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2015 Economic Study Offshore Wind - Draft Results

Planning Advisory Committee Meeting

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S Y S T E M P L A N N I N G

Outline

- Overview
- Purpose
- Background and Assumptions
- Draft Study Results
- Appendix
  I. Detailed Study Assumptions
    - List of Carbon Heavy Units
    - EIA Fuel Price
    - Offshore Wind Output
  II. Generation by Fuel Type Metrics
  III. Interface Flow Duration Curves
  IV. Air Emission Metrics: NOx and SO_2

Overview

- The ISO is performing three Economic Studies for 2015
  - Keene Road area wind development and analysis of local interface constraints (request by SunEdison)
  - Offshore Wind Deployment (request by Massachusetts Clean Energy Center)
  - Maine Upgrades Identified in ISO-NE's Strategic Transmission Analysis for Wind Integration – Onshore Wind (request by RENEW Northeast)
- Today the ISO is seeking PAC input on the draft **Offshore Wind** study results
  - Review updated assumptions
  - Review of scenarios studied
  - Quantify the economic benefits of the offshore wind addition
  - Quantify the reduction of fossil fuel consumption in New England
- This analysis includes future resources in some scenarios, but does not account for the transmission facilities associated with the interconnection of the resource
- Final study results and report will be completed after consultation with the PAC

Purpose

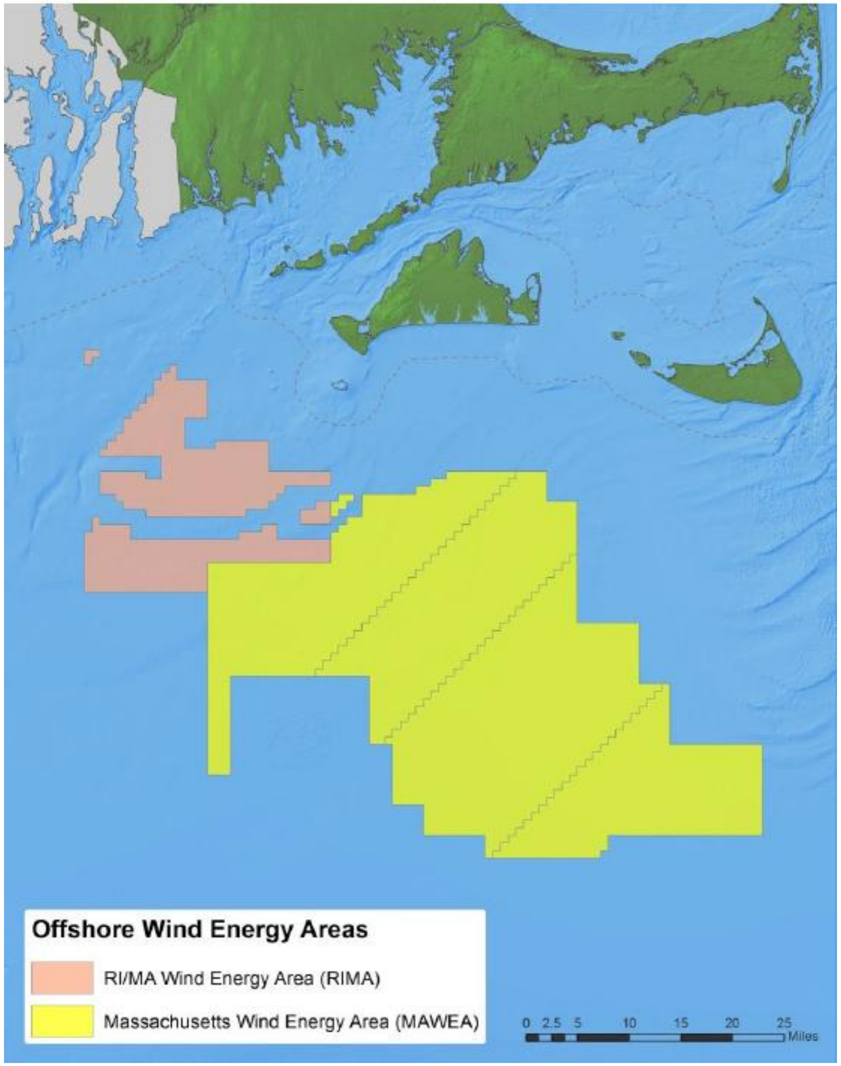
- Discuss the draft results of the offshore wind economic study, including the following economic and environmental metrics under studied scenarios
  - Production Cost Savings
  - Load Serving Entity (LSE) Expense Savings
  - CO_2 Emission Reductions
  - Offshore Wind Revenues
  - Average LMPs
  - Constraints

Background

- The Offshore Wind Scope of Work was presented at PAC in May and June, 2015
  - http://www.iso-ne.com/static-assets/documents/2015/06/a9_2015_economic_studies_off_shore_wind_scope_of_work_revised_draft.pdf
  - http://www.iso-ne.com/static-assets/documents/2015/06/a9_2015_economic_studies_assumptions_scope_of_work_revised_draft.pdf
  - http://www.iso-ne.com/static-assets/documents/2015/06/a9_2015_economic_studies_scope_of_work_stakeholder_comments.pdf
  - http://www.iso-ne.com/static-assets/documents/2015/05/a3_2015_economic_studies_scope_of_work_off_shore_wind.pdf

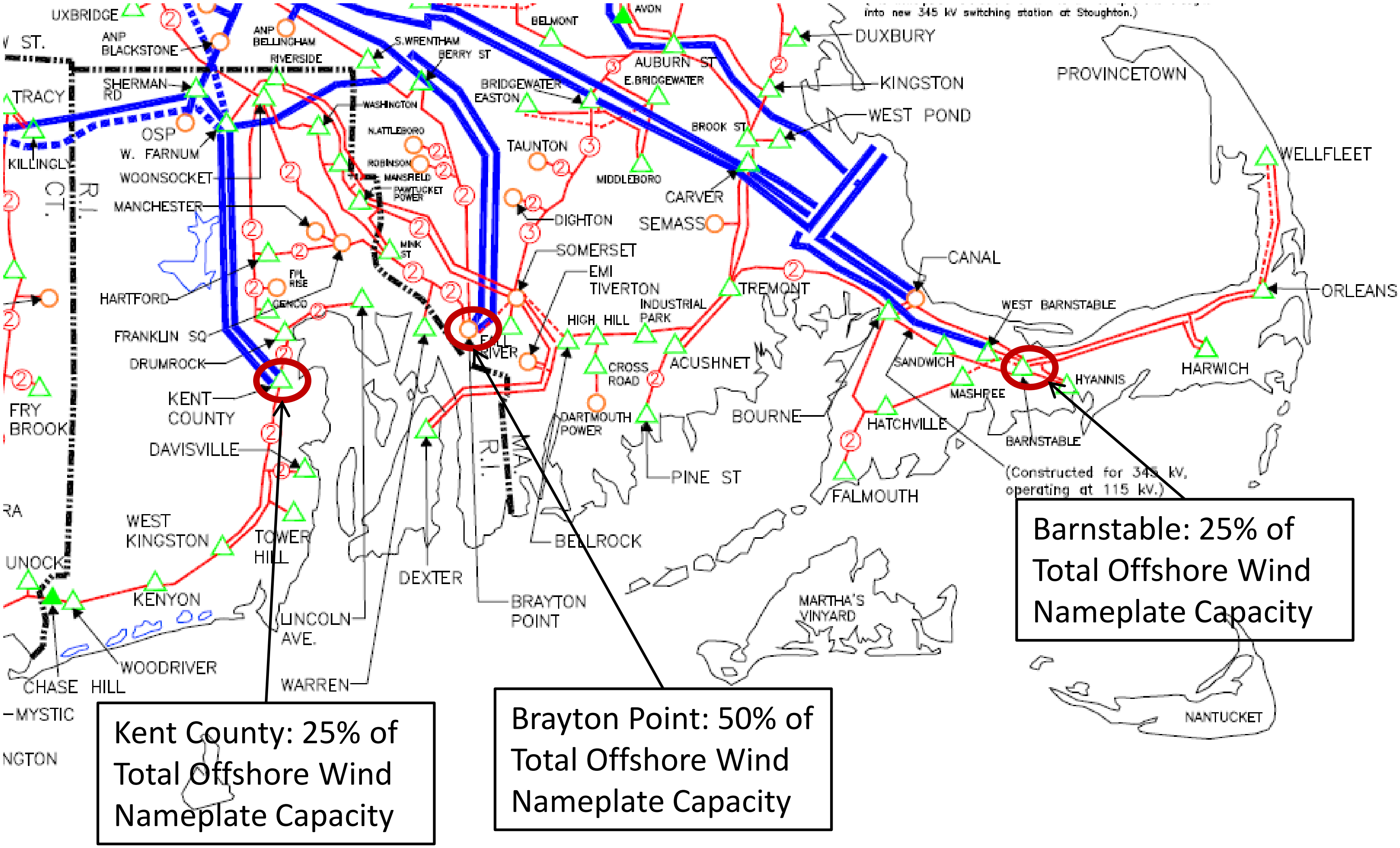
Study Scope – Offshore Wind

- Massachusetts Clean Energy Center requested for a 2015 economic study
  - to evaluate the impact of Offshore Wind Deployment on New England's Wholesale Electric Markets and Operations
- Three levels of offshore wind expansions were studied
  - 0 MW (Reference Case)
  - 1000 MW
  - 2000 MW
- Interconnection points of offshore wind into New England network
  - 25% of total nameplate capacity at Barnstable (capacity factor: 46%)
  - 50% of total nameplate capacity at Brayton Point (capacity factor: 45%)
  - 25% of total nameplate capacity at Kent County (capacity factor: 42%)



