2020 Economic Study: *Preliminary Production Cost Results* – *Revision 2*

Revision to the November 19, 2020 Presentation

Planning Advisory Committee

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ASSOCIATE ENGINEER | RESOURCE STUDIES AND ASSESSMENTS

BACKGROUND AND ASSUMPTIONS

2020 Economic Study Request

- ISO New England (ISO) received one request for an Economic Study
  - Request made by National Grid and presented to the PAC on April 23, 2020
- The goal of the National Grid request is to **"Provide stakeholders analyses of potential pathways to best use the MWh of clean energy resources to meet state goals cost-effectively, leveraging transmission[(1)] and/or storage as needed"**
  - Evaluate the potential economic benefits associated with the deployment of transmission[(1)] and/or storage under a range of assumed future resource portfolios
  - Use the existing and new ties to lower renewable build-out spillage by "energy banking"
  - Assess changes to thermal unit capacity factors, spillage and emissions as related to different resource and dispatch scenarios
  - The request is for a one-year study focusing on 2035
- A high-level draft scope of work and assumptions were presented to the PAC on May 20, 2020 (Part I of III), June 17, 2020 (Part II of III), and July 22, 2020 (Part III of III)

(1) Bi-directional transmission capability with neighbors

2020 National Grid Economic Study Key Differences Between Scenarios

Bidirectional Scenarios

B: Only imports across ties with HQ and NB, negative threshold pricing to reflect renewable energy credits (RECs)

B_HQNB: Same as prior with exports across ties with HQ and NB

B_HQNB_1T/2T: Same as prior with 1T/2T new 1,200 MW ties from HQ to CMA/NEMA

Incremental Scenarios

I_8000: Positive threshold pricing

I_8000_Oil: Same as prior with all oil resources retired

I_8000_Oil_NG: Same as prior with 50% of remaining NG units* retired and two new ties added from HQ to CMA/NEMA

** Including dual fuel units*

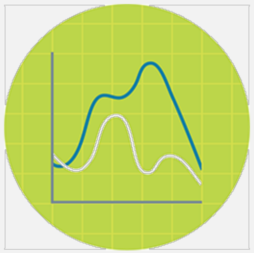
What’s New for the 2020 Economic Study

- Significant assumption changes as compared to previous Economic Studies
  - Assumptions likely to be analogous to the NEPOOL Future Grid Study
- Bi-directional use of external tielines with negative threshold prices to simulate incentives of RECs
  - Also explores addition of two new tielines & seasonal storage with Hydro Quebec

Disclaimer:

- All results use the 2015 solar and wind profiles. The results are specific to the 2015 weather year. If a different weather year is used for profile shapes the results will differ – the trends would be similar but specific numeric results will change.
- Curtailment of specific resources is driven by the threshold prices. Therefore, different prices and/or order may result in different outcomes.
- Production cost simulations were performed under two conditions: Unconstrained and Constrained. Unconstrained transmission is modeled as a one-bus system while constrained transmission is modeled using the “Pipe and RSP Bubble” configuration.

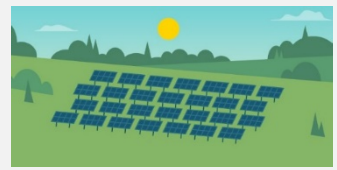
Significant Assumption Changes Reflected in the 2020 Economic Study



187 TWh
In 2020 National Grid

LOAD

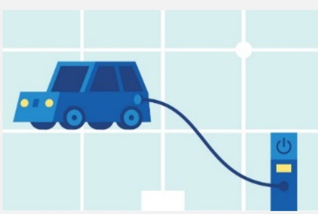
159 TWh
In 2019 NESCOE



20 TWh
In 2020 National Grid

SOLAR

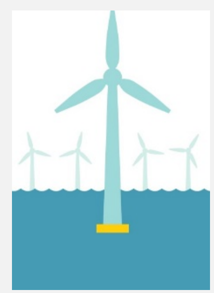
9 TWh
In 2019 NESCOE



16 TWh
In 2020 National Grid

Heat Pump & EVs

5 TWh
In 2019 NESCOE



39 TWh
In 2020 National Grid

WIND

35 TWh
In 2019 NESCOE

Bi-Directional Threshold Prices Reflect RECs and Make the Export Model Function

Bi-directional threshold prices assumed to reflect the value of RECs:

- Curtail imports first, then trigger exports, and only curtail renewables when export capability is exhausted

Price-Taking Resource	Threshold Price ($/MWh)
Behind-the-Meter PV	-100.00
FCM and Energy-only PV	-50.00
Offshore Wind	-40.00
Onshore Wind	-30.00
Trigger for Exports	-25.00
NECEC (1090 MW)	2.00
Imports from HQ (Including New Ties)	5.00
Imports from NB	10.00

- New England hydro is no longer modeled with a profile and therefore does not need a threshold price
- Threshold prices are used to facilitate the analysis of load levels where the amount of $0/MWh resources exceeds the system load
  - They are not indicative of "true" cost, expected bidding behavior or the preference for one type of resource over another
  - Use of a different order for threshold prices than indicated will produce different outcomes, particularly spillage by resource

Incremental Resource Scenario Threshold Prices

Different threshold price and order, as requested by National Grid, than what has been used in recent Economic Studies

- Curtail offshore wind first, followed by onshore wind, utility scale PV, imports from NB, imports from HQ, NECEC, and finally BTM-PV

Price-Taking Resource	Threshold Price ($/MWh)
Behind-the-Meter PV	1.00
NECEC (1090 MW)	2.00
Imports from HQ	5.00
Imports from NB	10.00
Utility Scale PV	11.00
Onshore Wind	12.00
Offshore Wind	13.00

- New England hydro is no longer modeled with a profile and therefore does not need a threshold price
- Incremental use a threshold price order similar those used in past economic studies
- Threshold prices are used to facilitate the analysis of load levels where the amount of $0/MWh resources exceeds the system load
  - They are not indicative of "true" cost, expected bidding behavior or the preference for one type of resource over another
  - Use of a different order for threshold prices than indicated will produce different outcomes, particularly spillage by resource

METRICS AND RESULTS

Bidirectional Scenarios

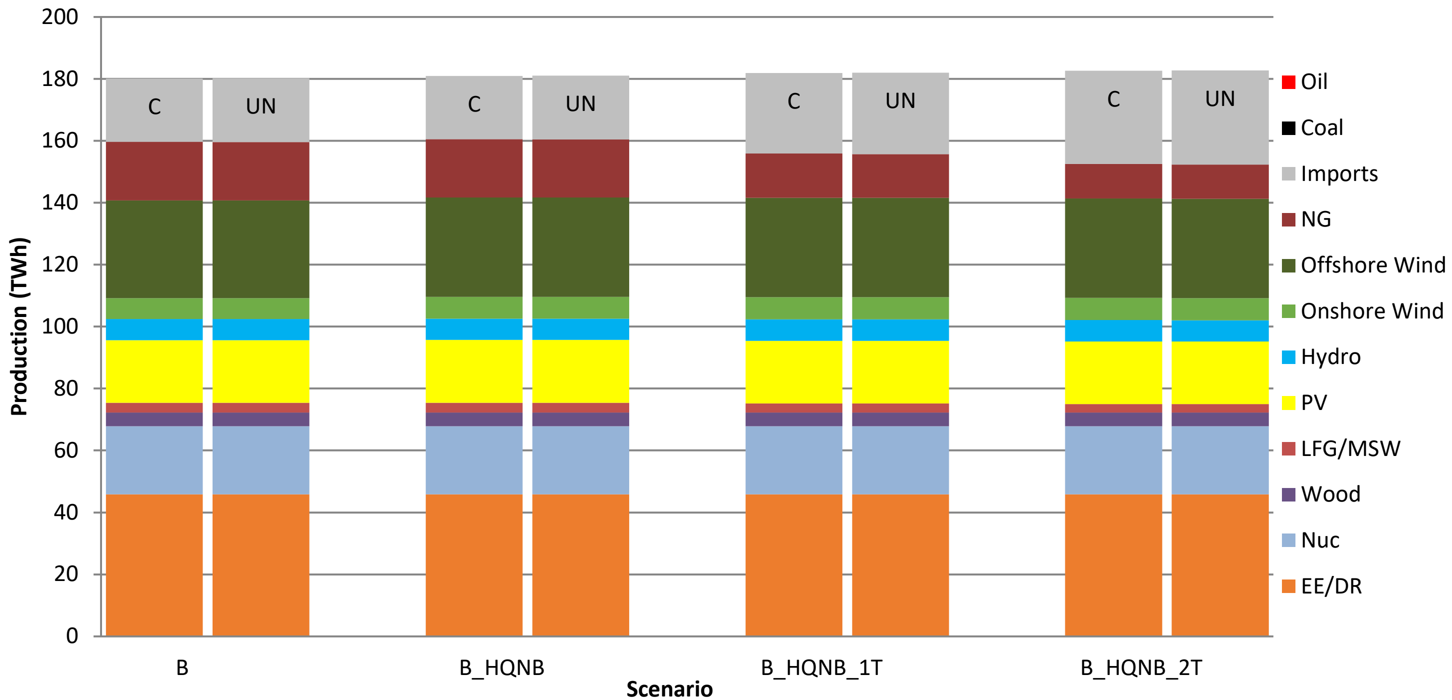
Summary of Results

Bidirectional Scenarios

- The introduction of bidirectionality across existing ties causes a reduction of spillage during situations in which there is low load and high variable resource production
  - Exporting excess supply to our neighbors to reduce spillage
- Total systemwide spillage is relatively low compared to NESCOE 8,000 MW case due to assumptions of high load in the study year 2035
  - Load levels were offered by National Grid
  - Retirement of Millstone 2 which provided ~900 MW of “must-run” supply
- Because emissions associated with imports from our neighbors are assumed to be zero, the impact of energy banking of non-emitting New England resources is not apparent in many of the systemwide metrics
- With the addition of new tie(s) with firm low threshold-price import capability from HQ, natural gas production is replaced

Total System-Wide Energy Production by Fuel Type (TWh)

*For Constrained (C) and Unconstrained (UN) Transmission**

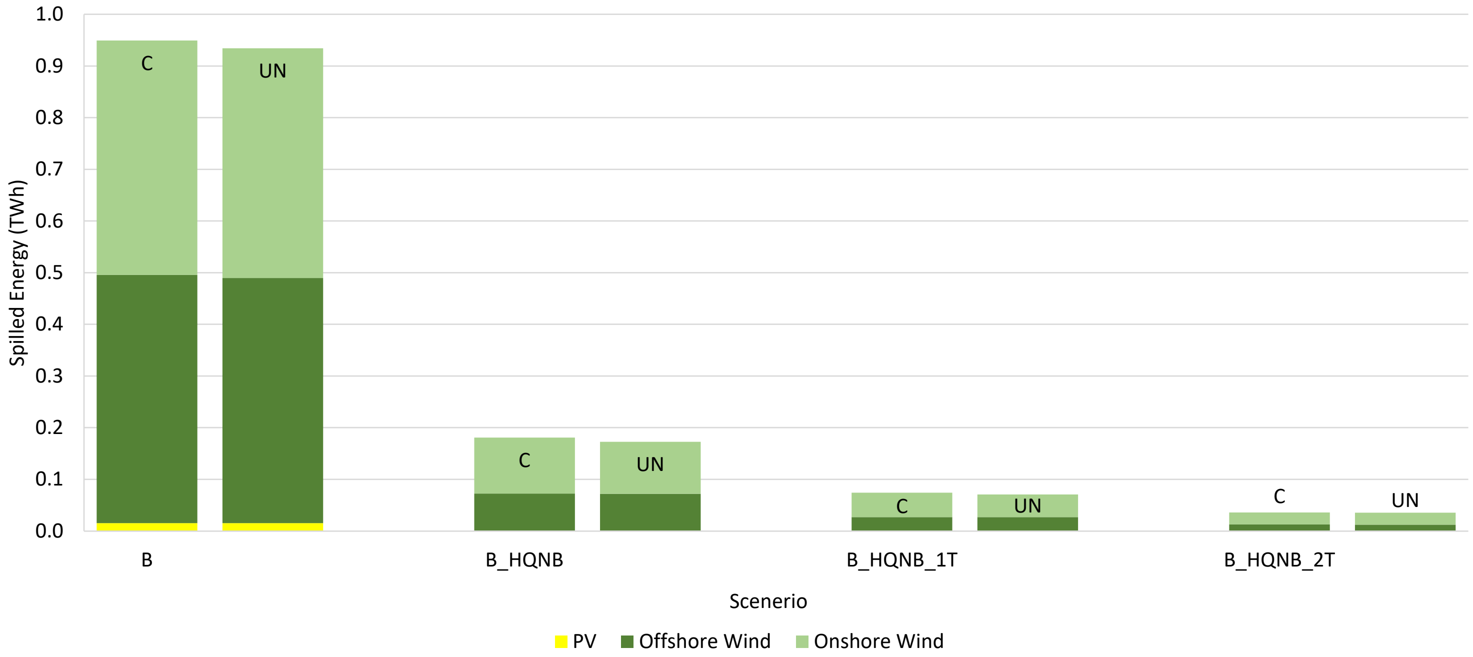


- Energy production by subtype remains mostly similar with the addition of bidirectionality
- By adding more imports, natural gas production in New England is decreased

