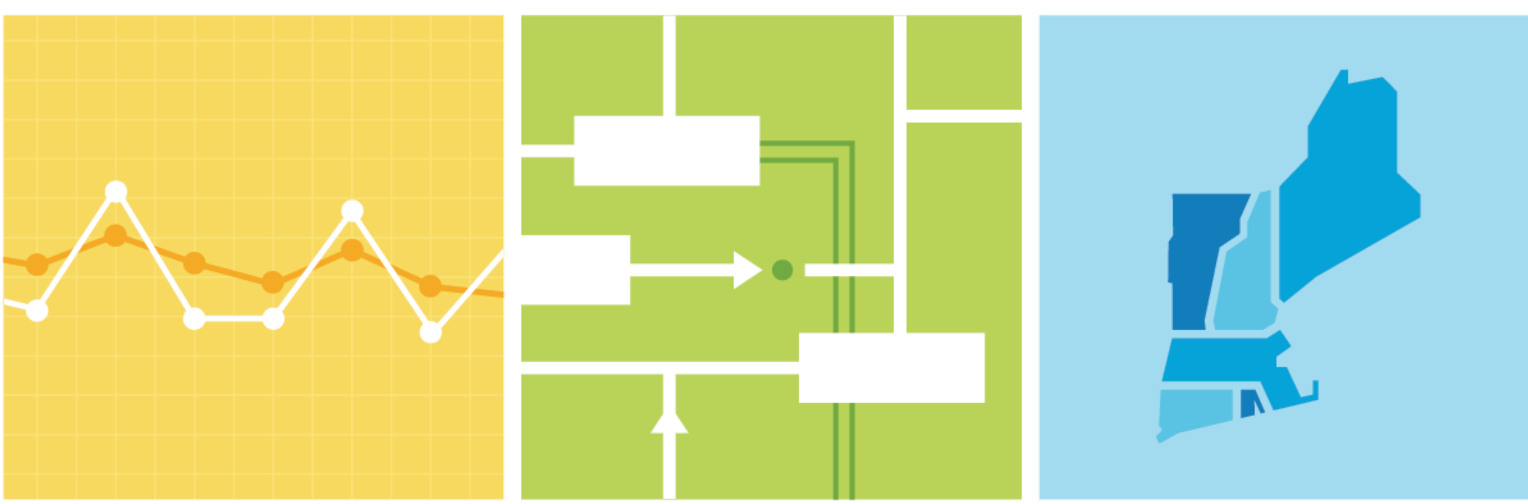
2016/2017 Maine Resource Integration Study

FINAL REPORT – REDACTED NON-CEII VERSION

MARCH 12, 2018



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Section 1
Executive Summary

ISO New England (ISO) conducted the *2016/2017 Maine Resource Integration Study* (MRIS) to identify the transmission upgrades necessary to enable the interconnection of proposed new resources in northern and western Maine. This MRIS was conducted pursuant to Attachment K of the ISO's *Open Access Transmission Tariff* (OATT), which is Section II of the *ISO New England Inc. (ISO) Transmission, Markets and Services Tariff* (ISO tariff), in consultation with the Planning Advisory Committee (PAC).[1]

This study was conducted 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 (FERC) in an October 31, 2017, order.[2] The clustering approach reflected in the FERC-approved rules uses a two-phased study methodology in certain circumstances to expedite the consideration of two or more Interconnection Requests and allocate interconnection upgrade costs among Interconnection Customers (ICs) on a cluster basis.

The first phase of the clustering process involves conducting a transmission planning study, performed under the Regional System Planning Process pursuant to the OATT, Attachment K (Section 15.4), to identify the transmission infrastructure and associated system upgrades necessary to enable the interconnection of potentially all the proposed resources in the interconnection queue. This infrastructure is called "Cluster-Enabling Transmission Upgrades" (CETUs), and the study is referred to a Cluster-Enabling Transmission Upgrade Regional Planning Study (CRPS).