Offshore Development Potential Map

Offshore Wind Interconnection Map



Source: the New England Geographic Transmission Map Through 2024 (Revision 12/17/2014)

Updated Study Assumptions – Offshore Wind

- Studied year 2021 instead of 2024
  - Net New England load difference between 2021 and 2024 is 388 MW based on CELT 2015

Load based on CELT 2015	2021	2024
NE Gross Peak Load (MW)	30,900	31,905
Behind-the-Meter PV (MW)	413	451
Passive DR and EE (MW)	3,000	3,579
Net NE Loads (Gross-PV-Passive DR/EE)	27,487	27,875

  - Same system topology (no RSP transmission projects proposed or planned post 2021) Major relevant transmission projects included:
    - NEEWS – Rhode Island Reliability Project
    - NEEWS – Interstate Reliability Project
    - Greater Boston Solutions
    - Pittsfield/Greenfield Solutions
- Contingencies: a set of critical operational contingencies in SEMA and RI is modeled

Study Assumptions – Offshore Wind

- New England System Characteristics
  - Total onshore wind development in New England
    - 878 MW (nameplate) – Existing wind
    - 4,405 MW (nameplate) –Wind in interconnection queue as of 4/1/2015
  - 2021 load, EE and PV forecast based on CELT 2015
  - FCA #9 resources with a Capacity Supply Obligation (CSO) and 2015 CELT resources without a CSO
  - EIA fuel prices and fuel price sensitivities (eg. double NG & Oil prices)
  - NREL wind hourly profiles
  - External interface flows modeled as average interchange of three years (2012-2014) except for the Maritimes modeled as the maximum monthly diurnal seen in 2013 or 2014
  - External interface imports curtailable when LMP below $10/MWh
  - Offshore wind capacity value based on Summer Reliability Hours
    - Offshore wind capacity value in the range of 30% to 37% of its nameplate
    - Used to calculate replacement capacity required in assumed nuclear plants retirement scenarios
- More detailed assumptions are available in the Appendix

Study Scenarios

Scenarios[1]	Natural Gas/Oil Prices	Imports and Exports	Retirements		CO_2 Allowance Costs
			Nuclear	Oil & Coal	
A. Business as Usual	EIA Reference NG/Oil prices	Average 3 years historical interchange values for NY AC ties, CSC, NNC, HG & Phase II; highest monthly diurnal values of 2013 or 2014 for Maritimes. All curtailable if LMP < $10/MWh.	None[2]	None	Base: 20 *$/Short Ton*
B. Most Favorable to Offshore Wind (OSW)	Double NG and Oil prices	Same as above	FCA#9 resources and existing wind: Retire Pilgrim, Seabrook, and Millstone; replace them with simple cycle gas units at specific substations proportionally (keeping total system capacity constant while adding offshore wind).	None	High: 40 *$/Short Ton*
C. Favorable to OSW	EIA High Oil prices				
D. Most Unfavorable to OSW	Half NG and Oil prices	Same as above	None[2]	FCA#9 resources and all renewable in the queue with "active" status as of 4/1/2015: Replace the carbon heavy capacity with natural gas combined cycle capacity.	Low: 10 *$/Short Ton*
E. Unfavorable to OSW	EIA Low Oil prices				

Note 1: scenario names are consistent with original request from Massachusetts Clean Energy Center.
Note 2: Pilgrim not retired consistent with FCA #9. 677 MW of base load nuclear generation could serve as a proxy for higher levels of EE, wind, and imports.

Case Description

Three wind expansion levels and five scenarios resulted in 15 cases

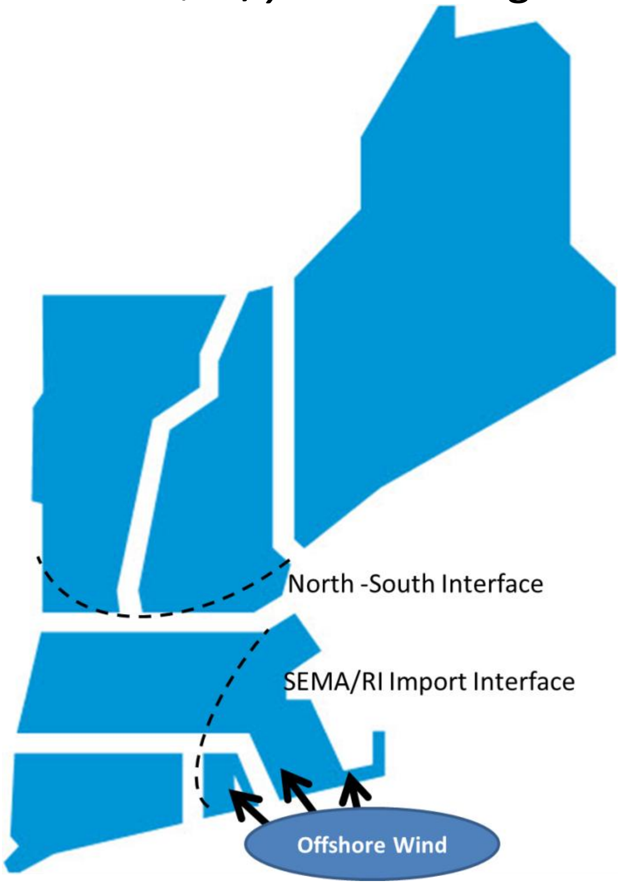
Offshore Wind Expansion Levels Nameplate (MW)	Scenarios	Description	Onshore Wind Nameplate (MW)	New England Total Wind (Offshore + Onshore) Nameplate (MW)
0	A	Business as Usual	878	878
	B	Most Favorable to OSW (Double NG and Oil prices)	878	878
	C	Favorable to OSW (EIA High Oil Price)	878	878
	D	Most Unfavorable to OSW (Half NG and Oil prices)	4405	4405
	E	Unfavorable to OSW (EIA Low Oil Price)	4405	4405
1000	A	Business as Usual	878	1878
	B	Most Favorable to OSW (Double NG and Oil prices)	878	1878
	C	Favorable to OSW (EIA High Oil Price)	878	1878
	D	Most Unfavorable to OSW (Half NG and Oil prices)	4405	5405
	E	Unfavorable to OSW (EIA Low Oil Price)	4405	5405
2000	A	Business as Usual	878	2878
	B	Most Favorable to OSW (Double NG and Oil prices)	878	2878
	C	Favorable to OSW (EIA High Oil Price)	878	2878
	D	Most Unfavorable to OSW (Half NG and Oil prices)	4405	6405
	E	Unfavorable to OSW (EIA Low Oil Price)	4405	6405

DRAFT STUDY RESULTS

Summary of Draft Results

Study Year 2021

- Simulation results of offshore wind expansions with a total nameplate capacity of 1000 MW and 2000 MW show
  - Annual production cost savings range from a low of 104 *$M/year* to a high of 807 *$M/year*
  - LSE expense savings range from a low of 56 *$M/year* to a high of 491 *$M/year*
  - Total annual revenue to offshore wind range from 83 *$M/year* to a high of 732 *$M/year*
  - Reduced air emissions
- Transmission constraints on the major interfaces are less binding with the addition of offshore wind interconnected to the Barnstable, Brayton Point, and Kent County substations
  - Addition of offshore wind reduces total constrained hours seen on the SEMA/RI Import Interface and the North-South Interface



Summary of Draft Results, cont.

Study Year 2021

- Transmission constraints, cont.
  - No constraints seen on the SEMA/RI Export and East-West interfaces
  - A few SEMA/RI area 115 kV constraints were observed under Business as Usual, Most Favorable and Favorable to OSW scenarios
    - Consistent with recent area studies
    - Low congestion cost for the conditions studied (~$1M/year)
    - Not considered further as part of this economic study

New England Production Cost ($M/Year)

Scenarios	Description	Production Cost *($M/Year)*		
		0 MW Offshore Wind	1000 MW Offshore Wind	2000 MW Offshore Wind
A	Business as Usual	3,774	3,577	3,381
B	Most Favorable to OSW	9,678	9,271	8,871
C	Favorable to OSW	6,120	5,854	5,598
D	Most Unfavorable to OSW	1,869	1,765	1,665
E	Unfavorable to OSW	2,906	2,732	2,568

Observation: Higher values of offshore wind (1000 & 2000 MW) reduce the systemwide annual production cost. Total annual production cost results showed the same order of magnitude for the offshore wind expansion cases simulated under the same fuel price and resources mix assumptions. Assuming different fuel prices and resource mixes showed significant changes in the magnitude of the systemwide annual production cost.