** Wholesale Market Impact analyses was performed under two conditions: Unconstrained and Constrained. Unconstrained transmission is modeled as a one-bus system while constrained transmission is modeled using the "Pipe and RSP Bubble" configuration.*

Systemwide Spillage of Renewables (TWh)

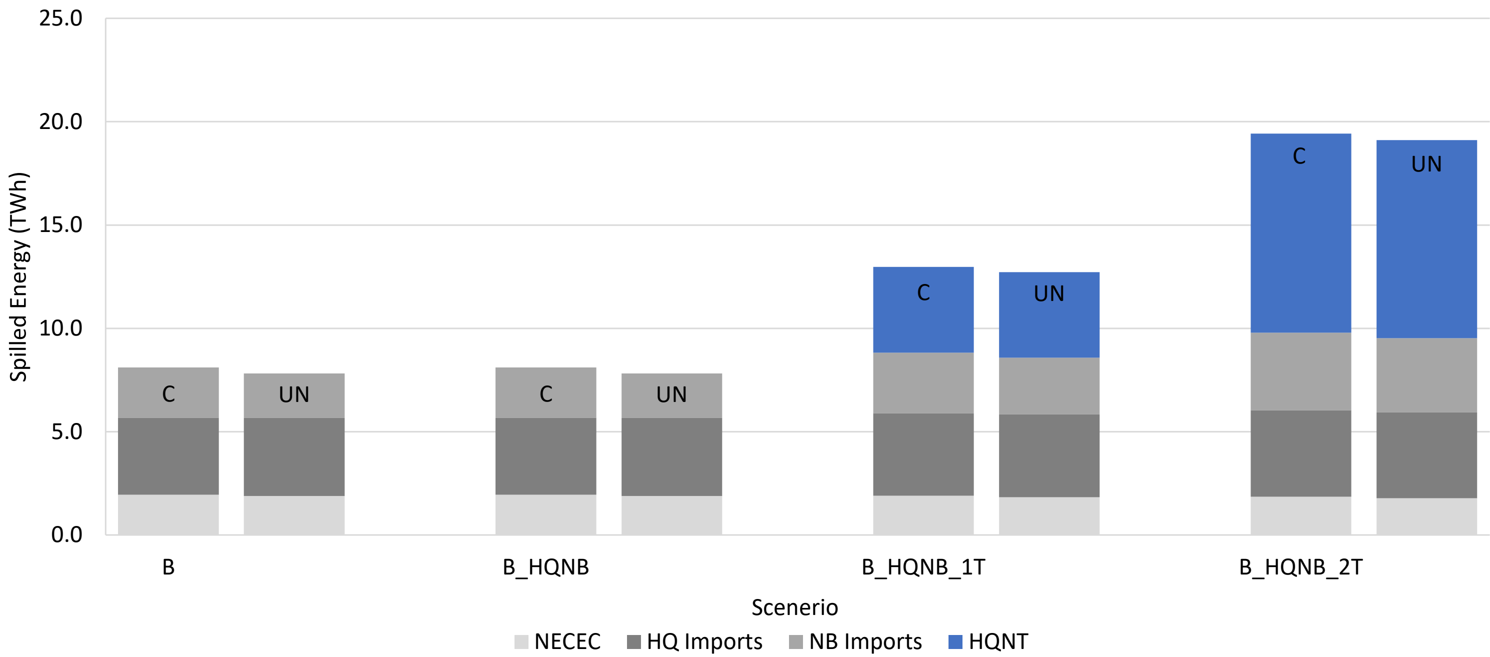
For Constrained (C) and Unconstrained (UN) Transmission



- Adding bidirectionality to existing ties significantly reduces spillage of offshore and onshore wind
  - Spillage of renewables is reduced 96% from the Bi-Directional Reference (B) scenarios to the Bi-Directional New Transmission 2 (B_HQNB_2T)

Systemwide Spillage of Imports (TWh)

For Constrained (C) and Unconstrained (UN) Transmission

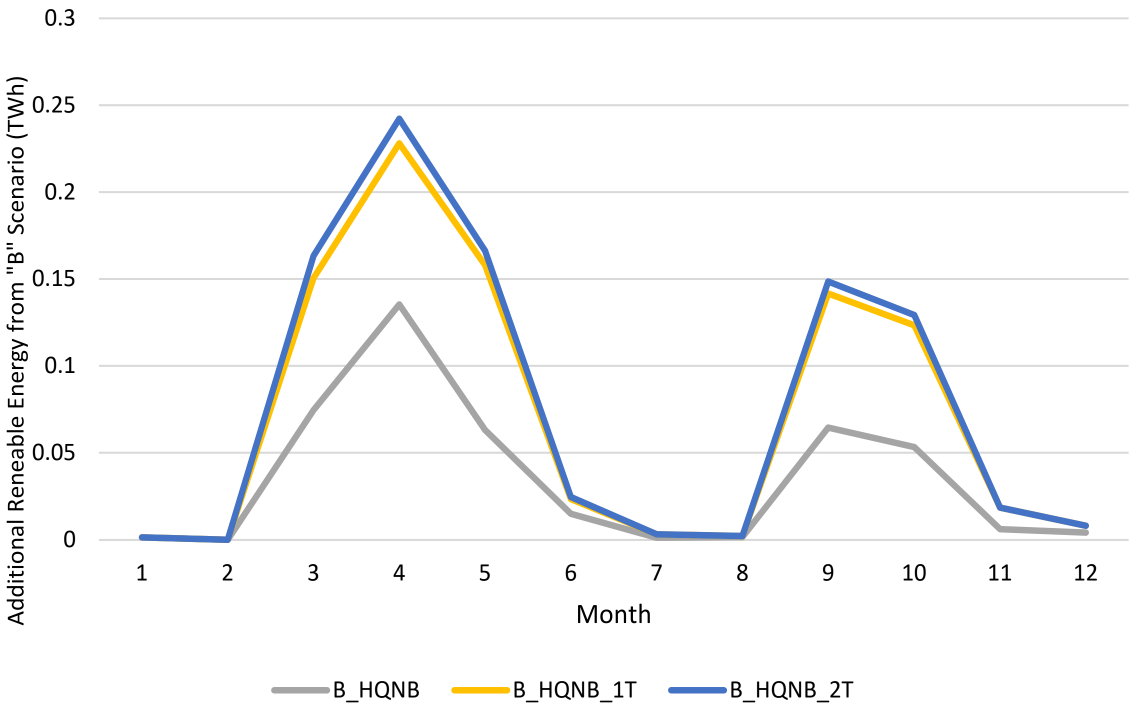


- As new bidirectional ties are added, total spillage increases because ISO-NE cannot always absorb energy from the new imports
  - During certain hours of "import spillage" the ties are used to export energy to HQ and NB

1T= One new 1,200 MW tie; 2T= Two new 1,200 MW ties (2,400 MW total)

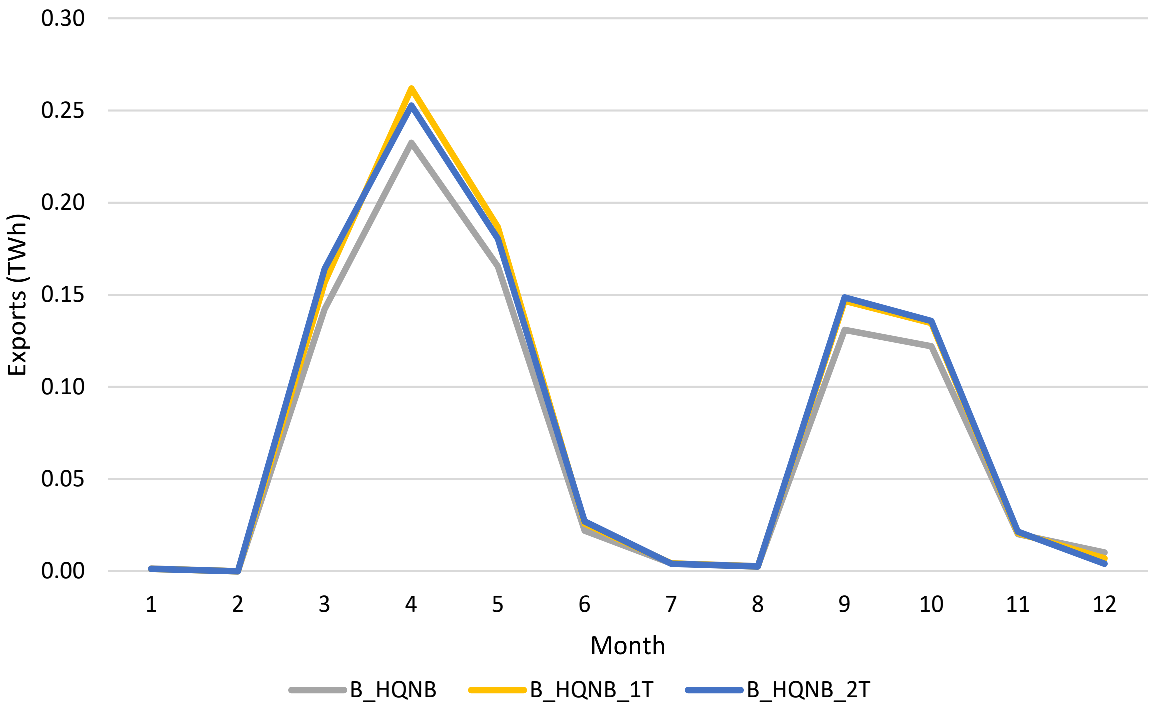
Increase in Renewable Production from “B” Scenario (TWh)

Constrained Transmission



While NE Renewable (PV & wind) exporting only occurs in shoulder months, export capability limits how much energy can be exported during the hour it occurs

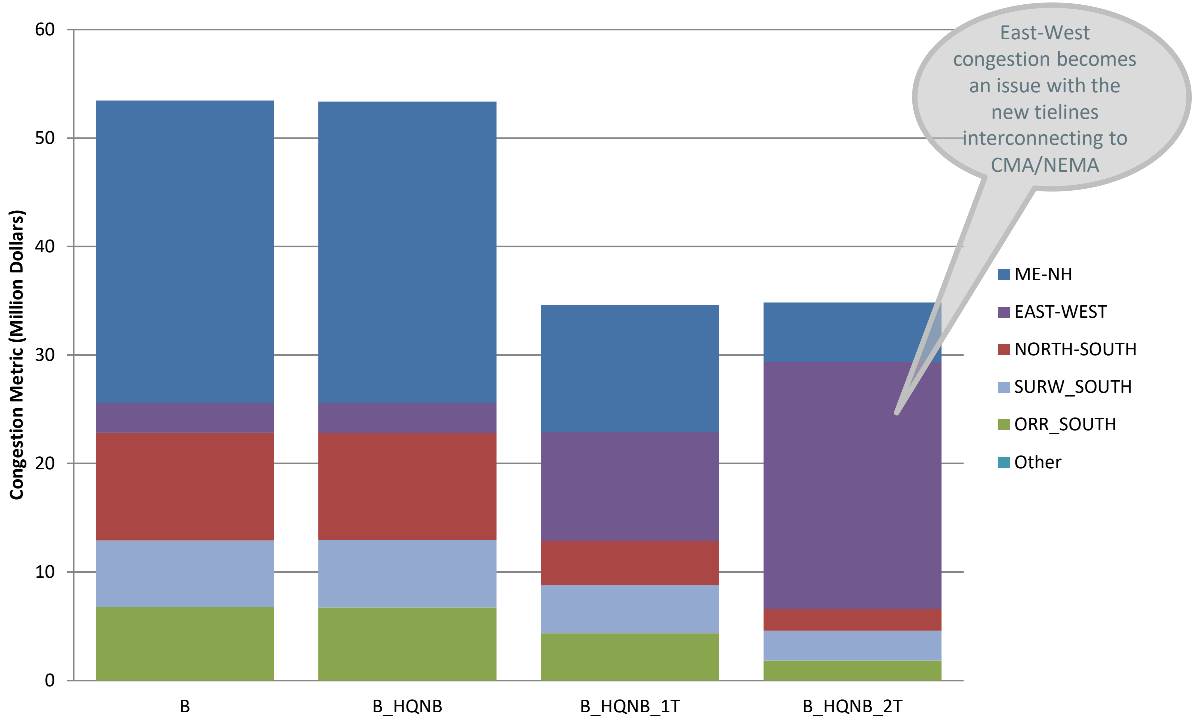
Monthly Energy Exported (TWh)



