
621	93.6	-	-	$ 2	$ 43	-	-	$ 5	$ 0	-	-	-	$ 8	$ 58	$ 2.92
639	1200	-	-	$ 28	-	-	-	-	$ 4	-	-	-	-	$ 32	$ 1.59
652	ETU	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ 1.00
658	ETU	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ 1.00
659	ETU	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ 1.00
661	ETU	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ 1.00
662	150	-	-	$ 3	$ 68	-	-	$ 9	$ 1	-	-	-	$ 13	$ 94	$ 4.68

Table 6-6: Cost Allocation for the Cluster Upgrades

7 Conclusion

This MRIS constitutes the first CRPS pursuant to Section 15.4 of Attachment K, and forms the basis for the first CSIS to be conducted in accordance with Section 4.2.3 of Schedule 22, Section 1.5.3.3 of Schedule 23, and Section 4.2.3 of Schedule 25 to the OATT. As described in this report, the study identifies the Interconnection Requests, by Queue Position, that are eligible to be included in the second-phase study, the transmission upgrades (i.e., CETUs and associated system upgrades) required to enable interconnection and the cost allocation for eligible projects if they elect to proceed to the second phase of the clustering process.

The posting, consistent with Section 2.4 (d) of Attachment K, of the final CRPS report on the ISO website will trigger the Cluster Interconnection System Impact Study Entry Deadline (CSIS Entry Deadline) specified in Section 4.2.3.1 of Schedule 22, Section 1.5.3.3.1 of Schedule 23, and Section 4.2.3.1 of Schedule 25 to the OATT. The associated CSIS Entry Deadline is 30 days from the posting of the final CRPS report.

Appendices

Appendix information is not included in this redacted non-critical energy infrastructure information version of this report.