New England Production Cost Savings (*$M/Year*)

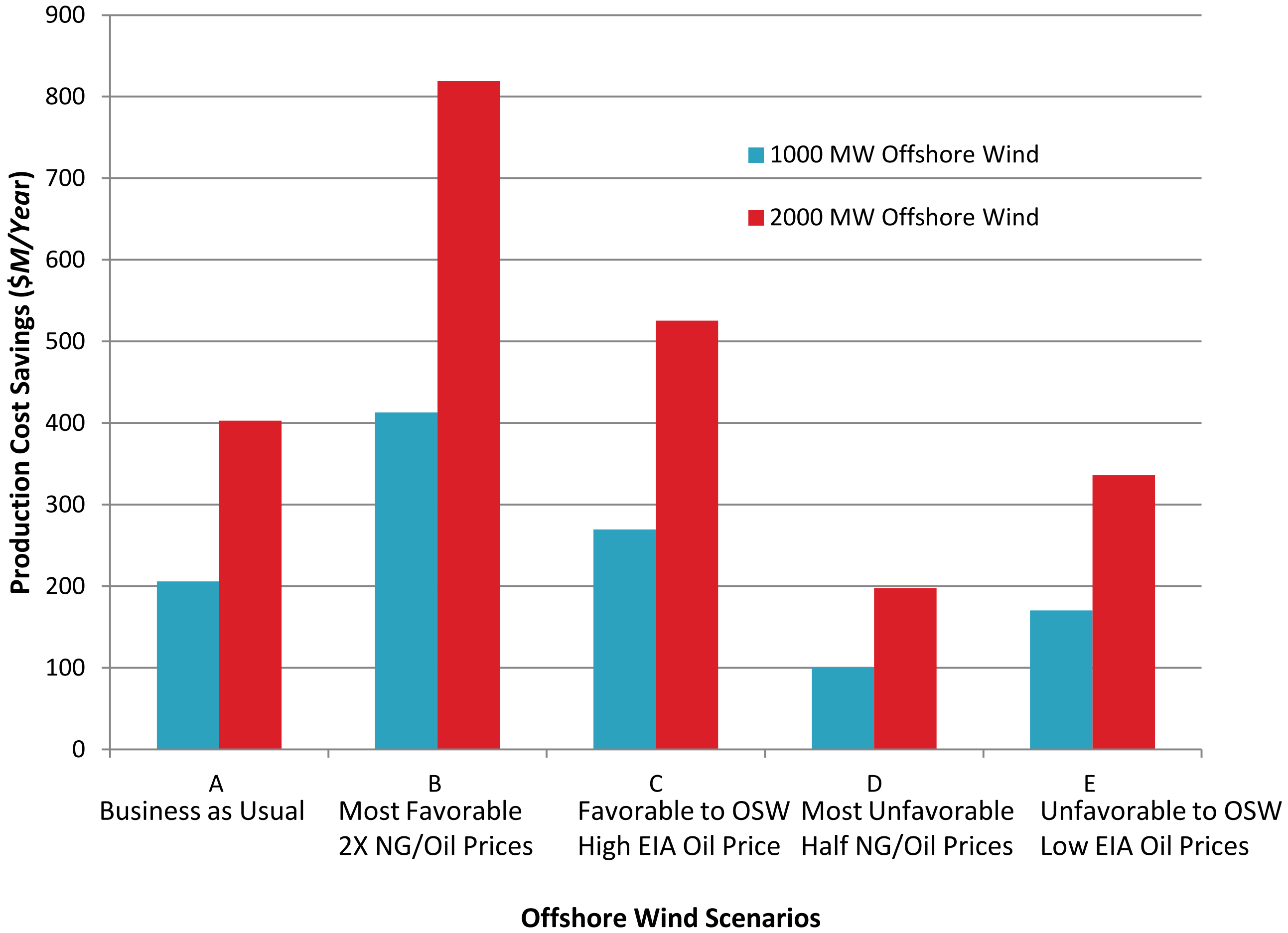
Scenarios	Description	Production Cost Savings *($M/Year)*		
		0 MW Offshore Wind	1000 MW Offshore Wind	2000 MW Offshore Wind
A	Business as Usual	Reference	196	392
B	Most Favorable to OSW	Reference	407	807
C	Favorable to OSW	Reference	266	522
D	Most Unfavorable to OSW	Reference	104	205
E	Unfavorable to OSW	Reference	174	339

Note: numbers may not exactly match due to rounding.

Observation: Production cost savings resulted from offshore wind additions nearly doubled when offshore wind capacity increased from 1000 MW to 2000 MW. Under the Most Favorable to OSW scenario, total production cost savings could be as high as $407 *M/Year* for the 1000 MW expansion case and $807 *M/Year* for the 2000 MW expansion case.

New England Production Cost Savings (*$M/Year*)

Compared to the 0 MW Offshore Wind Cases



New England Load Serving Entity (LSE) Energy Expense (*$M/Year*)

Scenarios	Description	LSE Energy Expense *($M/Year)*		
		0 MW Offshore Wind	1000 MW Offshore Wind	2000 MW Offshore Wind
A	Business as Usual	6,788	6,626	6,440
B	Most Favorable for OSW	14,872	14,630	14,380
C	Favorable for OSW	10,254	10,044	9,843
D	Most Unfavorable for OSW	3,302	3,246	3,174
E	Unfavorable for OSW	5,406	5,284	5,133

Observation: Under the Business as Usual scenario, LSE energy expenses range from $6,440 *M/Year* to $6,788 *M/Year*.

New England LSE Energy Expense Savings (*$M/Year*)

Scenarios	Description	LSE Energy Expense Savings (*$M/Year*)		
		0 MW Offshore Wind	1000 MW Offshore Wind	2000 MW Offshore Wind
A	Business as Usual	Reference	163	348
B	Most Favorable to OSW	Reference	241	491
C	Favorable to OSW	Reference	210	412
D	Most Unfavorable to OSW	Reference	56	128
E	Unfavorable to OSW	Reference	123	273

Note: numbers may not exactly match due to rounding.

Observation: LSE energy expense savings almost doubled when offshore wind capacity increased from 1000 MW to 2000 MW.

New England Annual Average LMP by Load (*$/MWh*)

Scenarios	Description	Average LMP *($/MWh)*		
		0 MW Offshore Wind	1000 MW Offshore Wind	2000 MW Offshore Wind
A	Business as Usual	46.00	44.90	43.64
B	Most Favorable to OSW	100.77	99.14	97.44
C	Favorable to OSW	69.48	68.06	66.69
D	Most Unfavorable to OSW	22.38	22.00	21.51
E	Unfavorable to OSW	36.63	35.80	34.78

Observation: Addition of offshore wind decreases the New England annual average LMP under the studied scenarios.

Total Energy Revenue to Offshore Wind (*$M/Year*)

Scenarios	Description	Total Revenue to Offshore Wind *($M/Year)*		
		0 MW Offshore Wind	1000 MW Offshore Wind	2000 MW Offshore Wind
A	Business as Usual	NA	168	320
B	Most Favorable to OSW	NA	376	732
C	Favorable to OSW	NA	255	495
D	Most Unfavorable to OSW	NA	83	160
E	Unfavorable to OSW	NA	134	253

Observation: Total revenue to offshore wind ranges from $83 M/Year under the Most Unfavorable to OSW scenario to $732 M/Year under the Most Favorable to OSW scenario.

Systemwide CO_2 Emission (kton)

Scenarios	Description	CO2 Amount *(kton)*		
		0 MW Offshore Wind	1000 MW Offshore Wind	2000 MW Offshore Wind
A	Business as Usual	31,880	29,929	28,013
B	Most Favorable to OSW	52,251	50,141	48,069
C	Favorable to OSW	43,295	41,163	39,065
D	Most Unfavorable to OSW	27,595	26,077	24,561
E	Unfavorable to OSW	27,434	25,795	24,234

Note: numbers may not exactly match due to rounding.

Observation: Higher values of offshore wind (1000 & 2000 MW) reduce the systemwide annual CO_2 Emission amount. Assuming different fuel prices and resource mixes showed significant changes in the magnitude of the systemwide annual CO_2 Emission amount.

Systemwide Reductions of CO_2 (kton)

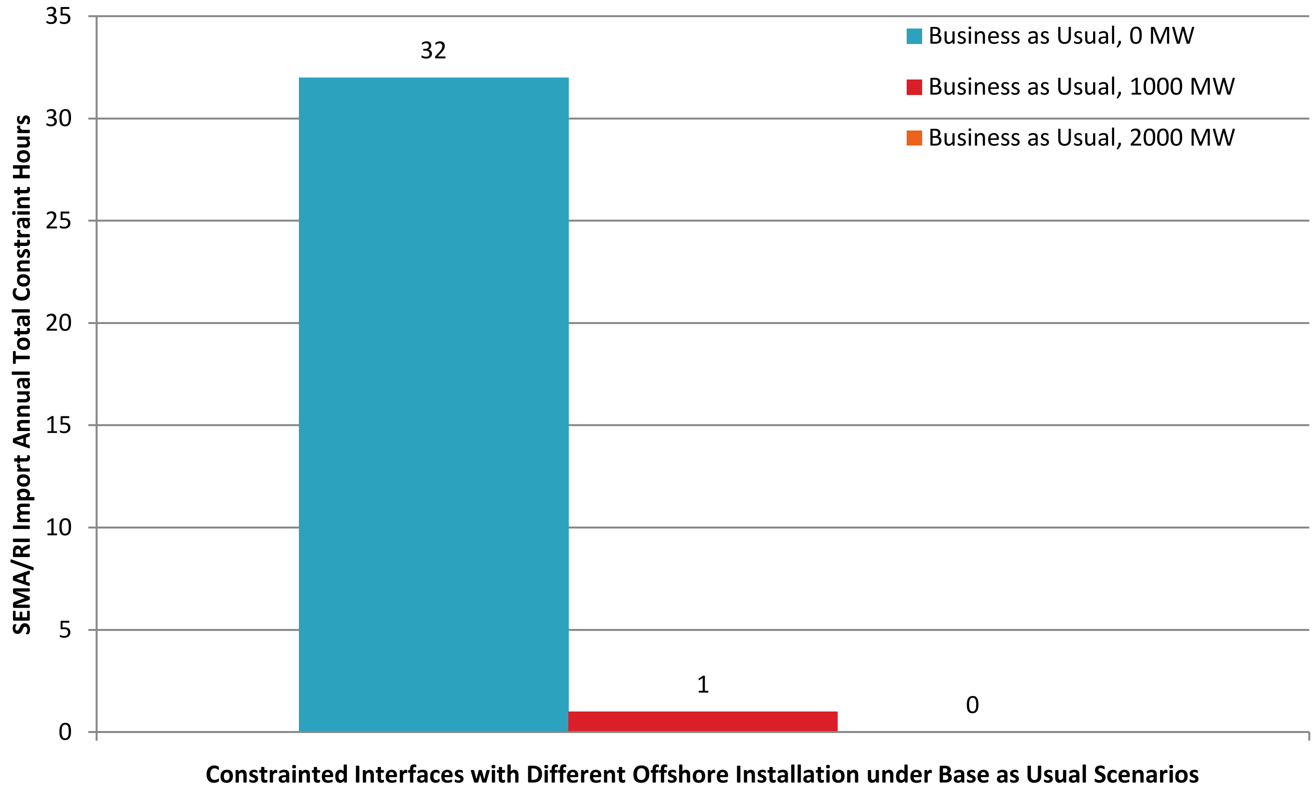
Scenarios	Description	CO2 Reduction *(kton)*		
		0 MW Offshore Wind	1000 MW Offshore Wind	2000 MW Offshore Wind
A	Business as Usual	Reference	1,951	3,867
B	Most Favorable to OSW	Reference	2,110	4,182
C	Favorable to OSW	Reference	2,132	4,230
D	Most Unfavorable to OSW	Reference	1,518	3,034
E	Unfavorable to OSW	Reference	1,639	3,200