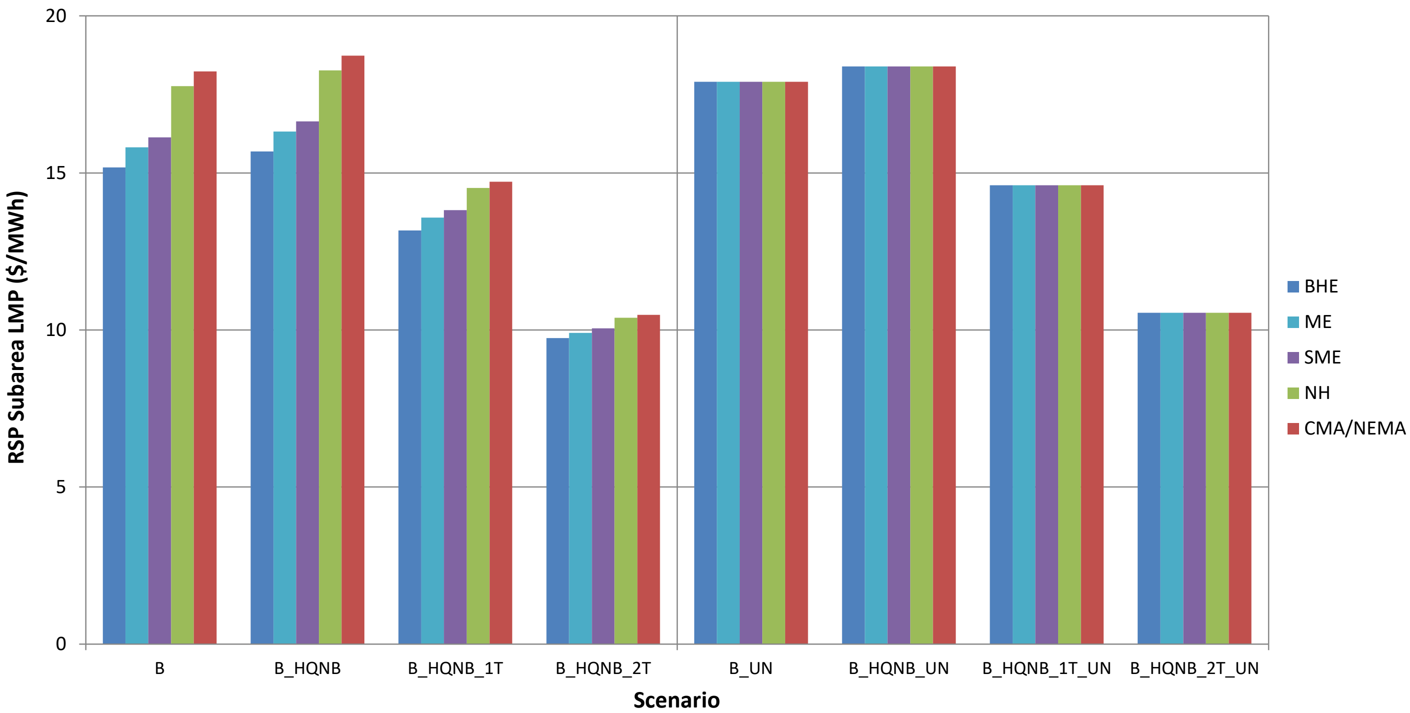
Exports are concentrated in the shoulder seasons in the additional tieline scenarios studied due to high electrification loads absorbing New England resource production.

Congestion Cost by Interface ($ Million)

Overall congestion decreases with the addition of new ties as the energy from the ties supplants other resources in ME including NB imports



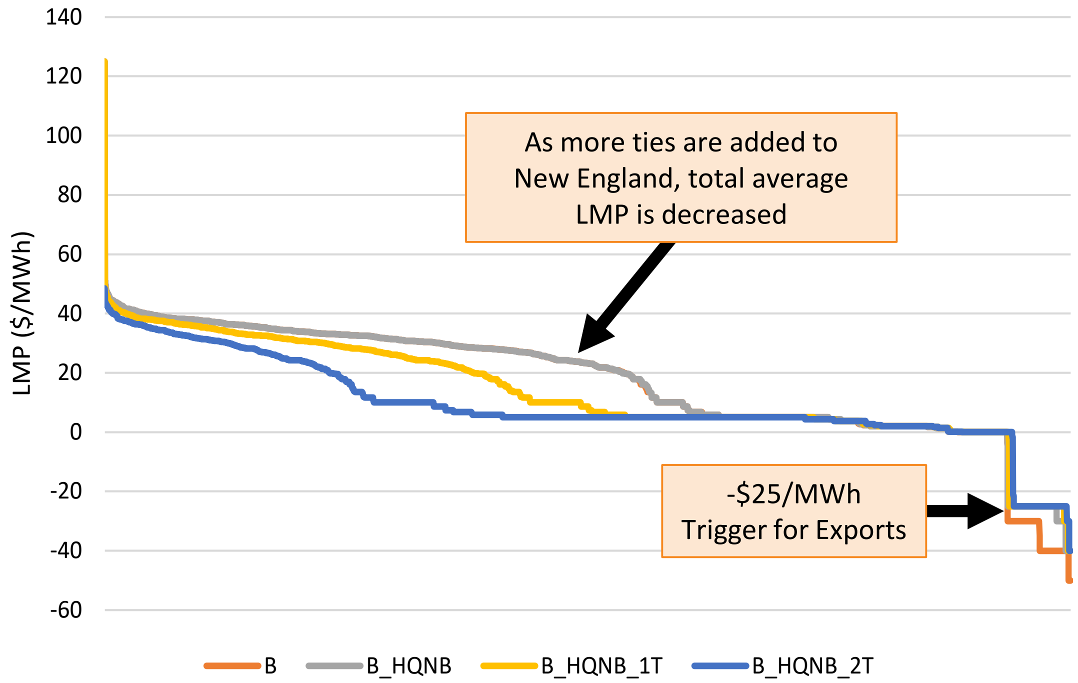
Annual Average LMPs by RSP Subarea ($/MWh)



- Average LMP is higher when adding bidirectionality because exports reduce the number of hours where LMPs go further negative and curtail resources
  - LMP differs only when ties are exporting
- As more ties are added, average LMP decreases as zero-cost imports displace natural gas production

Average LMP for ISO-NE Hub

For Constrained Transmission

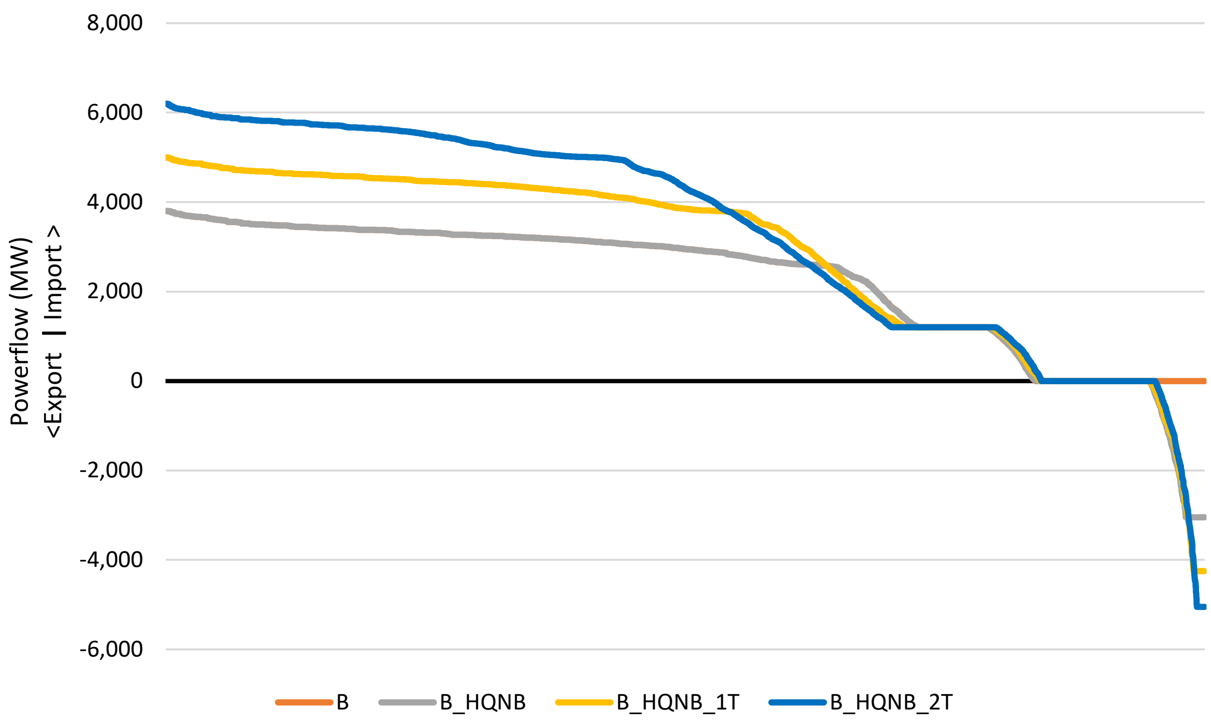


Adding bidirectionality only changes LMP when exports are triggered as expected

- "B" (orange line) is hidden behind "B_HQNB" (grey line)

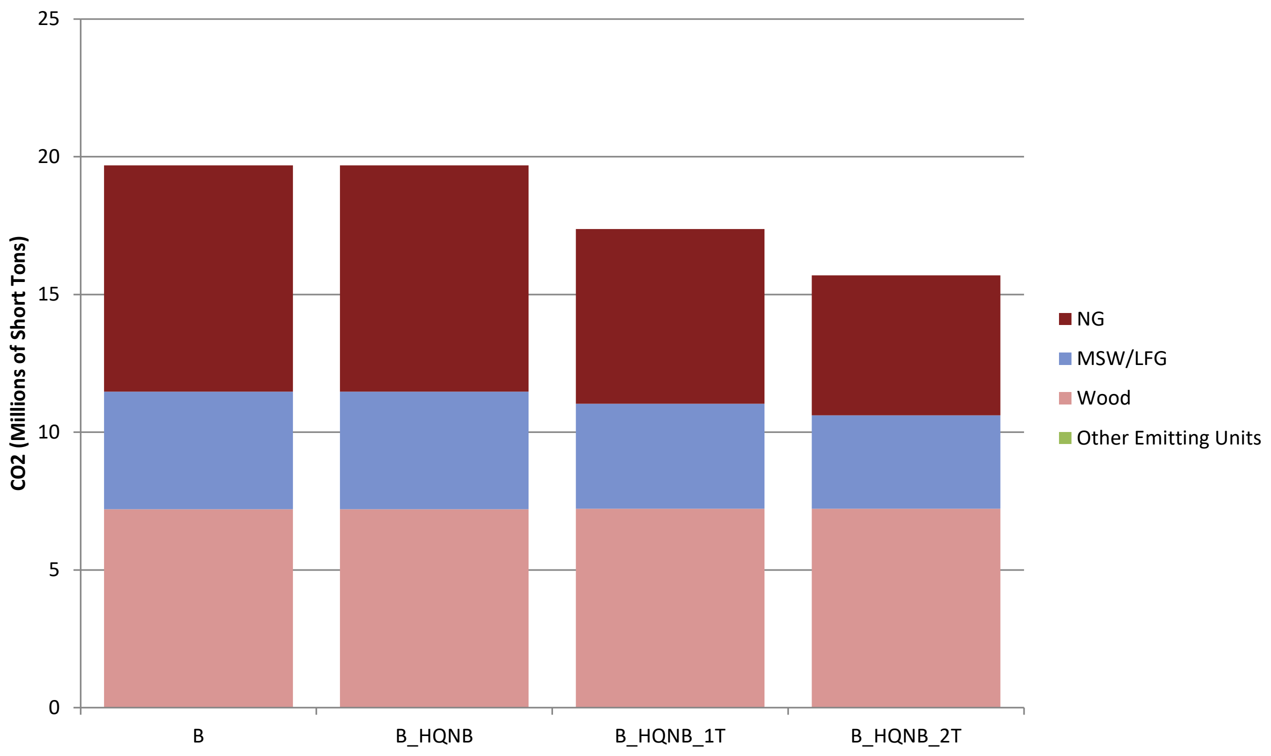
Annual Power Flow Across External Ties (MW)