The second phase consists of conducting a Cluster-Interconnection System Impact Study (CSIS) pursuant to the interconnection procedures in the OATT (Schedule 22, Section 4.2.3; Schedule 23, Section 1.5.3.3; and Schedule 25, Section 4.2.3) and a Cluster-Interconnection Facilities Study (CFAC) performed under the Interconnection Procedures contained in Schedules 22, 23, and 25 of the OATT.[3] These studies must 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 Cluster-Enabling Transmission Upgrade Regional Planning Study and forms the basis for the first Cluster-Interconnection System Impact Study 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 MRIS identifies the Interconnection Requests, by Queue Position, eligible to be included in the second-phase study, the transmission upgrades (i.e., CETUs and

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[1] *ISO New England Inc. Transmission, Markets, and Services Tariff* (ISO tariff) (2018), http://www.iso-ne.com/regulatory/tariff/index.html, including Section II, *ISO New England Open Access Transmission Tariff* (https://www.iso-ne.com/participate/rules-procedures/tariff/oatt), Attachment K, "Regional System Planning Process."

[2] FERC, *Order Accepting Tariff Revisions*, ISO New England Inc., Docket No. ER17-2421-000, 16 FERC ¶ 61,123 (October 31, 2017), https://www.iso-ne.com/static-assets/documents/2017/11/er17-2421-000_order_accept_interconnection_queue_clustering.pdf.

[3] ISO New England, OATT, Schedule 22, *Large Generator Interconnection Procedures* (2017); Schedule 23, *Small Generator Interconnection Procedures* (2017); and Schedule 25, *Elective Transmission Upgrade Interconnection Procedures* (2017), https://www.iso-ne.com/participate/rules-procedures/tariff/oatt.

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.

Consistent with Section 2.4 (d) of Attachment K, the posting of the final CRPS report on the ISO website will trigger the entry deadline for the Cluster Interconnection System Impact Study (Cluster Entry Deadline) specified in the OATT (Schedule 22, Section 4.2.3.1; Schedule 23, Section 1.5.3.3.1; and Schedule 25, Section 4.2.3.1). The associated Cluster Entry Deadline is 30 days after 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 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 alternating current (AC) or high-voltage direct current (HVDC).

In accordance with the OATT (Schedule 22,Section 5.1.1.2; Schedule 23, Section 1.6.1.2; and Schedule 25, Section 5.2.1.2) , 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 ISO identified the following Interconnection Requests, referenced by Queue Position (QP), as eligible to participate in the second-phase cluster studies it will conduct (in accordance with the OATT Schedule 22, Section 4.2.3; Schedule 23, Section 1.5.3.3; and Schedule 25, Section 4.2.3):

- **Northern Maine Cluster Queue Positions**

QP 458	QP 461	QP 471
QP 459	QP 462	QP 590
QP 460	QP 470	QP 626

- **Western Maine Cluster Queue Positions**

QP 571	QP 591	QP 661
QP 572	QP 593	QP 662
QP 573	QP 594	QP 663
QP 574	QP 621	QP 664
QP 576	QP 639	QP 665
QP 577	QP 652	QP 666
QP 578	QP 658	QP 667
QP 589	QP 659	

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

This MRIS provides a planning level description of the CETUs and associated system upgrades. It also provides the approximate megawatt (MW) quantities 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 (and defined in) Schedules 22, 23 and 25 of the OATT.