Note: numbers may not exactly match due to rounding.

Observation: Reductions in CO_2 emissions range from 1,518 ktons to 4,230 ktons. The two favorable to OSW scenarios (B & C) result in the most CO_2 reductions. Scenario C results in a slightly higher CO_2 reduction than Scenario B, which has higher production from coal units.

SEMA/RI Import Interface Constrained Hours

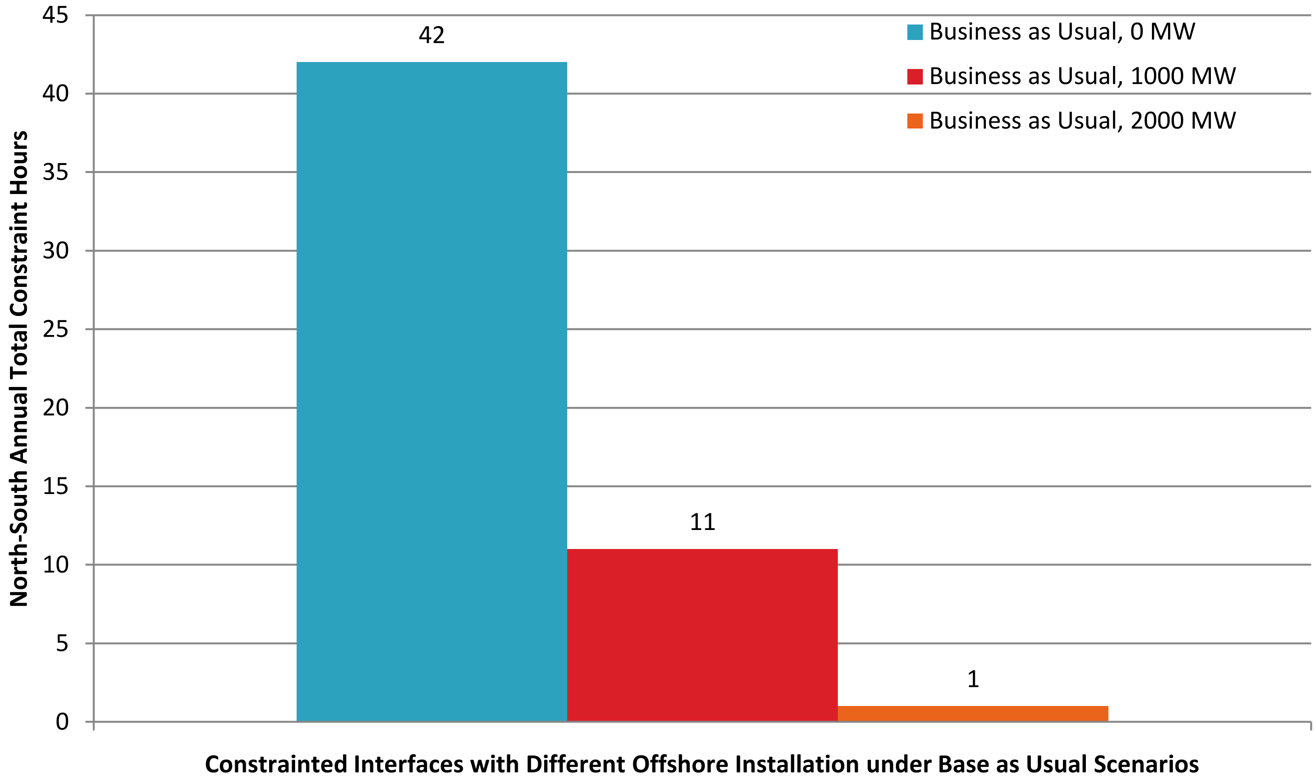
SEMA/RI Import Limit: 1280 MW



Observation: The SEMA/RI Import Interface constrained 32 hours per year under Business as Usual and 0 MW expansion scenario. Addition of 1000 MW offshore wind almost eliminated the constraint (1 hour per year) under the Business as Usual scenario.

North-South Interface Constrained Hours

North-South Interface Limit: 2675 MW



Observation: Offshore wind at $0/MWh added to southern New England results in reduced total constrained hours on the North-South Interface. With the addition of 2000 MW offshore wind, the constraint is almost eliminated (<5 hours per year) under the Business as Usual scenario.

2015 Economic Study – Offshore Wind: Next Steps

- Review and address stakeholder comments on the draft Offshore Wind Study results
- Develop report summarizing the Offshore Wind Study and post the draft report for PAC review

Questions

APPENDIX I

Detailed Study Assumptions

- *List of Carbon Heavy Units*
- *2021 EIA Fuel Prices*
- *Offshore Wind Output*
- *Offshore Wind Capacity Factor*

Appendix I-1: List of High Carbon Emitting Units

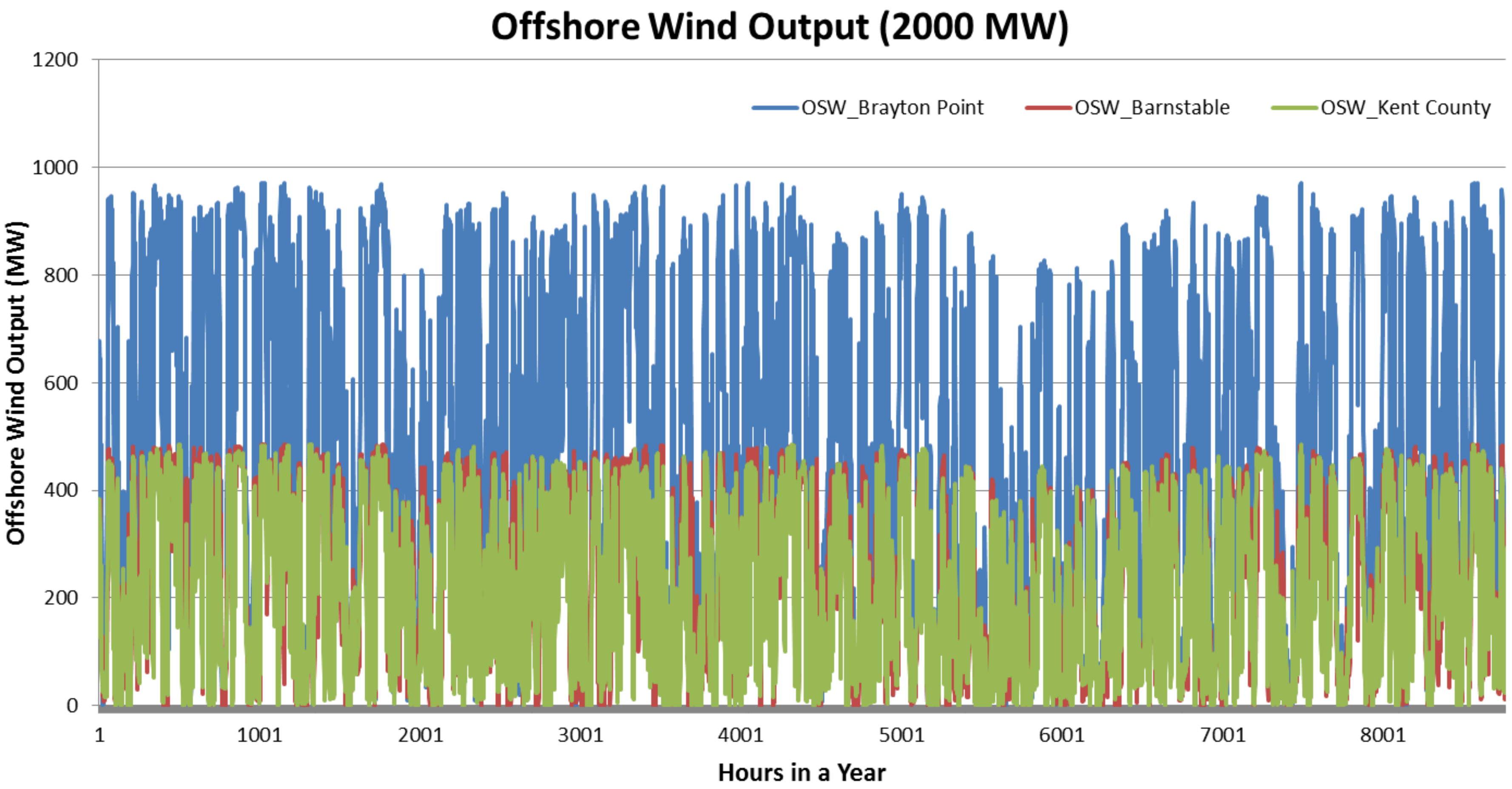
Name	Asset ID	RSP Subarea	Fuel Type	FCA#9 Summer Qualified Capacity (MW)
Bridgeport Harbor 3	340	SWCT	Subbituminous Coal	383.4
Canal 1	365	SEMA	Residual Fuel Oil (RFO)	547.1
Canal 2	366	SEMA	RFO	545.1
Merrimack 1	489	NH	Anthracite Coal and Bituminous Coal (BIT)	112.5
Merrimack 2	490	NH	BIT	334.2
Middletown 2	480	CT	RFO	117.0
Middletown 3	481	CT	RFO	236.0
Middletown 4	482	CT	RFO	400.0
Montville 5	493	CT	RFO	81.0
Montville 6	494	CT	RFO	406.2
Mystic 7	502	BOSTON	Natural Gas	575.5
New Haven Harbor 1	513	CT	RFO	447.9
Newington 1	508	NH	RFO	400.2
Schiller 4	556	NH	BIT	47.5
Schiller 6	558	NH	BIT	47.9
West Springfield 3	633	WMA	Natural Gas	94.3
Yarmouth 1	639	SME	RFO	0
Yarmouth 2	640	SME	RFO	51.1
Yarmouth 3	641	SME	RFO	115.1
Yarmouth 4	642	SME	RFO	603.2