For Constrained Transmission



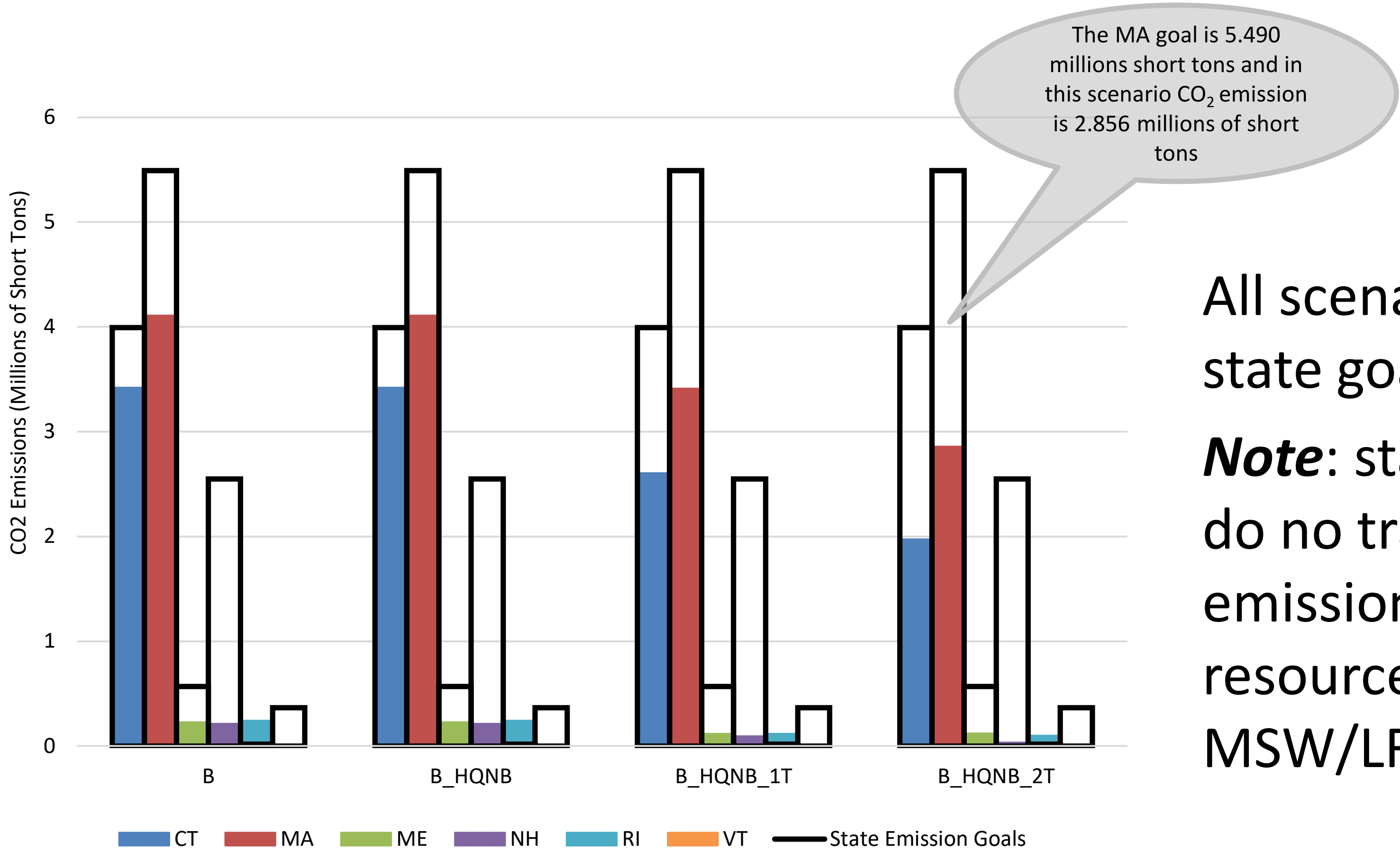
Compared to NESCOE 8000 in 2019 Economic Study, with the assumed loads from increased electrification there are limited hours, primarily in the shoulder months, where excess renewable energy is exported to Canada

Native New England Resource CO_2 Emissions by Fuel Type



In all scenarios, Municipal Solid Waste (MSW), Landfill Gas (LFG) and wood resources contribute a significant amount of carbon emissions

CO_2 Emissions by State vs 2035 State Goal



All scenarios exceed state goals

Note: state goals* do no track emissions from all resources, including MSW/LFG resources

**Estimation of state CO_2 emission goals provided by National Grid*

Percent of Energy to Gross Load

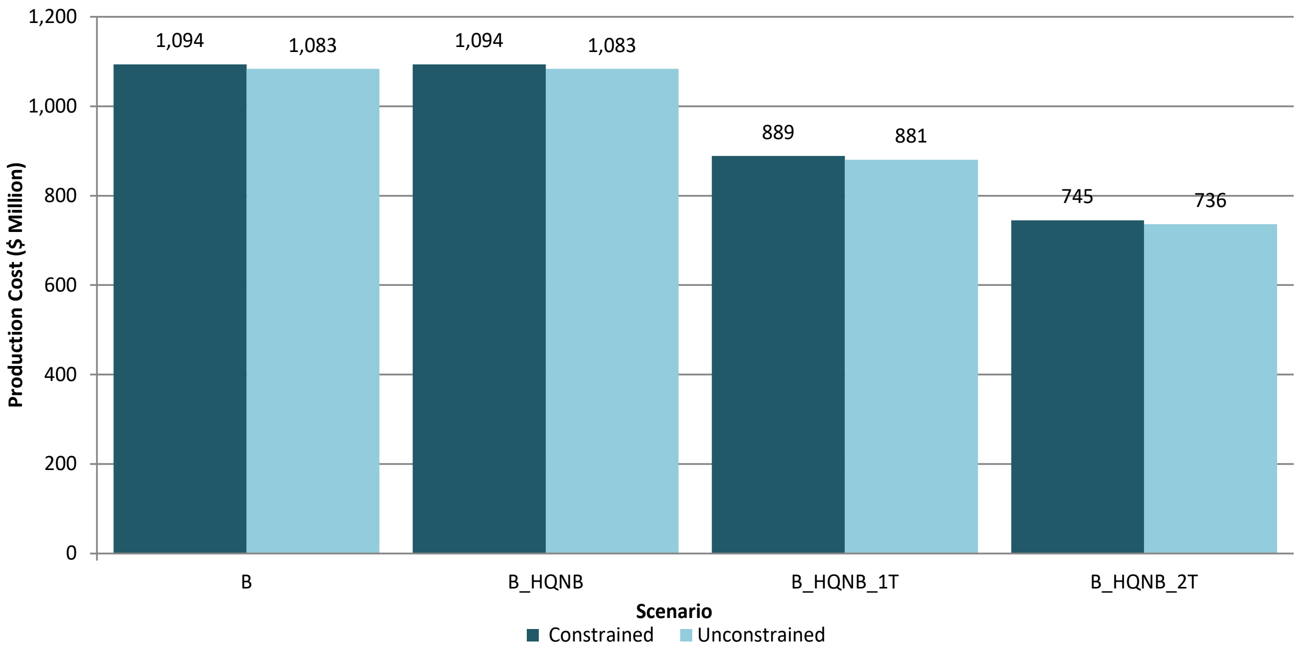
For Constrained Transmission

Formula (MWh)	B	B_HQNB	B_HQNB_1T	B_HQNB_2T
$\frac{Renewables + EE}{Gross\ Energy}$	66.0%	66.2%	65.8%	65.4%
$\frac{Renewables + EE + Nuclear}{Gross\ Energy}$	78.2%	78.3%	77.8%	77.4%
$\frac{Renewables}{Gross\ Energy - EE}$	54.4%	54.7%	54.2%	53.8%
$\frac{Renewables + Nuclear}{Gross\ Energy - EE}$	70.7%	70.9%	70.3%	69.8%
$\frac{Renewables + Nuclear + Imports}{Gross\ Energy - EE}$	85.9%	86.0%	89.5%	91.8%

**Renewables include: Onshore/Offshore Wind, PV, Hydro, wood, MSW, and LFG*

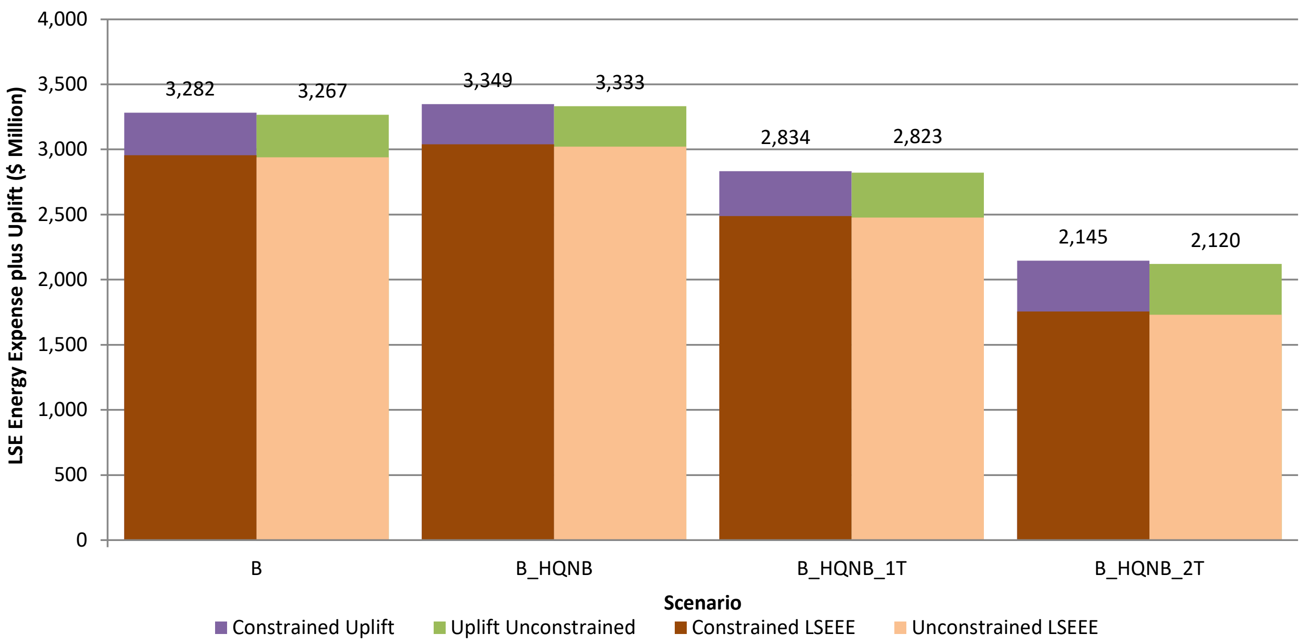
- Percentages of energy are mostly similar between scenarios
- Since a large portion of imports from Canada are carbon free, then new and existing ties increase the percent of carbon-free energy

System-Wide Energy Production Costs ($ Million)



Additional zero-cost 1,200 MW tie line(s) drive down system energy production costs significantly.

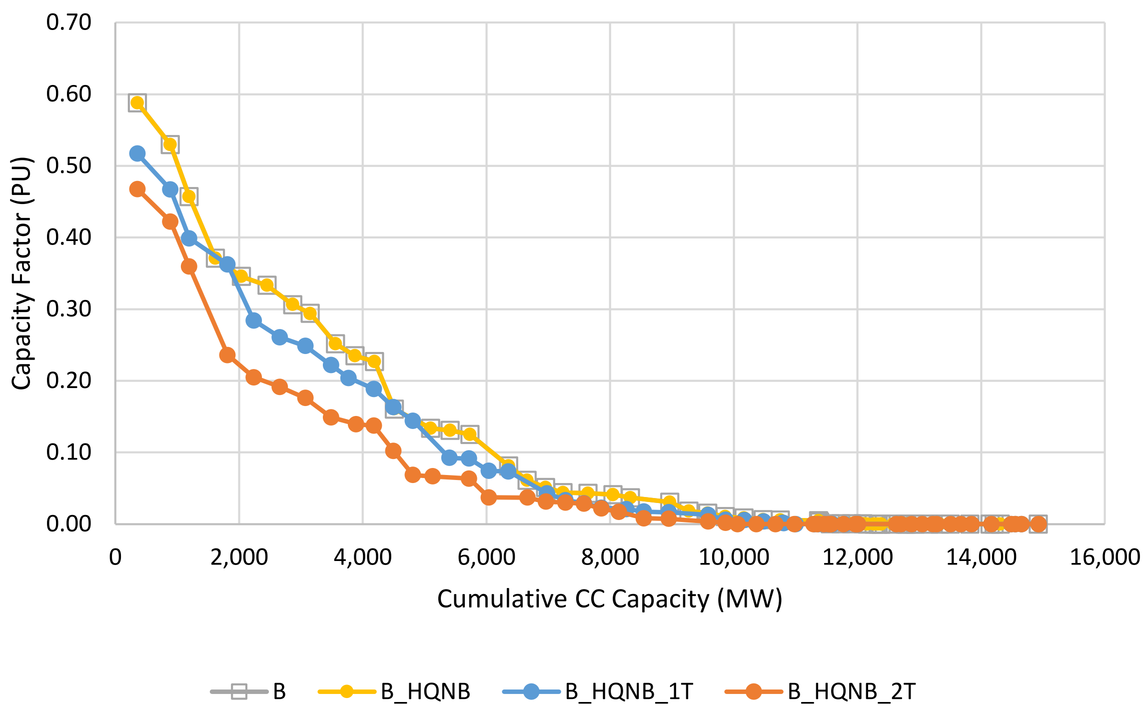
Load-Serving Entity Energy Expense and Uplift ($ Million)