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

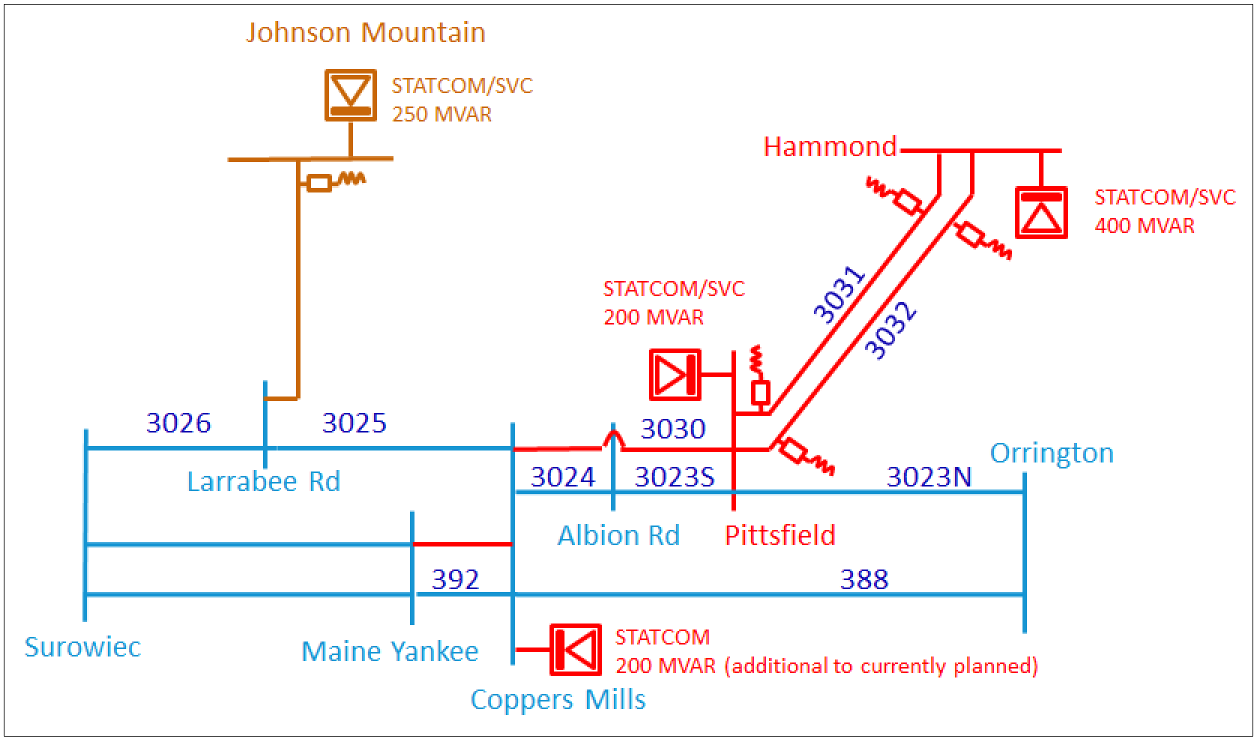

Figure 1-1: One-Line representation of the cluster-enabling upgrades for northern and western Maine.

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–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–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. The clusters will be filled in queue-position order up to these potential totals.

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, Interconnection Requests for internal Elective Transmission Upgrades (ETUs) in the ISO-administered interconnection queue are eligible to participate in the second-phase cluster studies as potentially eligible to take the place of CETUs. Specifically, QP 590 is eligible to take the place of the CETU between Hammond and Pittsfield. QP 571, QP 652, QP 658 or QP 659, or QP 661 are all eligible to take the place of the CETU between Johnson Mountain and Larrabee Road. OATT Schedule 11 specifies that ETUs that take the place of CETUs are not included in the cost allocation identified for Interconnection Customers under the Interconnection Procedures. Therefore, provided that the contractual commitment (between the ETU and the Interconnection Requests that need to use the ETU that will take the place of a CETU) is indicated by the Cluster Entry Deadline, the required initial Cluster Participation Deposit is reduced by the removal of the costs associated with the CETU that is being replaced by the ETU.

1.4 Cost Estimates and Cost Allocation

Table 1-1 provides a nonbinding good-faith order-of-magnitude estimate, developed by the applicable transmission owners (TOs), of the costs for the CETUs. The list also includes other facilities that may be needed in addition to the CETUs and a nonbinding good-faith order-of-magnitude estimate, developed by the applicable TOs, of the costs for these facilities. The MRIS does not provide descriptions of expected Interconnection Facilities for specific Interconnection Requests when 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.