Appendix I-2: EIA Fuel Price

Sector and Source	2021		
	Reference	High Oil price	Low Oil price
Electric Power			
Distillate Fuel Oil ($/MMBtu)	18.80	32.19	14.63
Residual Fuel Oil ($/MMBtu)	9.27	19.73	6.01
Natural Gas ($/MMBtu)	5.46	5.61	5.16

Note: the fuel price above is based on the EIA Annual Energy Outlook 2015.

Appendix I-3: Offshore Wind Output



Appendix I-4: Offshore Wind Capacity Factor

Offshore Wind Sites	Capacity Factor
OSW_Barnstable	46%
OSW_Brayton Point	45%
OSW_Kent County	42%

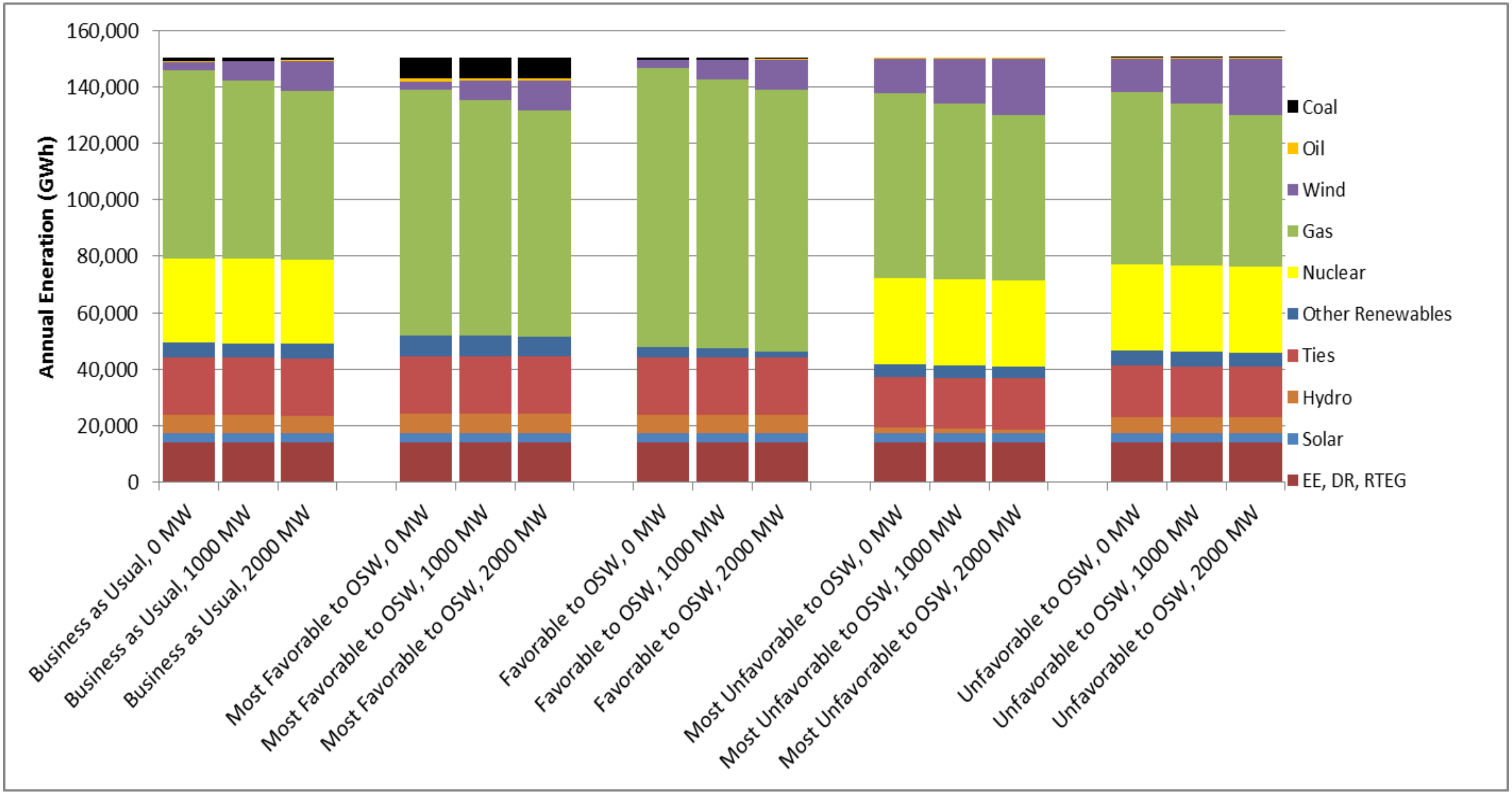
Note: Wind – onshore has an estimated capacity factor of 32% and Wind – offshore has an estimated capacity factor of 41% based on New England aggregated 2011-2014 capacity factors of system resources and 2007 NEWIS study.

Observation: The SEMA/RI offshore wind sites have capacity factors in the same order of magnitude as that of wind – offshore (41%) in New England's Estimated Energy from New Renewable Energy Projects, only slightly higher.

APPENDIX II

Generation by Fuel Type Metrics

Appendix II-1: Annual Generation by Fuel Type



Appendix II-2: Annual Generation by Wind

Scenarios	Description	Wind Type	Annual Generation by Wind *(GWh)*		
			0 MW Offshore Wind	1000 MW Offshore Wind	2000 MW Offshore Wind
A	Business as Usual	Offshore	NA	3,892	7,785
		Onshore	2,733	2,733	2,733
B	Most Favorable to OSW	Offshore	NA	3,892	7,785
		Onshore	2,733	2,733	2,733
C	Favorable to OSW	Offshore	NA	3,892	7,785
		Onshore	2,733	2,733	2,733
D	Most Unfavorable to OSW	Offshore	NA	3,892	7,785
		Onshore	12,099	12,094	12,097
E	Unfavorable to OSW	Offshore	NA	3,892	7,785
		Onshore	12,053	12,078	12,078

Appendix II-3: Annual Generation by Resource Type (GWh)

Description	Resource Type									
	Other Renewables	EE, DR, RTEG	Nuclear	Hydro	Solar	Ties	Gas	Wind	Oil	Coal
Business as Usual, 0 MW	5,198	14,238	29,754	6,545	2,990	20,388	66,901	2,733	336	1,138
Business as Usual, 1000 MW	5,094	14,238	29,754	6,479	2,990	20,385	63,385	6,626	314	956
Business as Usual, 2000 MW	4,971	14,238	29,754	6,340	2,990	20,363	60,009	10,518	276	755
Most Favorable to OSW, 0 MW	7,132	14,238	0	7,120	2,990	20,383	87,152	2,733	1,160	7,314
Most Favorable to OSW, 1000 MW	7,006	14,238	0	7,117	2,990	20,383	83,640	6,626	996	7,225
Most Favorable to OSW, 2000 MW	6,875	14,238	0	7,109	2,990	20,383	80,124	10,518	891	7,086
Favorable to OSW, 0 MW	3,458	14,238	0	6,612	2,990	20,389	98,906	2,733	333	562
Favorable to OSW, 1000 MW	3,267	14,238	0	6,584	2,990	20,389	95,273	6,626	311	541
Favorable to OSW, 2000 MW	2,094	14,238	0	6,456	2,990	20,391	92,729	10,518	291	506
Most Unfavorable to OSW, 0 MW	4,548	14,238	30,431	1,988	2,989	18,000	65,665	12,099	238	0
Most Unfavorable to OSW, 1000 MW	4,512	14,238	30,431	1,746	2,989	17,965	62,084	15,987	228	0
Most Unfavorable to OSW, 2000 MW	4,438	14,238	30,431	1,485	2,989	17,917	58,572	19,882	215	0
Unfavorable to OSW, 0 MW	5,344	14,238	30,431	5,960	2,989	17,983	60,988	12,053	211	0
Unfavorable to OSW, 1000 MW	5,245	14,238	30,431	5,800	2,989	17,996	57,307	15,971	204	0
Unfavorable to OSW, 2000 MW	5,129	14,238	30,431	5,567	2,989	17,964	53,791	19,863	197	0