Additional zero-cost 1,200 MW tie line(s) reduces total LSEEE but slightly increases uplift

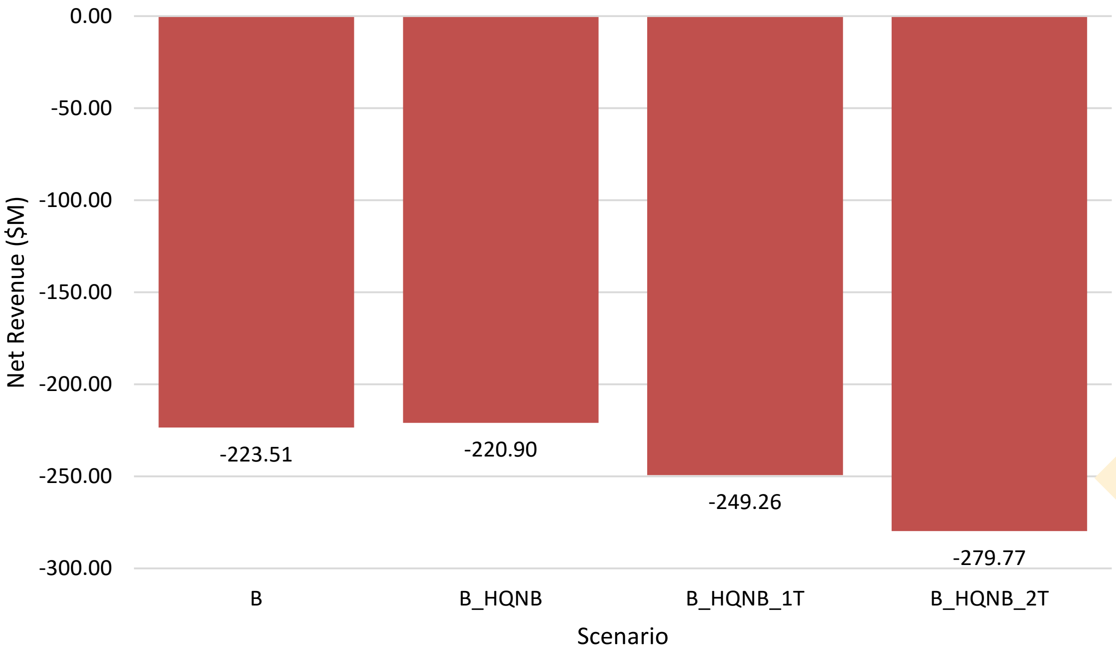
Combined Cycle Capacity Factors by Cumulative Capacity

For Constrained Transmission



Combined cycle units are run at nearly the same capacity factor when bidirectionality is added, and adding new ties reduces the capacity factors of most combined cycle units

Negative Net Revenue for Natural Gas Generators (Uplift Required)



With increased renewables, natural gas (NG) resources have a negative net revenue in the production cost simulation.

Additional imports further reduce dispatch of NG resources and drives net revenue further negative

Observing Low and High Spill Days

High Spill Day

Adding bidirectionality reduces spillage of New England resources and increases LMP

Addition of one new tie reduces spillage significantly

Addition of two new ties eliminates all New England resource spillage

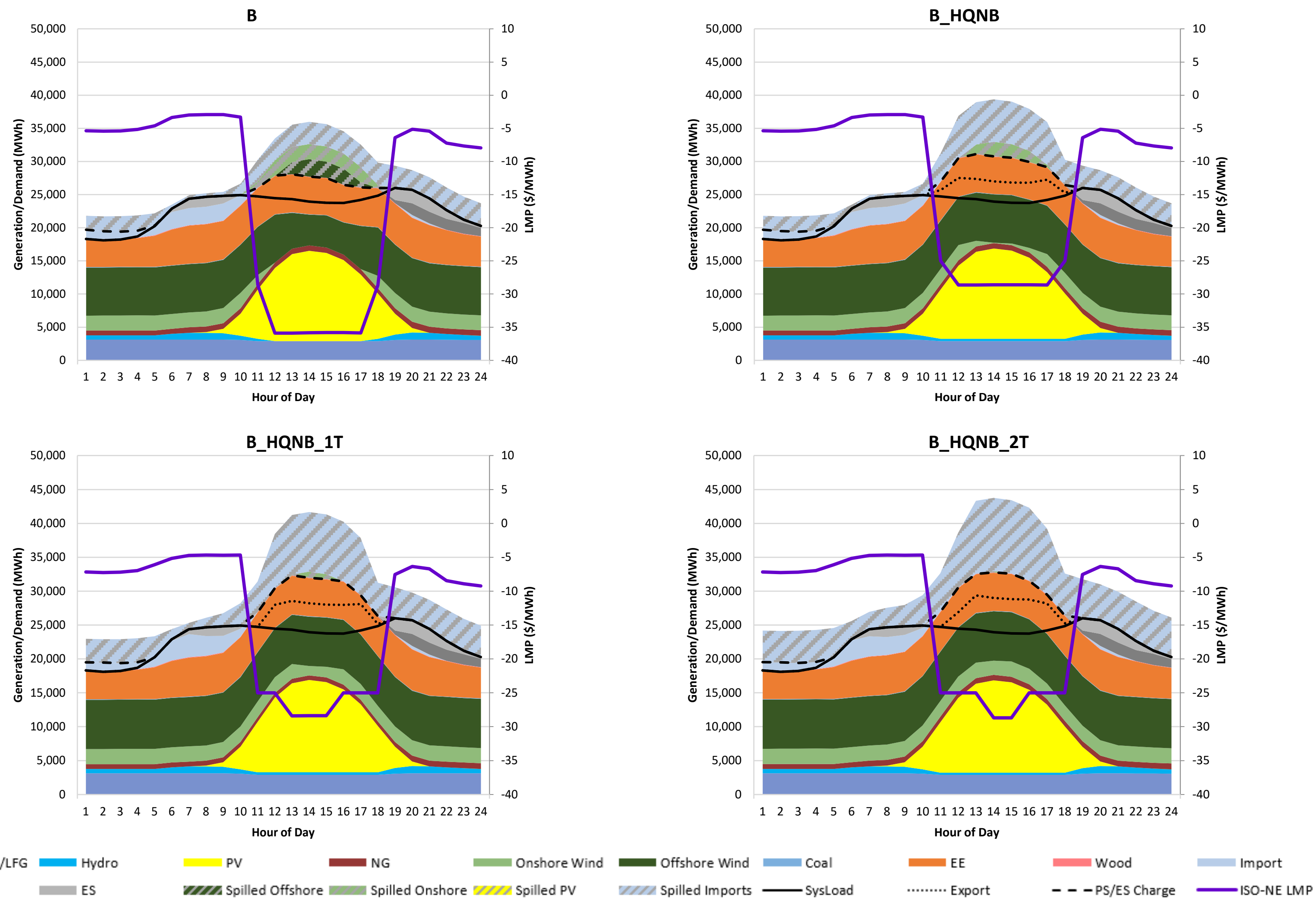
Low Spill Day

Since no energy is exported on this day, adding bidirectionality does not make a difference

Additional imports causes the replacement of cost taking natural gas resource thereby reducing LMP

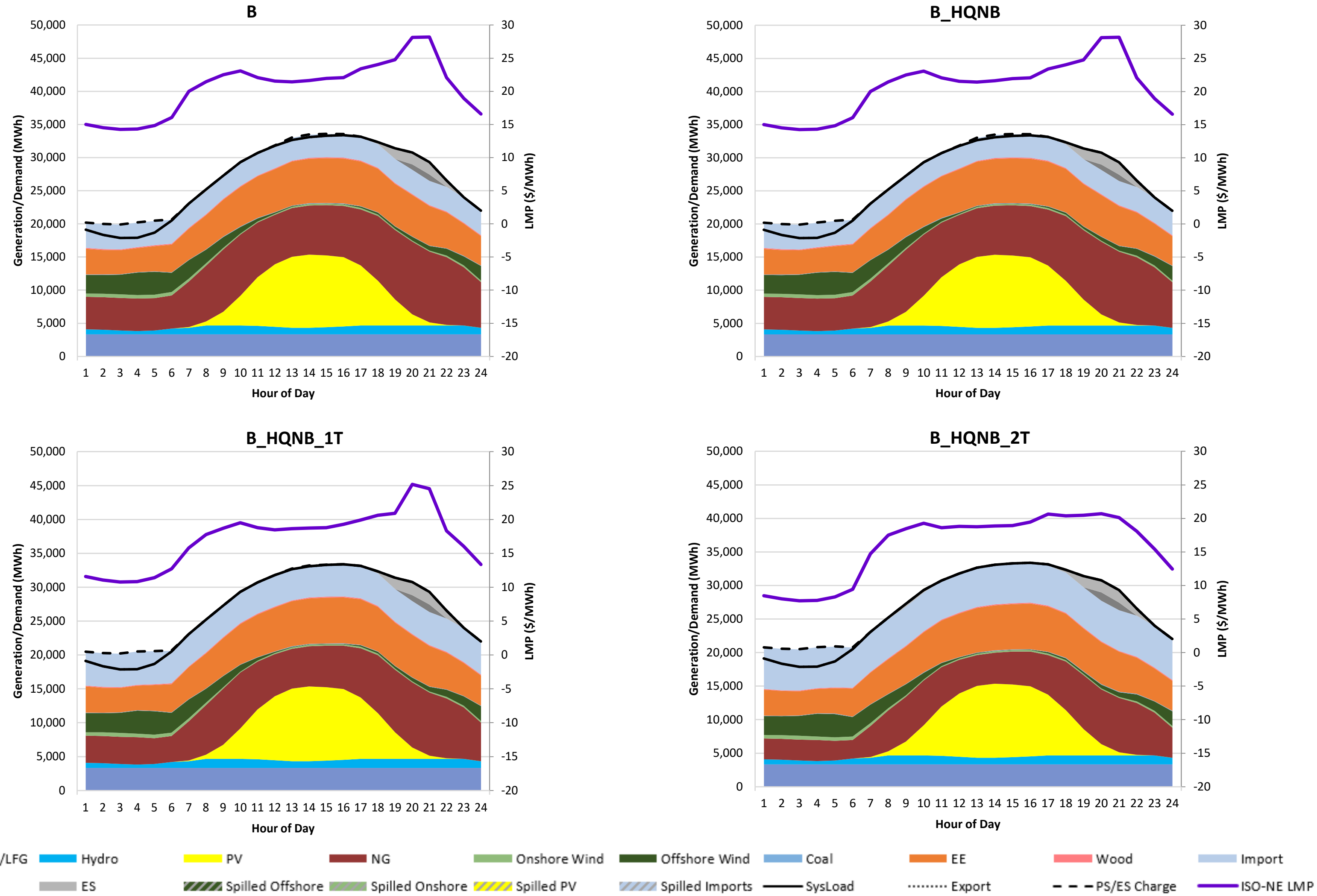
Generation by Subtype High Spill Day

October 18th, 2035



Generation by Subtype Low Spill Day

July 29th, 2035



METRICS AND RESULTS

Incremental Scenarios

2020 National Grid Economic Study Key Differences Between Scenarios

Bidirectional Scenarios

B: Only imports across ties with HQ and NB, negative threshold pricing to reflect renewable energy credits (RECs)

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Incremental Scenarios

I_8000: Positive threshold pricing

I_8000_Oil: Same as prior with all oil resources retired

I_8000_Oil_NG: Same as prior with 50% of remaining NG units* retired and two new ties added from HQ to CMA/NEMA