Table 1-1
Cost Allocation for the Cluster Upgrades in Northern and Western Maine

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	$819.5	$153.0	$108.1	$353.2	$35.3	$44.4	$44.5	$4.1	$105.4	$54.6	$43.1	$65.7	Cost	Cluster
Queue Position	MW													Allocation	Participation
Northern Total	1118	$819.5	$153.0	$ 90.1	-	$35.3	$44.4	-	-	$105.4	$54.6	$43.1	-	$1,345.6	Deposit $ M
458	104	$ 76.2	$ 14.2	$ 8.4	-	$ 3.3	$ 4.1	-	-	$ 9.8	$ 5.1	$ 4.0	-	$ 125.2	$ 6.26
459	104	$ 76.2	$ 14.2	$ 8.4	-	$ 3.3	$ 4.1	-	-	$ 9.8	$ 5.1	$ 4.0	-	$ 125.2	$ 6.26
460	104	$ 76.2	$ 14.2	$ 8.4	-	$ 3.3	$ 4.1	-	-	$ 9.8	$ 5.1	$ 4.0	-	$ 125.2	$ 6.26
461	104	$ 76.2	$ 14.2	$ 8.4	-	$ 3.3	$ 4.1	-	-	$ 9.8	$ 5.1	$ 4.0	-	$ 125.2	$ 6.26
462	104	$ 76.2	$ 14.2	$ 8.4	-	$ 3.3	$ 4.1	-	-	$ 9.8	$ 5.1	$ 4.0	-	$ 125.2	$ 6.26
470	600.6	$440.3	$ 82.2	$ 48.4	-	$19.0	$23.9	-	-	$ 56.6	$29.3	$23.1	-	$ 722.9	$ 36.14
471	600.6	$440.3	$ 82.2	$ 48.4	-	$19.0	$23.9	-	-	$ 56.6	$29.3	$23.1	-	$ 722.9	$ 36.14
590	ETU	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ 1.00
626	376.2	$275.8	$ 51.5	$ 30.3	-	$11.9	$14.9	-	-	$ 35.5	$18.4	$14.5	-	$ 452.8	$ 22.64
Western Total	777	-	-	$ 18.0	$353.2	-	-	$44.5	$4.1	-	-	-	$65.7	$ 485.4	
571	ETU	-	-	-	-	-	-			-	-	-	-	$ -	$ 1.00
572	113.88	-	-	$ 2.6	$ 51.8	-	-	$ 6.5	$0.6	-	-	-	$ 9.6	$ 71.1	$ 3.56
573/594/663	245.38	-	-	$ 5.7	$111.5	-	-	$14.0	$1.3	-	-	-	$20.7	$ 153.3	$ 7.66
574/593/664	216.41	-	-	$ 5.0	$ 98.4	-	-	$12.4	$1.1	-	-	-	$18.3	$ 135.2	$ 6.76
576/666	52.26	-	-	$ 1.2	$ 23.8	-	-	$ 3.0	$0.3	-	-	-	$ 4.4	$ 32.6	$ 1.63
577/665	25.08	-	-	$ 0.6	$ 11.4	-	-	$ 1.4	$0.1	-	-	-	$ 2.1	$ 15.7	$ 0.78
578/667	152	-	-	$ 3.5	$ 69.1	-	-	$ 8.7	$0.8	-	-	-	$12.8	$ 94.9	$ 4.75
589	ETU	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ 1.00
591	ETU	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ 1.00
621	93.6	-	-	$ 2.2	$ 42.5	-	-	$ 5.4	$0.5	-	-	-	$ 7.9	$ 58.5	$ 2.92
639	1200	-	-	$ 27.7	-	-	-	-	$4.1	-	-	-	-	$ 31.8	$ 1.59
652	ETU	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ 1.00
658	ETU	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ 1.00
659	ETU	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ 1.00
661	ETU	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ 1.00
662	150	-	-	$ 3.5	$ 68.2	-	-	$ 8.6	$0.8	-	-	-	$12.7	$ 93.7	$ 4.68

Each resource that choses to enter the CSIS must pay a Cluster Participation Deposit (CPD), as shown in Table 1-1 for each Interconnection Request, on the basis of the expected cost allocation for each Interconnection Request. The CPD for internal ETUs shown on the table is $1 million. In general for internal ETUs, the CPD is the lesser of $1million, or 5% of the Interconnection Customer's estimated costs for the internal ETU as of the time the initial Cluster Participation Deposit is due.

Section 2
Introduction

2.1 Background to the 2016/2017 Maine Resource Integration Study

The northern and western Maine areas of the system comprise a transmission network built to serve low levels of area load, and a number of generators already are 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 megawatts (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 to individually 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 ISO New England *Transmission, Markets and Services Tariff* (ISO tariff) were developed to incorporate a clustering approach (Clustering Rules).[4] The ISO filed the Clustering Rules with the Federal Energy Regulatory Commission (FERC) on September 1, 2017, which FERC approved on October 31, 2017.[5] The Clustering Rules provide the process to resolve the queue backlog in northern and western Maine and elsewhere on the New England transmission system, should similar conditions arise in the future. 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 (ICs) in a cluster in certain circumstances.