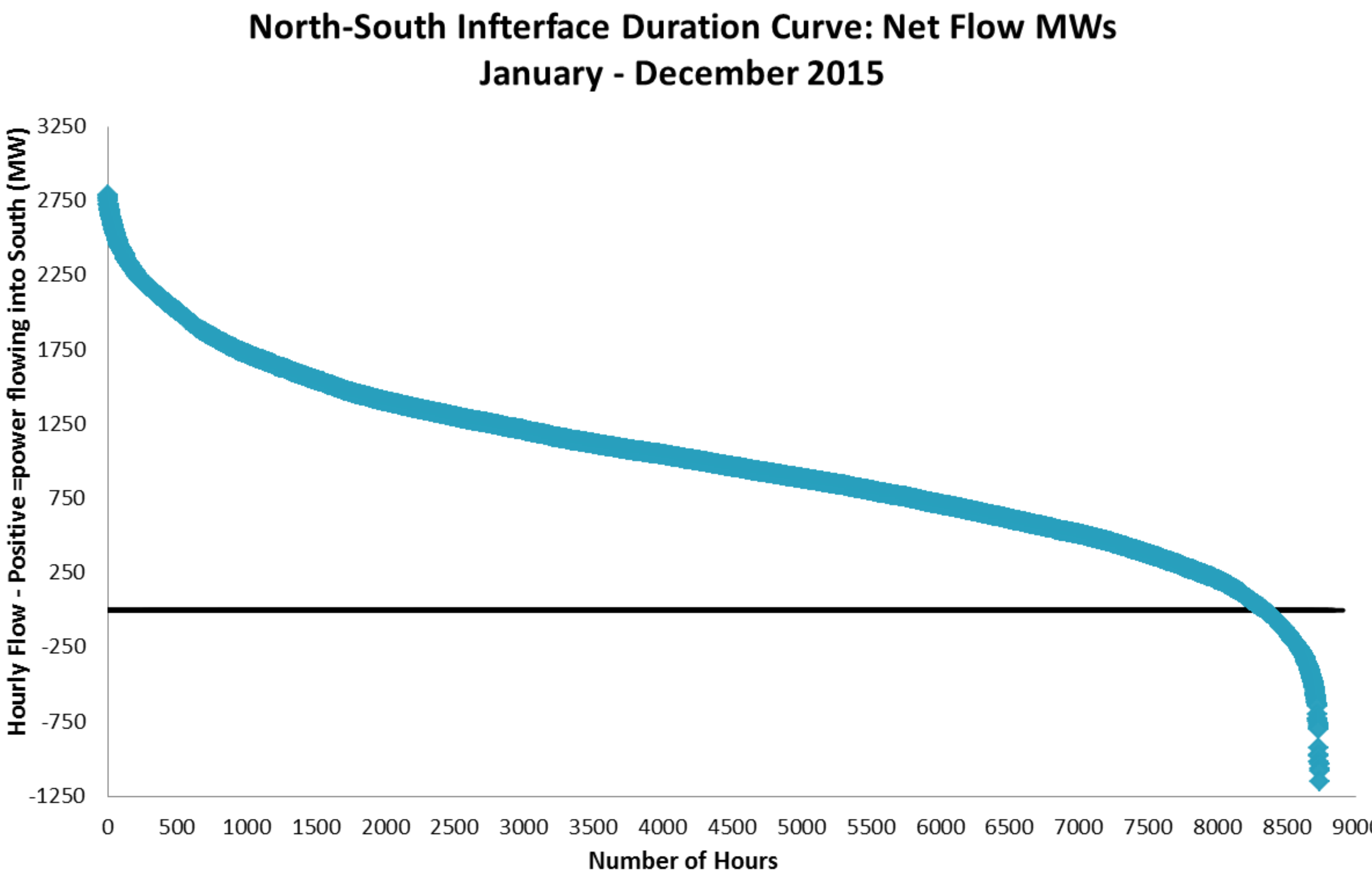
APPENDIX III

Interface Flow Metrics

- *Historical*
- *Draft Study Results*

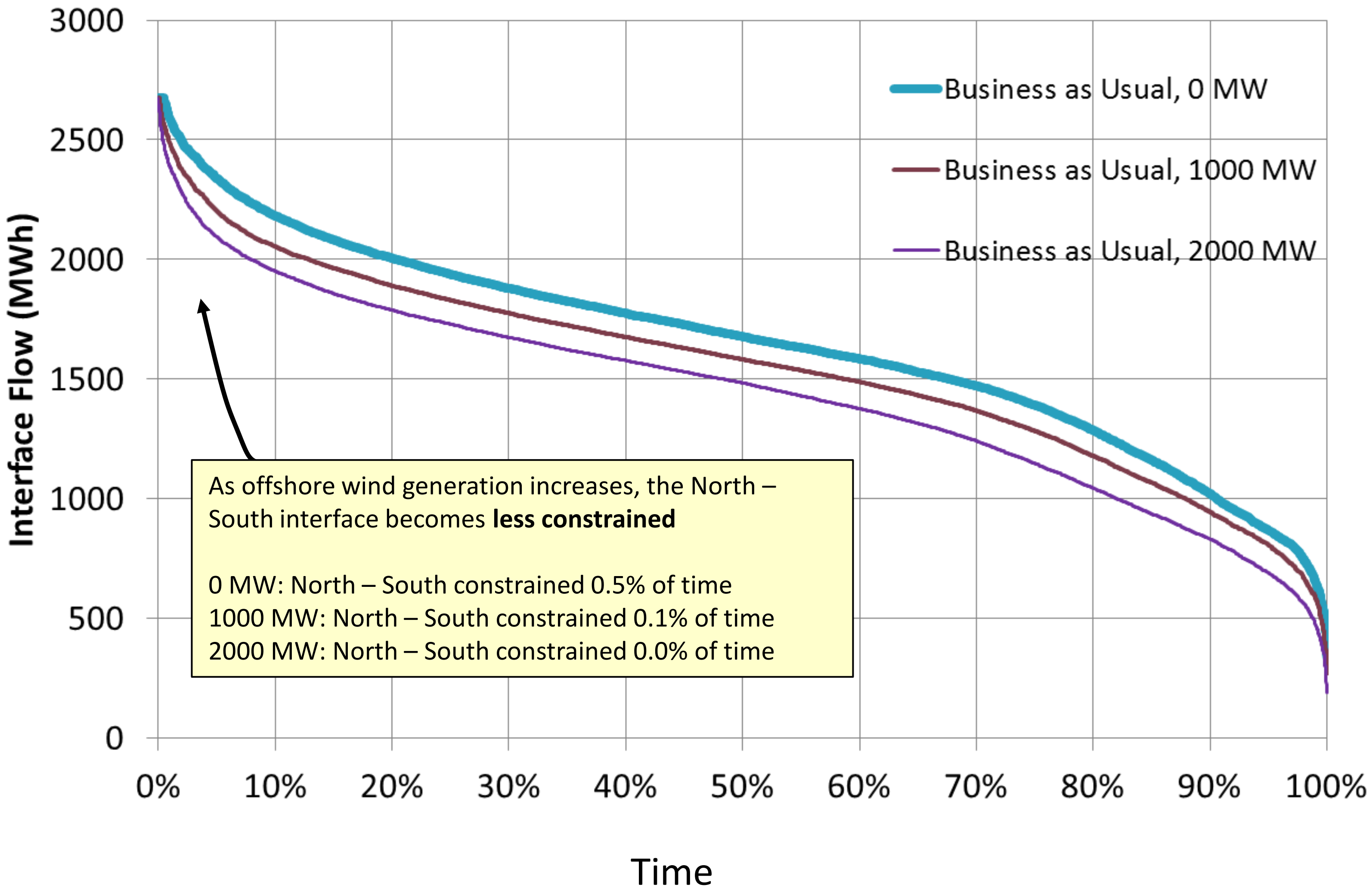
2015 Historical Interface Flow (MW)