** Including dual fuel units*

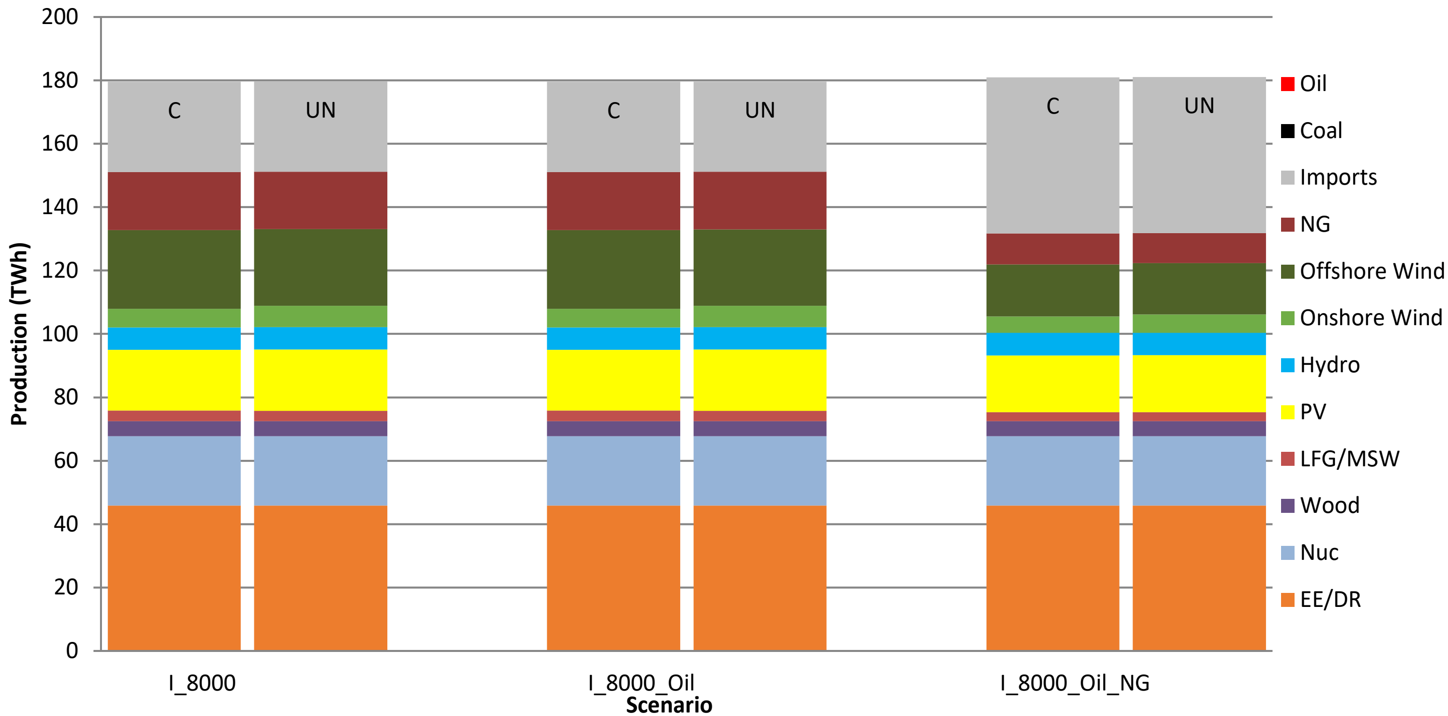
Summary of Results

Incremental_8000 Scenarios

- Since oil units are not committed in I_8000, there is no difference in results between I_8000 and I_8000_Oil
- With the assumed retirements and new ties in I_8000_Oil_NG, there is:
  - Larger spillage of wind and solar resources due to assumed threshold price
  - A reduction of LMP/production cost as the ties replace price-taking NG

Total System-Wide Energy Production by Fuel Type (TWh)

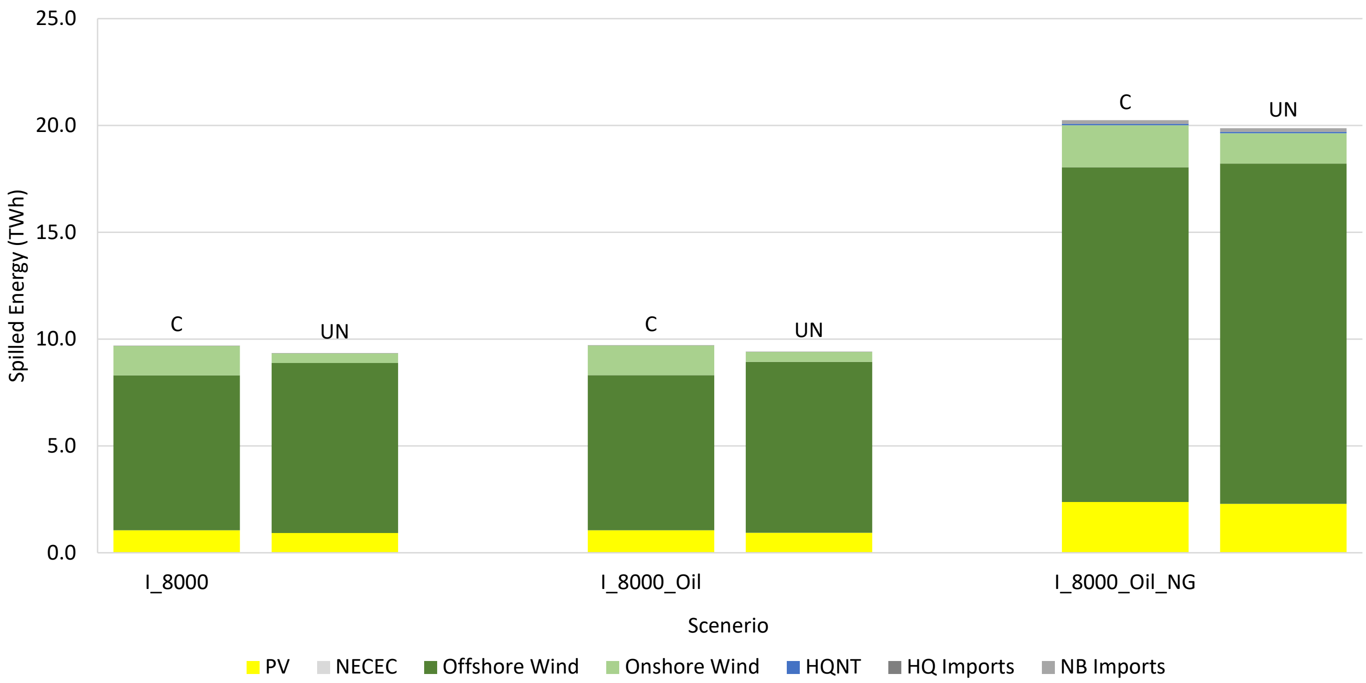
For Constrained (C) and Unconstrained (UN) Transmission



- The replacement of NG units with 2 × 1,200 MW ties from HQ to CMA/NEMA reduces the amount of wind and PV resources being committed to load

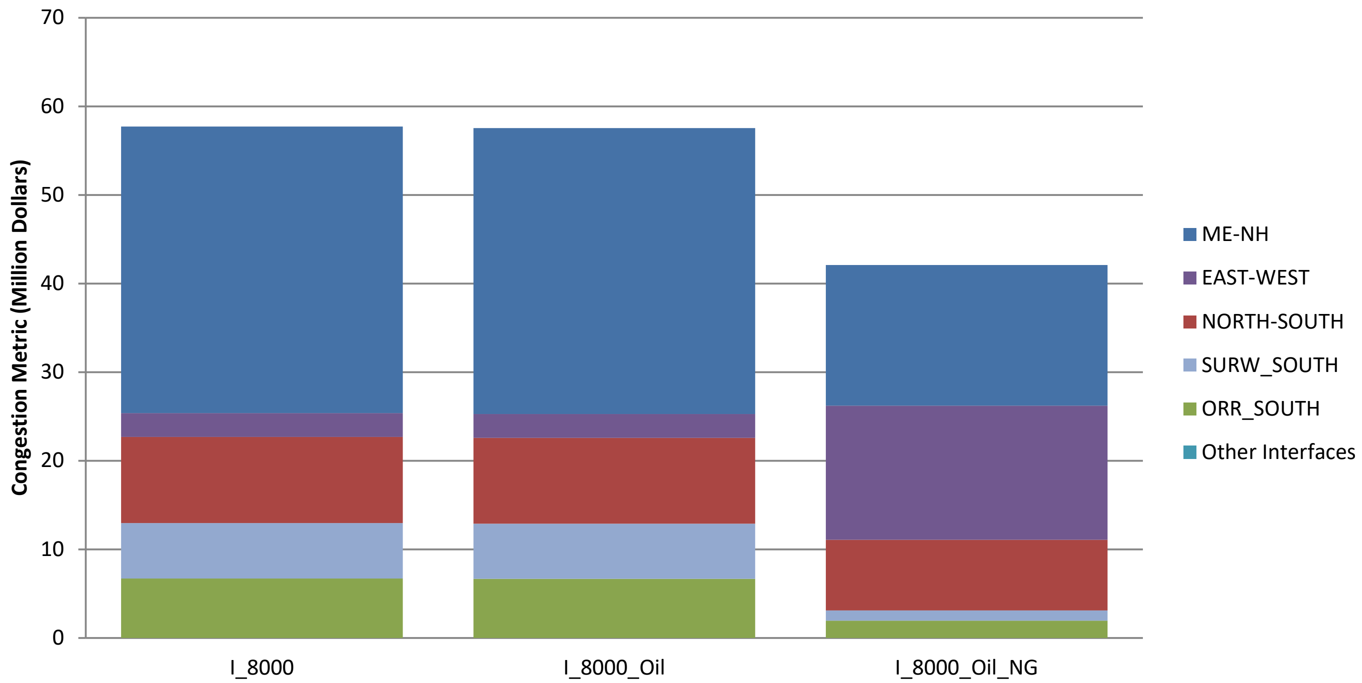
Systemwide Spillage by Subtype (TWh)

For Constrained (C) and Unconstrained (UN) Transmission



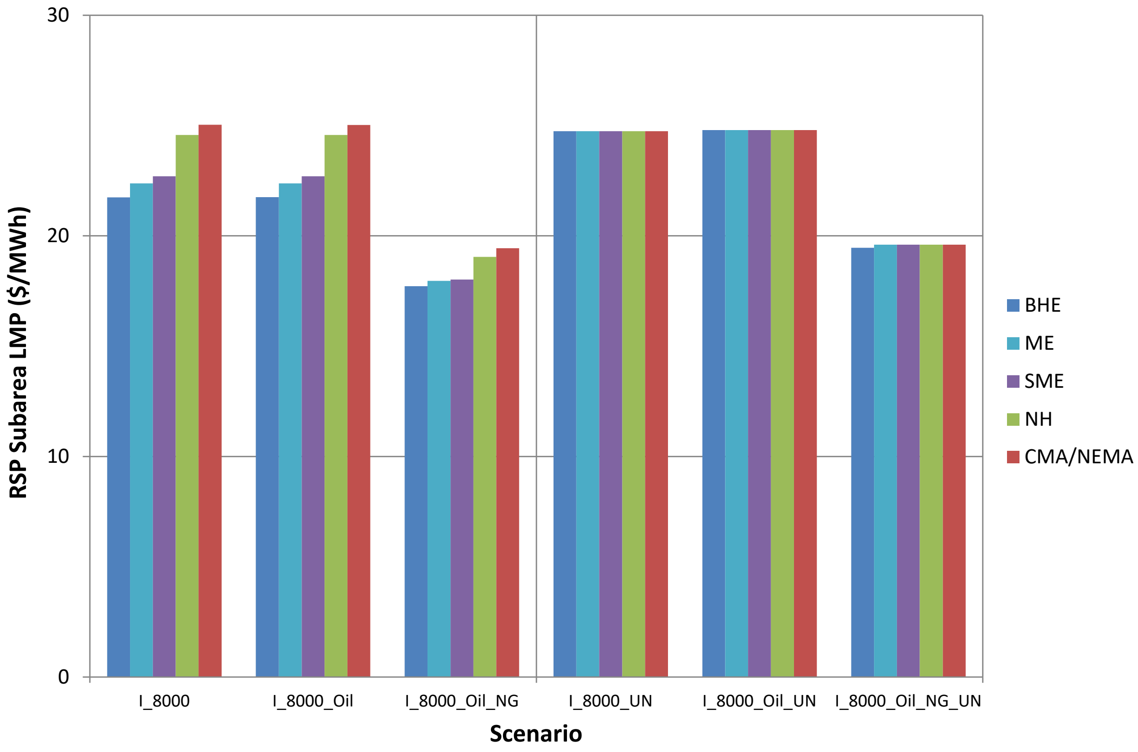
Due to Threshold Price order, wind and PV energy is spilled before imported energy from Canada is spilled

Congestion by Interface ($ Million)