In parallel with changes to the ISO tariff, the ISO also initiated a strategic infrastructure study—this Maine Resource Integration Study (MRIS)—to identify the transmission upgrades necessary to enable the interconnection of potentially all the proposed resources in northern and western Maine. This work not only informed the development of the clustering approach reflected in the FERC-approved Clustering Rules, but it is also the first Cluster-Enabling Transmission Upgrade Regional Planning Study (CRPS) and will be the basis for the first Cluster- Interconnection System Impact Study (CSIS).

[4] *ISO New England Inc. Transmission, Markets, and Services Tariff* (ISO tariff) (2018), https://www.iso-ne.com/participate/rules-procedures/tariff.

[5] ISO New England, Joint Filing of Revisions to the ISO New England Inc. Transmission, Markets and Services Tariff to Incorporate a Clustering Approach in the Interconnection Procedures, Docket No. ER17-000, FERC filing (September 1, 2017), https://www.iso-ne.com/static-assets/documents/2017/09/rev_to_incorporate_clustering.pdf. FERC, Order Accepting Tariff Revisions, ISO New England Inc., Docket No. ER17-2421-000, 16 FERC ¶ 61,123 (October 31, 2017), https://www.iso-ne.com/static-assets/documents/2017/11/er17-2421-000_order_accept_interconnection_queue_clustering.pdf.

In this report, the capitalized terms refer to terms defined in the ISO's *Transmission, Markets, and Services Tariff*, Section 1, as well as in the OATT, Schedules 22, 23, and 25.[6]

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 the resources proposed in the Interconnection Requests for which the ISO has identified that significant common new infrastructure is required to interconnect.

For 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 March 28, 2016, Planning Advisory Committee (PAC) to solicit stakeholder input for the ISO's consideration on the CRPS scope, parameters, and assumptions, consistent with the responsibilities of the PAC.[7]

The ISO identified that the CRPS would include the following:

- A summary of the Interconnection Requests that gave rise to the need to consider major new transmission line infrastructure
- The preliminary transmission upgrade concepts proposed for consideration in the study

The preliminary transmission upgrade concepts developed in the MRIS accounted for previously conducted transmission-reinforcement studies and previously identified concepts for transmission upgrades in the relevant electrical area, including Elective Transmission Upgrades (ETUs) with Interconnection Requests pending in the interconnection queue before the initiation of the study.

At the September and November 2016 PAC meetings, 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.[8] The November 2016 presentation also discussed the various difficulties associated with interconnecting major new infrastructure north of the Orrington–South interface in northern Maine. Section 3 of this report discusses the results of these alternative evaluations.

Preliminary stability testing results that supported the identification of a preferred upgrade configuration were discussed at the February 2017 PAC meeting.[9] The preferred upgrade configuration was tested with the following detailed analyses:

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[6] ISO New England, ISO tariff, Section 1, *General Terms and Conditions* (November 21, 2017); *Open Access Transmission Tariff*, Schedule 22, *Large Generator Interconnection Procedures* (November 1, 2017); Schedule 23, *Small Generator Interconnection Procedures* (November 1, 2017); and Schedule 25, *Elective Transmission Upgrade Interconnection Procedures* (November 1, 2017), https://www.iso-ne.com/participate/rules-procedures/tariff/oatt.

[7] ISO New England, *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.

[8] ISO New England, *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, and *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.

[9] ISO New England, *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.

- Steady-state thermal
- Steady-state voltage
- Stability
- Power System Computer-Aided Design (PSCAD)

The results of the detailed testing were presented at the May 2017 PAC meeting and are discussed in Section 4 of this report.[10]

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) of resources that could be interconnected in a way that meets the Network Capability Interconnection Standard and the Capacity Capability Interconnection Standard (CCIS) 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.[11] Section 5 of this report contains the results of the megawatt sensitivities.

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 and September 2017 PAC meetings.[12] Section 6 of this report contains the cost estimates and projected cost allocations for the required upgrades.

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[10] ISO New England, *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.

[11] ISO New England, *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.

[12] ISO New Engalnd, *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.

Section 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.

Section 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.