North – South Interface Limit: 2,100 MW in 2015



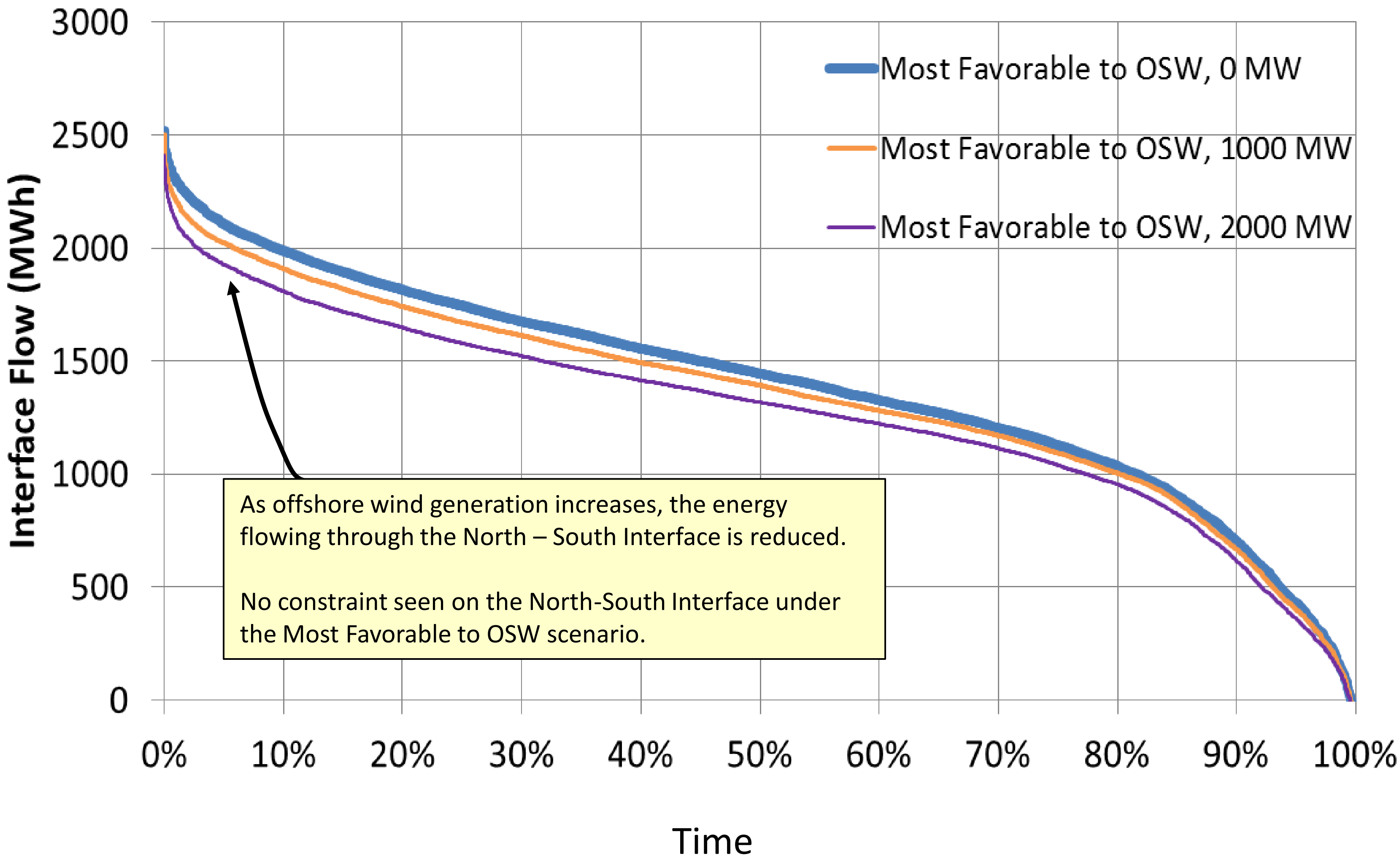
Interface: North – South, Business as Usual

Duration Curve (North-South limit: 2675 MW)



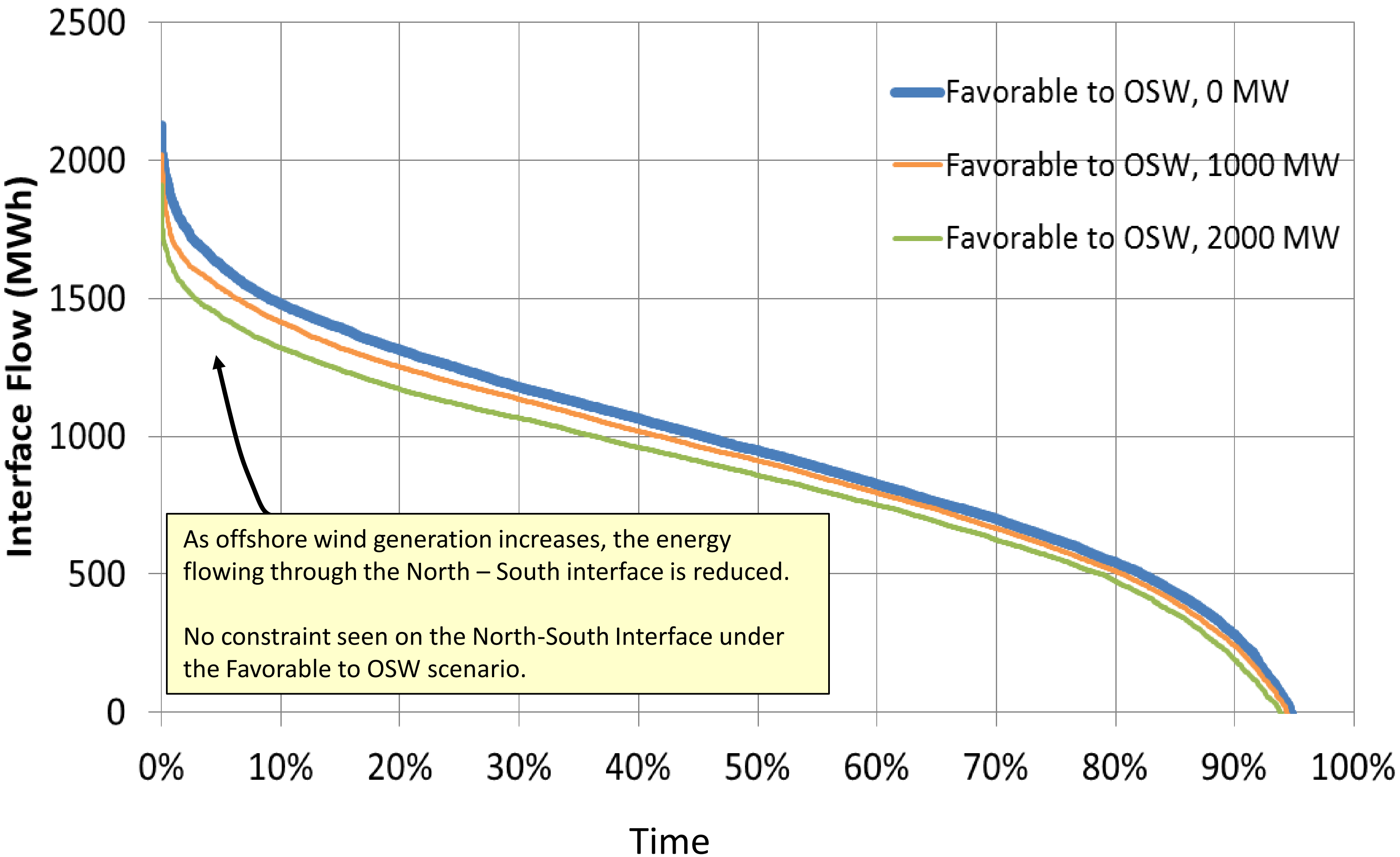
Interface: North – South, Most Favorable to OSW

Duration Curve (North-South limit: 2675 MW)



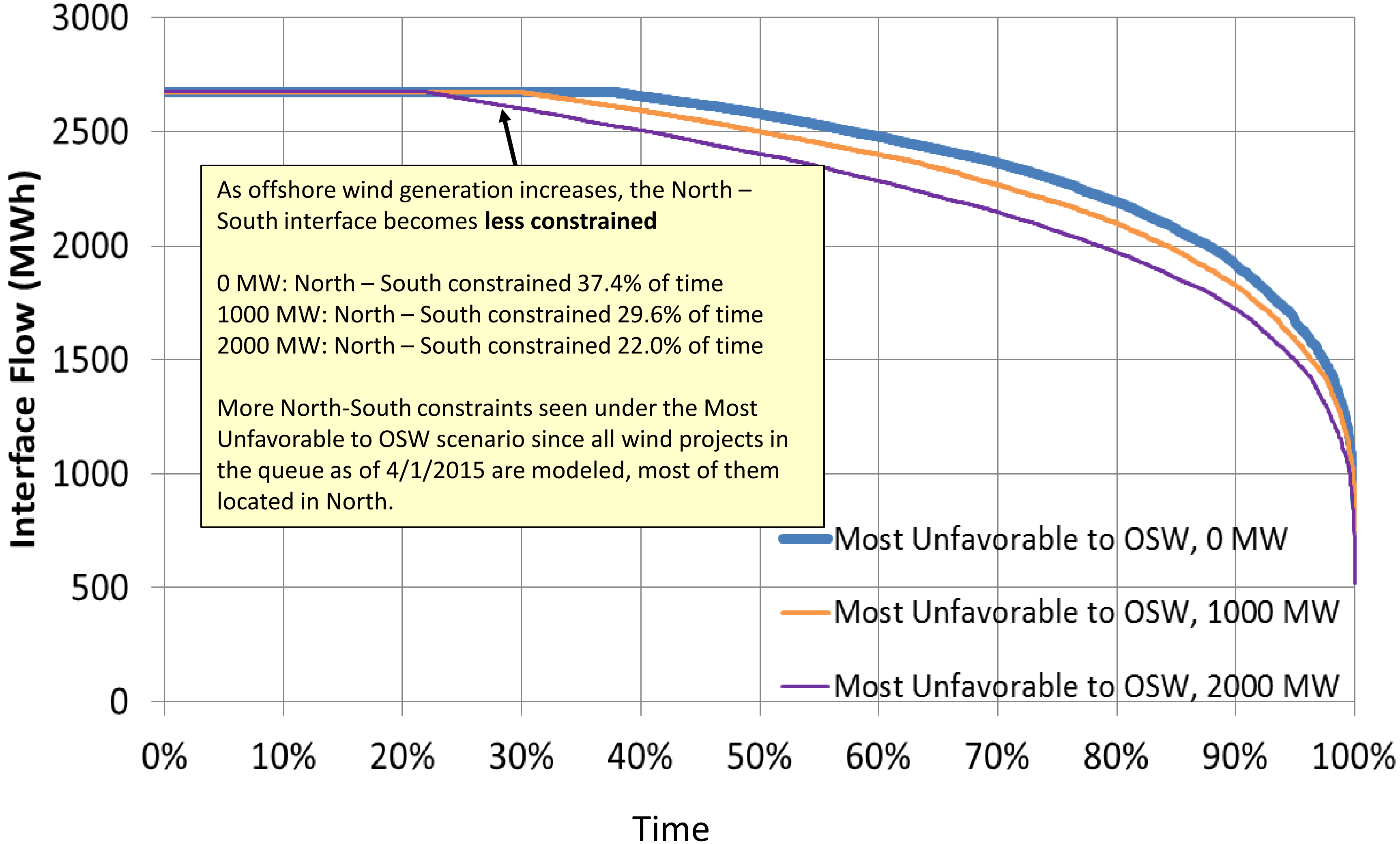
Interface: North – South, Favorable to OSW