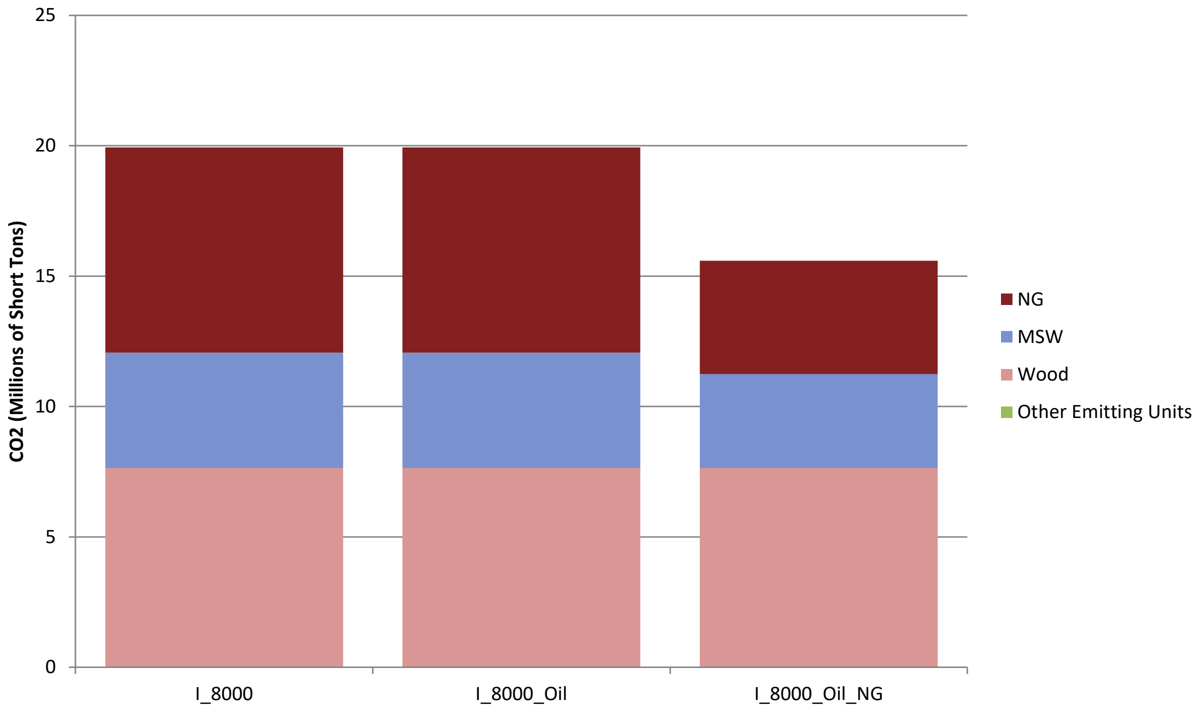
- With the addition of the 2 new ties from HQ to CMA/NEMA congestion cost is reduced on most interfaces in New England
  - An increase in congestion cost on the East-West interface is a result of adding the new tie lines

Annual Average LMPs by RSP Subarea ($/MWh)



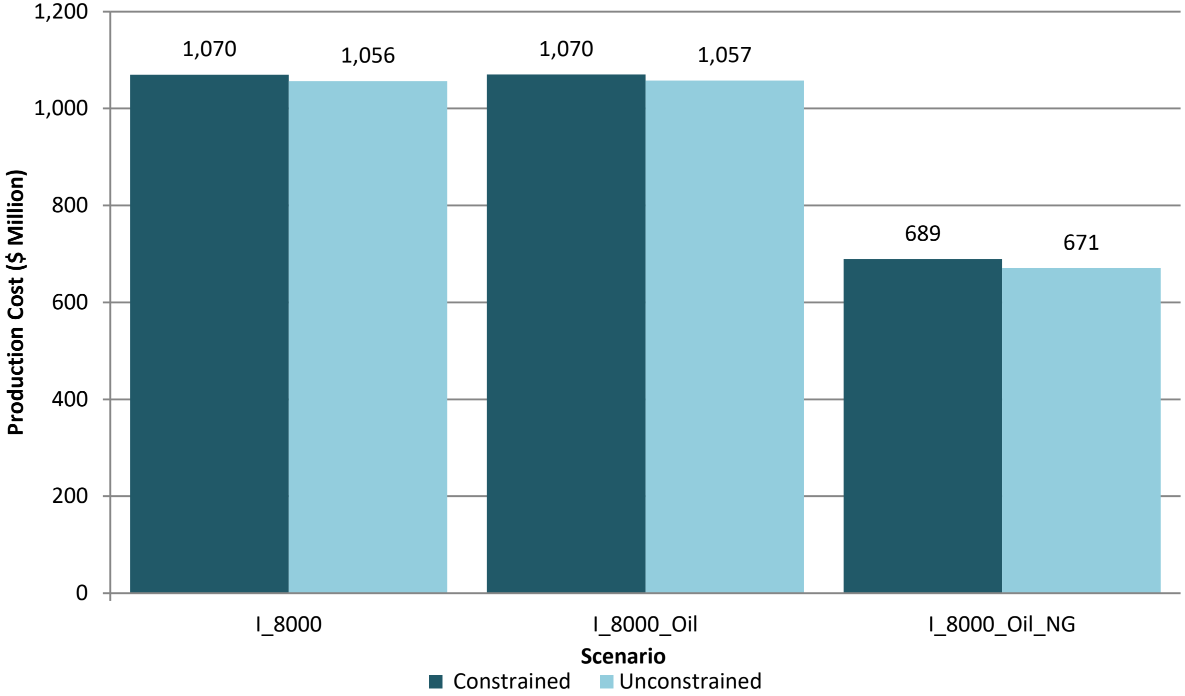
The replacement of dispatchable natural gas with imports from HQ causes a reduction in annual average LMP

Native New England Resource CO_2 Emissions



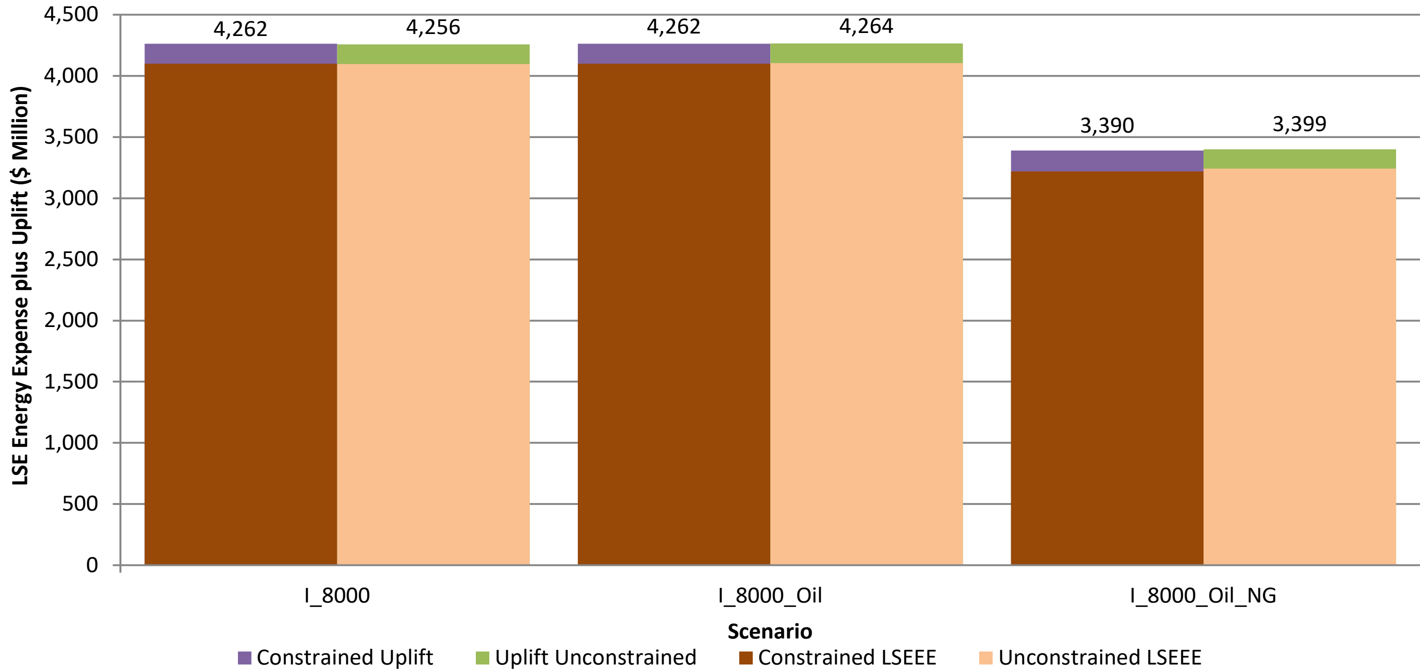
Retired natural gas units being replaced with imports from HQ leads to a reduction of CO_2 emissions within New England

Systemwide Energy Production Costs



Imports that replace dispatchable NG cause a reduction in production cost

Load-Serving Entity Energy Expense (LSEEE) and Uplift



LSEEE decreases as tielines replace retired NG units

Uplift remains relatively constant across scenarios

NEXT STEPS

Next Steps for the 2020 Economic Study

Q4 2020

Identify sensitivity scenario(s) and assumptions

Q1 2021

Present sensitivity scenario(s) simulation results

Present draft ancillary services (EPECS) results

Present assumptions for ancillary services analysis

Q2 2021

Issue final report

Feedback for Sensitivities

Please provide any feedback or comments to PACmatters@iso-ne.com by **December 1st, 2020** including possible sensitivities

Questions

APPENDIX I

Additional Tables and Graphs

2020 National Grid Economic Study Scenarios

<table>
<tr><th>Scenarios</th><th>Threshold Prices Used</th><th>Retirements</th><th>Must Run Units</th><th>Wind Additions (Nameplate)</th><th>Peak Demand from Heat Pumps</th><th>Peak Demand from Electric Vehicles</th><th>Nameplate Storage Additions</th><th>Bi-Directional External Tie(s)</th></tr>
<tr><td>Bi-Directional Reference (B)</td><td rowspan="4">REC-Inspired</td><td rowspan="4">FCA 14, Mystic 8&9, Millstone 2, NE Coal, + 75% of conventional NE oil including dual-fuel based on age</td><td rowspan="7">Nuclear, Municipal Solid Waste, Landfill Gas, Wood</td><td rowspan="7">1,330 MW Onshore

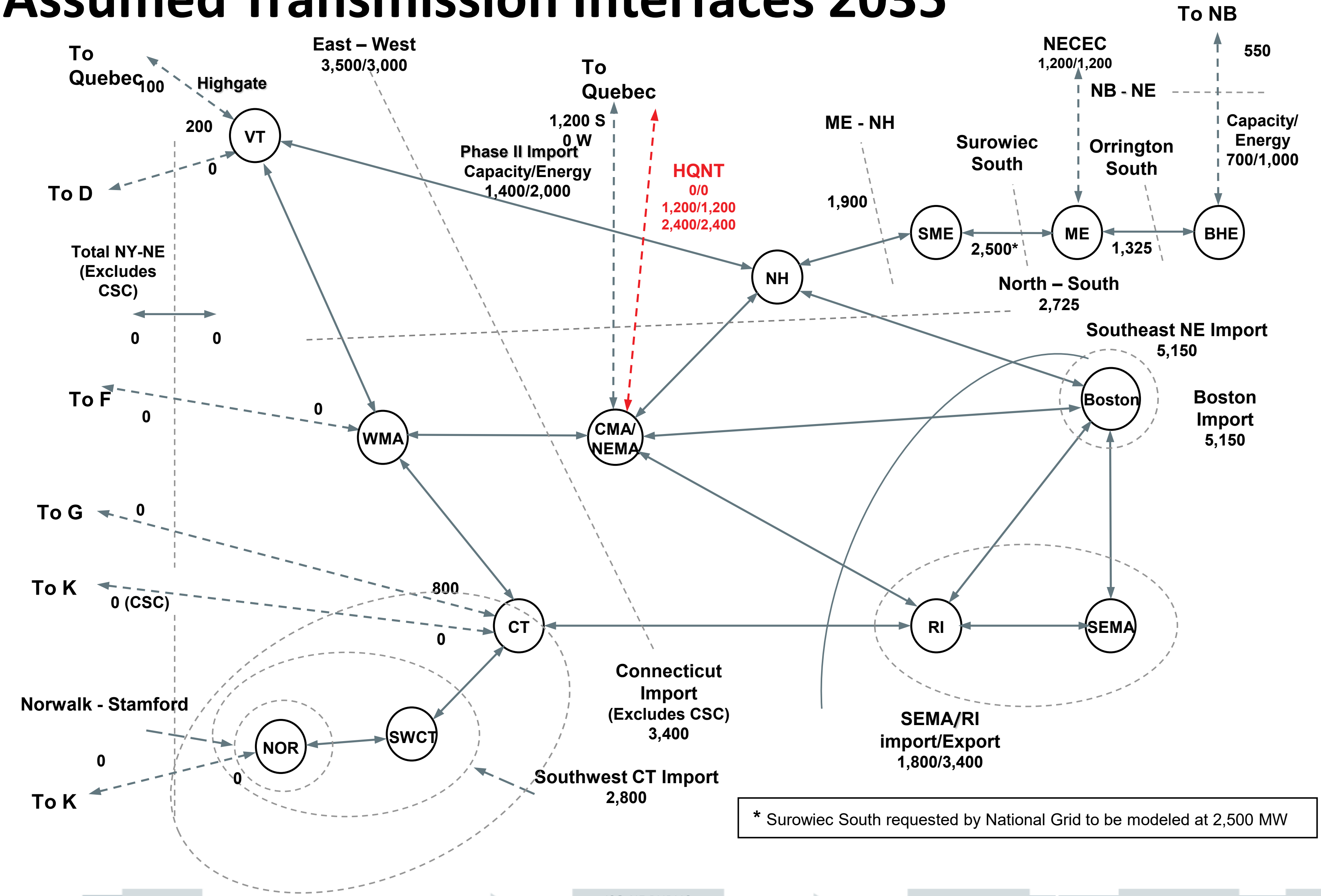
8,000 MW Offshore[1]</td><td rowspan="7">5,214 MW</td><td rowspan="7">1,817 MW (2.2 million vehicles)</td><td rowspan="4">2,000 MW Battery[1] and Utilizing Hydro Quebec as Virtual Storage</td><td>None</td></tr>
<tr><td>Bi-Directional Legacy (B_HQNB)</td><td>HQ PHII and NB</td></tr>
<tr><td>Bi-Directional New Transmission 1 (B_HQNB_1T)</td><td>HQ PHII, NB, HG, One New 1,200 MW Tie[3]</td></tr>
<tr><td>Bi-Directional New Transmission 2[2] (B_HQNB_2T)</td><td>HQ PHII,HQ HG, NB, Two New 1,200 MW Ties[3]</td></tr>
<tr><td>Incremental_8000 (I)</td><td rowspan="3">Positive Threshold Prices</td><td>FCA 14, Mystic 8&9, Millstone 2, NE Coal</td><td rowspan="3">2,000 MW Battery[1]</td><td rowspan="3">None</td></tr>
<tr><td>Incremental_8000 with Oil retirements (I_Oil)</td><td>Same as (I) plus all of the oil resources</td></tr>
<tr><td>Incremental_8000 Oil and NG Retirements (I_Oil_NG)</td><td>Same as (I_Oil) plus 50% of the remaining NG units including dual-fuel units</td></tr>
</table>