Section 5
Megawatt Sensitivities and Scenario Analyses

As described in Section 4, 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

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

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

Upgrade	Facilities	1,118 MW North	559 MW North	777 MW West	1,118 MW North and 777 MW West
New 345 kV 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	2 X 200	2 X 100		2 X 200
	@Pittsfield	1 X 200	1 X 200		1 X 200
	@Coopers Mills	1 x 200			1 X 200
	@Johnson Mt.			1 X 250	1 X 250
Reactors (MVAR)	@Pittsfield	2 X 65	1 X 65		2 X 65
	@Hammond	2 X 65	1 X 65		2 X 65
	@NNE	1 X 30	1 X 30		1 X 30
	@Horse Mt.	1 X 30	1 X 30		1 X 30
	@Johnson Mt.			2 X 35	2 X 35
	@Jim Pond			2 X 35	2 X 35
Upgrades of existing system	Larrabee Rd. autotransformer			X	X
	Bath–ME Yankee tap (207-2)	X			X

5.2 Additional Northern Thresholds

Two additional megawatt thresholds were identified for the northern resources.

The first threshold identifies the maximum amount of megawatts 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 double-circuit tower)
- No new 345 kV lines between Pittsfield and Coopers Mills or between Coopers Mills and Maine Yankee
- Reactive upgrades as needed

Approximately 325 to 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 one or more synchronous condensers would also be required for this megawatt level of injection. The exact megawatt 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 megawatts 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 one or more synchronous condensers would also be required for this megawatt level of injection. Exact megawatt 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 no local constraints other than Surowiec–South, these upgrades would result in room for approximately 800 MW of additional CNRC north of Surowiec–South.

This analysis does not constitute the definitive determination of the ability to meet the 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 FCM as intermittent resources. The qualified capacity of intermittent resources is based on the output over specified (reliability) peak hours in each season. Typically, onshore wind resources qualify for the FCM with summer qualified capacity of approximately 15 to 20% of their nameplate capability.

Section 6
Cluster Formation, Cost Estimates, and Cost Allocation

The results of the sensitivity analysis presented in Section 5 identified that some of the new transmission facilities and dynamic reactive upgrades 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. This section describes the cost estimates of the associated infrastructure and assumptions for each cluster.

6.1 Cost Estimates

Table 6-1 shows the estimates for the northern resource upgrades, and Table 6-2 shows the estimates for the western resource upgrades.

Table 6-1
Cost Estimates for Upgrades for Northern Resources[(a)]

Transmission Facility Upgrades (1,118 MW Northern)		Miles/Size	Cost ($M)
Substation upgrades	New Hammond 345 kV switching station[(b)]		35.3
	New Pittsfield 345 kV switching station		44.4
Transmission upgrades[(c)]	New 345 kV AC transmission line from Hammond substation to Pittsfield (DCT)[(d)]	149	819.5
	New 345 kV AC transmission line between Pittsfield and Coopers Mills[(d)]	40	153.0
	New 345 kV AC transmission line between Coopers Mills and Maine Yankee[(e)]	27	108.1
Reactive upgrades	Statcom/SVC at the Hammond substation	2 x 200	105.4
	Statcom/SVC at the Pittsfield switching station	200	54.6
	Additional statcom at the Coopers Mills substation	200	43.1
	Shunt reactors at Pittsfield	2 x 65	(f)
	Shunt reactors at Hammond	2 x 65	(f)
		Total	**1,363.5**

(a) The estimates are good-faith, nonbinding, order-of-magnitude estimates per the ISO's Planning Procedure No. 4, Appendix D, with an assumed accuracy of −50% to +200%. The assumed contingency is 30%, and the billing adder is 16%. Because developers are assumed to supply the capital for the project, there is no allowance for funds used during construction (i.e., the AFUDC = is 0%). The assumed escalation is 8.3%; four years of escalation are assumed with construction assumed to occur in 2021. In general, Maine Electric Power Company (MEPCO) provided estimates based on the breaker configuration identified in this study; breaker configurations will be finalized in the CSIS.

(b) Two 345 kV generator terminals were assumed at Hammond; in the event more terminations are required, this cost will increase.

(c) Estimates assumed the use of bundled (2) 1590 ASCR conductor for all new 345 kV transmission lines.

(d) Substation terminal costs are included in the pricing.

(e) 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. The estimate assumes that work is required at Coopers Mills for both the 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.

(e) Hammond/Pittsfield shunt reactor costs are included in substation costs.

Table 6-2
Cost Estimates for Upgrades for Western Resources[a]

Transmission Facility Upgrades (777 MW Western)		Miles/Size	Cost ($M)
Substation upgrades	New Johnson Mtn. 345 kV switching station[b]		44.5
	Larrabee Road 345 kV terminal upgrades		4.1
Transmission upgrades[b]	New 345 kV AC transmission line between Johnson Mtn. and Larrabee	100.8	353.2
	New 345 kV AC transmission line between Cooper Mills and Maine Yankee[d]	27	108.1
Reactive upgrades	Statcom/SVC at Johnson Mtn.	250	65.7
	Shunt reactor at Johnson Mtn.	2 x 35	(e)
		Total	**575.5**

(a) The estimates are good-faith, nonbinding, order-of-magnitude estimates per the ISO's Planning Procedure No. 4, Appendix D, with an assumed accuracy of −50% to +200%. The assumed contingency is 30%, and the billing adder is 16%. Because developers are assumed to supply the capital for the project, there is no allowance for funds used during construction (i.e., the AFUDC = is 0%). The assumed escalation is 8.3%; four years of escalation are assumed with construction assumed to occur in 2021. In general, Central Maine Power (CMP) provided estimates based on the breaker configuration identified in this report; breaker configurations will be finalized in the CSIS.

(b) Estimates assume bundled (2) 1590 ACSR conductor for all new 345 kV transmission lines.

(c) 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. The estimate assumes that work is required at Coopers Mills for both the 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.

(d) Johnson Mountain shunt reactor costs are included in the substation costs.

(a) Two 345 kV generator terminals were assumed at Johnson Mountain, as shown in this report; in the event more terminations are required, this cost will increase.

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 (i.e., change in electrical loading on system facilities due to a change in electric power transfer from one part of the electric power system to another), expressed in percentage of the change in the power transfer. The calculation of the distribution factor for each of the eligible upgrades must do the following:

- Use the final CSIS study case for summer peak load conditions
- Use the precontingency condition (i.e., no contingencies will be modeled)
- 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 or ETU IC with an Interconnection Request included in the cluster shall be determined by multiplying the generator 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 must be the sum of all the individual distribution impacts for the generator and ETU ICs with Interconnection Requests included in the cluster.

Where the 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 or ETU IC with an Interconnection Request included in the cluster must be obligated to pay the costs of such an upgrade based on 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 share for the cluster upgrades, and Table 6-6 contains the cost allocation for the cluster upgrades.

Table 6-3
Distribution Factors 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	$819.5	$153.0	$108.1	$353.2		$35.3	$44.4	$44.5	$4.1		$105.4	$54.6	$43.1	$65.7		
Queue Position	MW																
Northern Total	1118	100.0%	29.0%	27.9%	-												
458	104	100.0%	29.0%	27.9%	-												
459	104	100.0%	29.0%	27.9%	-												
460	104	100.0%	29.0%	27.9%	-												
461	104	100.0%	29.0%	27.9%	-												
462	104	100.0%	29.0%	27.9%	-												
470	600.6	100.0%	29.0%	27.9%	-												
471	600.6	100.0%	29.0%	27.9%	-												
590	ETU	-	-	-	-												
626	376.2	100.0%	29.0%	27.9%	-												
Western Total	777	-	-	8.0%	100.0%												
571	ETU	-	-	-	-												
572	113.88	-	-	8.0%	100.0%												
573/594/663	245.38	-	-	8.0%	100.0%												
574/593/664	216.41	-	-	8.0%	100.0%												
576/666	52.26	-	-	8.0%	100.0%												
577/665	25.08	-	-	8.0%	100.0%												
578/667	152	-	-	8.0%	100.0%												
589	ETU	-	-	-	-												
591	ETU	-	-	-	-												
621	93.6	-	-	8.0%	100.0%												
639	1200	-	-	8.0%	-												
652	ETU	-	-	-	-												
658	ETU	-	-	-	-												
659	ETU	-	-	-	-												
661	ETU	-	-	-	-												
662	150	-	-	8.0%	100.0%												