(1) Other magnitudes of these resources may be considered as sensitivities

*(2) **May** be performed depending on utilization of the scenario where a single 1,200 MW transmission line is added*

(3) New ties added are from Hydro Québec to CMA/NEMA

New England Pipe and Bubble Representation (MW) Assumed Transmission Interfaces 2035



* Surowiec South requested by National Grid to be modeled at 2,500 MW

Total Systemwide Energy Production by Fuel Type (TWh)

For Constrained (C) and Unconstrained (UN) Transmission

Scenario	I_8000		I_8000_Oil		I_8000_Oil_NG		B		B_HQNB		B_HQNB_1T		B_HQNB_2T	
Fuel Type	C	UN	C	UN	C	UN	C	UN	C	UN	C	UN	C	UN
Offshore Wind	24.8	24.1	24.8	24.1	16.4	16.2	31.6	31.6	32.0	32.0	32.1	32.1	32.1	32.1
Onshore Wind	5.8	6.7	5.8	6.7	5.2	5.8	6.7	6.7	7.1	7.1	7.1	7.1	7.2	7.2
NG	18.4	18.1	18.4	18.2	9.8	9.5	18.9	18.7	18.9	18.7	14.3	14.2	11.2	11.0
Oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Imports	28.4	28.4	28.4	28.4	49.2	49.2	20.3	20.6	20.3	20.6	26.0	26.2	30.1	30.4
Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LFG/MSW	3.3	3.3	3.3	3.3	2.8	2.8	3.2	3.2	3.2	3.2	2.9	2.9	2.7	2.7
PV	19.2	19.3	19.2	19.3	17.9	18.0	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2
Wood	4.7	4.7	4.7	4.7	4.7	4.7	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Nuc	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9
EE/DR	45.9	45.9	45.9	45.9	45.9	45.9	45.9	45.9	45.9	45.9	45.9	45.9	45.9	45.9
Hydro	7.1	7.1	7.1	7.1	7.1	7.1	6.8	6.8	6.9	6.9	6.9	6.9	6.9	6.9
TOTAL	**179.6**	**179.7**	**179.6**	**179.6**	**181.0**	**181.1**	**180.1**	**180.2**	**180.9**	**181.0**	**181.9**	**182.0**	**182.6**	**182.7**

Systemwide Spillage by Subtype (TWh)

Transmission	Scenario	Offshore Wind	Onshore Wind	PV	NECEC	HQNT	HQ Imports	NB Imports	Total
Constrained	I_8000	7.249	1.377	1.056	0.000	0.000	0.002	0.001	**9.686**
	I_8000_Oil	7.260	1.377	1.057	0.000	0.000	0.002	0.001	**9.698**
	I_8000_Oil_NG	15.663	1.968	2.381	0.000	0.058	0.012	0.161	**20.244**
	B	0.480	0.454	0.015	1.951	0.000	3.733	2.424	**9.057**
	B_HQNB	0.072	0.108	0.000	1.951	0.000	3.733	2.424	**8.288**
	B_HQNB_1T	0.027	0.047	0.000	1.899	4.155	3.992	2.928	**13.048**
	B_HQNB_2T	0.013	0.023	0.000	1.862	9.637	4.182	3.744	**19.462**
Unconstrained	I_8000	7.945	0.453	0.933	0.000	0.000	0.002	0.001	**9.335**
	I_8000_Oil	8.004	0.458	0.935	0.000	0.000	0.002	0.001	**9.400**
	I_8000_Oil_NG	15.919	1.423	2.293	0.000	0.062	0.013	0.163	**19.874**
	B	0.474	0.445	0.015	1.892	0.000	3.775	2.154	**8.755**
	B_HQNB	0.072	0.101	0.000	1.892	0.000	3.775	2.154	**7.994**
	B_HQNB_1T	0.027	0.044	0.000	1.826	4.145	4.009	2.745	**12.796**
	B_HQNB_2T	0.012	0.023	0.000	1.787	9.579	4.148	3.591	**19.141**

Congestion by Interface ($ Million)

Interface	I_8000	I_8000_Oil	I_8000_Oil_NG	B	B_HQNB	B_HQNB_1T	B_HQNB_2T
ME-NH	32.3	32.3	15.9	27.9	27.8	11.7	5.5
NORTH-SOUTH	9.7	9.7	8.0	9.9	9.8	4.0	2.0
ORR_SOUTH	6.7	6.7	2.0	6.8	6.7	4.3	1.8
EAST-WEST	2.7	2.7	15.1	2.8	2.8	10.0	22.8
SEMA/RI	0.0	0.0	0.2	0.0	0.0	0.0	0.0
SURW_SOUTH	6.2	6.2	1.1	6.1	6.2	4.5	2.7
Other Interfaces	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**57.7**	**57.6**	**42.3**	**53.5**	**53.4**	**34.6**	**34.8**

CO_2 Emissions by State vs 2035 State Goal (Millions of Short Tons)

Transmission	Scenario	CT	MA	ME	NH	RI	VT
Target		**3.994**	**5.490**	**0.569**	**2.549**	**0.010**	**0.367**
Constrained	I_8000	3.310	3.869	0.237	0.196	0.228	0.000
	I_8000_Oil	3.312	3.874	0.233	0.196	0.230	0.000
	I_8000_Oil_NG	1.512	2.084	0.309	0.317	0.116	0.000
	B	3.410	4.096	0.229	0.209	0.241	0.000
	B_HQNB	3.410	4.096	0.229	0.209	0.241	0.000
	B_HQNB_1T	2.603	3.404	0.114	0.089	0.115	0.000
	B_HQNB_2T	1.979	2.855	0.118	0.030	0.097	0.000
Unconstrained	I_8000	3.243	3.821	0.268	0.179	0.223	0.000
	I_8000_Oil	3.252	3.826	0.264	0.177	0.225	0.000
	I_8000_Oil_NG	1.480	1.959	0.370	0.289	0.056	0.000
	B	3.357	4.063	0.268	0.189	0.230	0.000
	B_HQNB	3.357	4.063	0.268	0.189	0.230	0.000
	B_HQNB_1T	2.572	3.375	0.124	0.084	0.112	0.000
	B_HQNB_2T	1.946	2.829	0.116	0.028	0.096	0.000

State goals do no track emissions from all resources, including MSW/landfill gas (LFG) resources

Native New England Resource CO_2 Emissions by Fuel Type (Millions of Short Tons)

Transmission	Scenario	NG	MSW	Wood	Other Emitting Resources
Constrained	I_8000	7.868	4.419	7.644	0.000
	I_8000_Oil	7.875	4.418	7.644	0.000
	I_8000_Oil_NG	4.351	3.599	7.643	0.000
	B	8.209	4.268	7.208	0.000
	B_HQNB	8.209	4.269	7.208	0.000
	B_HQNB_1T	6.341	3.810	7.221	0.000
	B_HQNB_2T	5.083	3.388	7.223	0.000
Unconstrained	I_8000	7.763	4.393	7.644	0.000
	I_8000_Oil	7.772	4.396	7.644	0.000
	I_8000_Oil_NG	4.174	3.614	7.642	0.000
	B	8.128	4.241	7.212	0.000
	B_HQNB	8.128	4.242	7.213	0.000
	B_HQNB_1T	6.282	3.791	7.226	0.000
	B_HQNB_2T	5.026	3.357	7.226	0.000

Load-Serving Entity Energy Expense and Uplift ($ Million)

Transmission	Type	I_8000	I_8000_Oil	I_8000_Oil_NG	B	B_HQNB	B_HQNB_1T	B_HQNB_2T
Constrained	LSE energy expense	4,100	4,098	3,219	2,977	3,060	2,433	1,771
	Uplift	163	163	171	321	305	349	386
	Total	4,262	4,262	3,390	3,298	3,365	2,783	2,157
Unconstrained	LSE energy expense	4,095	4,103	3,242	2,962	3,043	2,417	1,745
	Uplift	161	160	156	323	307	350	387
	Total	4,256	4,264	3,399	3,285	3,350	2,767	2,132

Annual Average LMPs by RSP Subarea ($/MWh)

Transmission	Scenario	BHE	ME	SME	NH	CMA/NEMA
Constrained	I_8000	21.75	22.38	22.70	24.58	25.03
	I_8000_Oil	21.75	22.38	22.70	24.58	25.03
	I_8000_Oil_NG	17.72	17.96	18.02	19.05	19.44
	B	15.18	15.81	16.13	17.76	18.23
	B_HQNB	15.68	16.32	16.64	18.27	18.73
	B_HQNB_1T	13.17	13.58	13.81	14.52	14.72
	B_HQNB_2T	9.74	9.91	10.05	10.39	10.48
Unconstrained	I_8000	24.75	24.75	24.75	24.75	24.75
	I_8000_Oil	24.80	24.80	24.80	24.80	24.80
	I_8000_Oil_NG	19.46	19.60	19.60	19.60	19.60
	B	17.90	17.90	17.90	17.90	17.90
	B_HQNB	18.39	18.39	18.39	18.39	18.39
	B_HQNB_1T	14.61	14.61	14.61	14.61	14.61
	B_HQNB_2T	10.55	10.55	10.55	10.55	10.55

APPENDIX II

Acronyms

Acronyms

ACDR	Active Demand Capacity Resource	EFORd	Equivalent Forced Outage Rate demand
ACP	Alternative Compliance Payments	EIA	U.S. Energy Information Administration
AGC	Automatic Generator Control	EPECS	Electric Power Enterprise Control System
BESS	Battery Energy Storage Systems	FCA	Forward Capacity Auction
BTM PV	Behind the Meter Photovoltaic	FCM	Forward Capacity Market
BOEM	Bureau of Ocean Energy Management	FOM	Fixed Operation and Maintenance Costs
CCP	Capacity Commitment Period	HDR	Hydro Daily, Run of River
CELT	Capacity, Energy, Load, and Transmission Report	HDP	Hydro Daily, Pondage
CSO	Capacity Supply Obligation	HQ	Hydro-Québec
Cstr.	Constrained	HY	Hydro Weekly Cycle
DR	Demand-Response	LFR	Load Following Reserve
EE	Energy Efficiency	LMP	Locational Marginal Price

Acronyms, *continued*

LSE	Load-Serving Entity
MSW	Municipal Solid Waste
NECEC	New England Clean Energy Connect
NESCOE	New England States Committee on Electricity
NG	Natural Gas
NICR	Net Installed Capacity Requirement
NREL	National Renewable Energy Laboratory
OSW	Offshore Wind
O&M	Operation and Maintenance
PHII	Phase II line between Radisson and Sandy Pond
PV	Photovoltaic
RECs	Renewable Energy Credits

RFP	Request for Proposals
RGGI	Regional Greenhouse Gas Initiative
RPS	Renewables Portfolio Standards
SCC	Seasonal Claimed Capability
Uncstr.	Unconstrained