Table 6-4
Distribution Impacts 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 6-5
Impact Shares 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 6-6
Cost Allocation 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	$819.5	$153.0	$108.1	$353.2	$35.3	$44.4	$44.5	$4.1	$105.4	$54.6	$43.1	$65.7	Cost	Cluster
Queue Position	MW													Allocation	Participation
Northern Total	1118	$819.5	$153.0	$ 90.1	-	$35.3	$44.4	-	-	$105.4	$54.6	$43.1	-	$1,345.6	Deposit $ M
458	104	$ 76.2	$ 14.2	$ 8.4	-	$ 3.3	$ 4.1	-	-	$ 9.8	$ 5.1	$ 4.0	-	$ 125.2	$ 6.26
459	104	$ 76.2	$ 14.2	$ 8.4	-	$ 3.3	$ 4.1	-	-	$ 9.8	$ 5.1	$ 4.0	-	$ 125.2	$ 6.26
460	104	$ 76.2	$ 14.2	$ 8.4	-	$ 3.3	$ 4.1	-	-	$ 9.8	$ 5.1	$ 4.0	-	$ 125.2	$ 6.26
461	104	$ 76.2	$ 14.2	$ 8.4	-	$ 3.3	$ 4.1	-	-	$ 9.8	$ 5.1	$ 4.0	-	$ 125.2	$ 6.26
462	104	$ 76.2	$ 14.2	$ 8.4	-	$ 3.3	$ 4.1	-	-	$ 9.8	$ 5.1	$ 4.0	-	$ 125.2	$ 6.26
470	600.6	$440.3	$ 82.2	$ 48.4	-	$19.0	$23.9	-	-	$ 56.6	$29.3	$23.1	-	$ 722.9	$ 36.14
471	600.6	$440.3	$ 82.2	$ 48.4	-	$19.0	$23.9	-	-	$ 56.6	$29.3	$23.1	-	$ 722.9	$ 36.14
590	ETU	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ 1.00
626	376.2	$275.8	$ 51.5	$ 30.3	-	$11.9	$14.9	-	-	$ 35.5	$18.4	$14.5	-	$ 452.8	$ 22.64
Western Total	777	-	-	$ 18.0	$353.2	-	-	$44.5	$4.1	-	-	-	$65.7	$ 485.4	
571	ETU	-	-	-	-	-	-			-	-	-	-	$ -	$ 1.00
572	113.88	-	-	$ 2.6	$ 51.8	-	-	$ 6.5	$0.6	-	-	-	$ 9.6	$ 71.1	$ 3.56
573/594/663	245.38	-	-	$ 5.7	$111.5	-	-	$14.0	$1.3	-	-	-	$20.7	$ 153.3	$ 7.66
574/593/664	216.41	-	-	$ 5.0	$ 98.4	-	-	$12.4	$1.1	-	-	-	$18.3	$ 135.2	$ 6.76
576/666	52.26	-	-	$ 1.2	$ 23.8	-	-	$ 3.0	$0.3	-	-	-	$ 4.4	$ 32.6	$ 1.63
577/665	25.08	-	-	$ 0.6	$ 11.4	-	-	$ 1.4	$0.1	-	-	-	$ 2.1	$ 15.7	$ 0.78
578/667	152	-	-	$ 3.5	$ 69.1	-	-	$ 8.7	$0.8	-	-	-	$12.8	$ 94.9	$ 4.75
589	ETU	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ 1.00
591	ETU	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ 1.00
621	93.6	-	-	$ 2.2	$ 42.5	-	-	$ 5.4	$0.5	-	-	-	$ 7.9	$ 58.5	$ 2.92
639	1200	-	-	$ 27.7	-	-	-	-	$4.1	-	-	-	-	$ 31.8	$ 1.59
652	ETU	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ 1.00
658	ETU	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ 1.00
659	ETU	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ 1.00
661	ETU	-	-	-	-	-	-	-	-	-	-	-	-	$ -	$ 1.00
662	150	-	-	$ 3.5	$ 68.2	-	-	$ 8.6	$0.8	-	-	-	$12.7	$ 93.7	$ 4.68

Section 7
Conclusion

This Maine Resource Integration Study constitutes the first Cluster-Enabling Transmission Upgrade Regional Planning Study pursuant to Section 15.4 of Attachment K of the OATT, and forms the basis for the first Cluster-Interconnection System Impact Study 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, eligible to be included in the second-phase study; the transmission upgrades (i.e., CETUs and associated system upgrades) required to enable the interconnection; and the cost allocation for eligible projects if they elect to proceed to the second phase of the clustering process.

Consistent with Section 2.4 (d) of the OATT Attachment K, the posting, 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 of 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.