Duration Curve (North-South limit: 2675 MW)



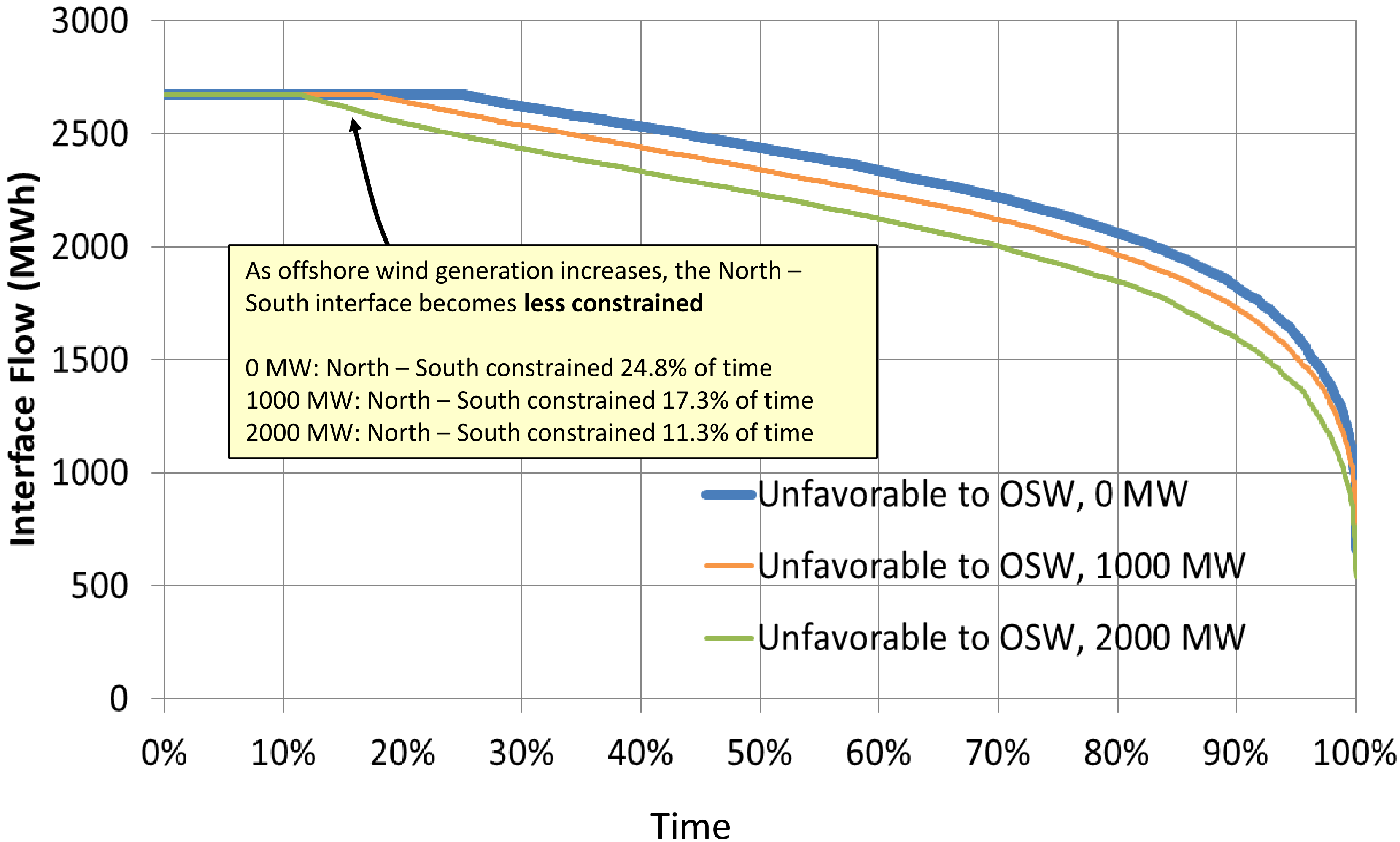
Interface: North – South, Most Unfavorable to OSW

Duration Curve (North-South limit: 2675 MW)



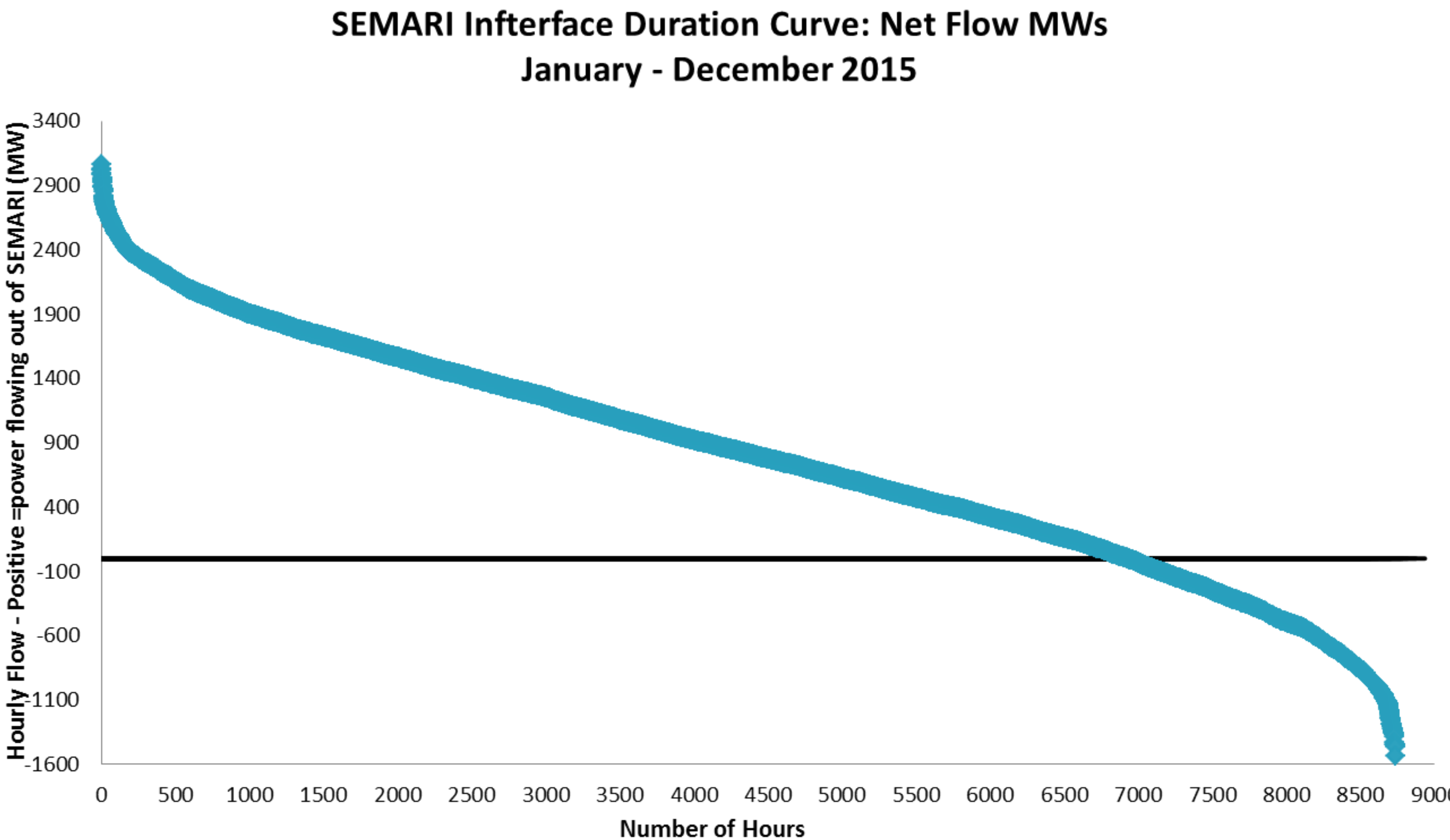
Interface: North – South, Unfavorable to OSW

Duration Curve (North-South limit: 2675 MW)



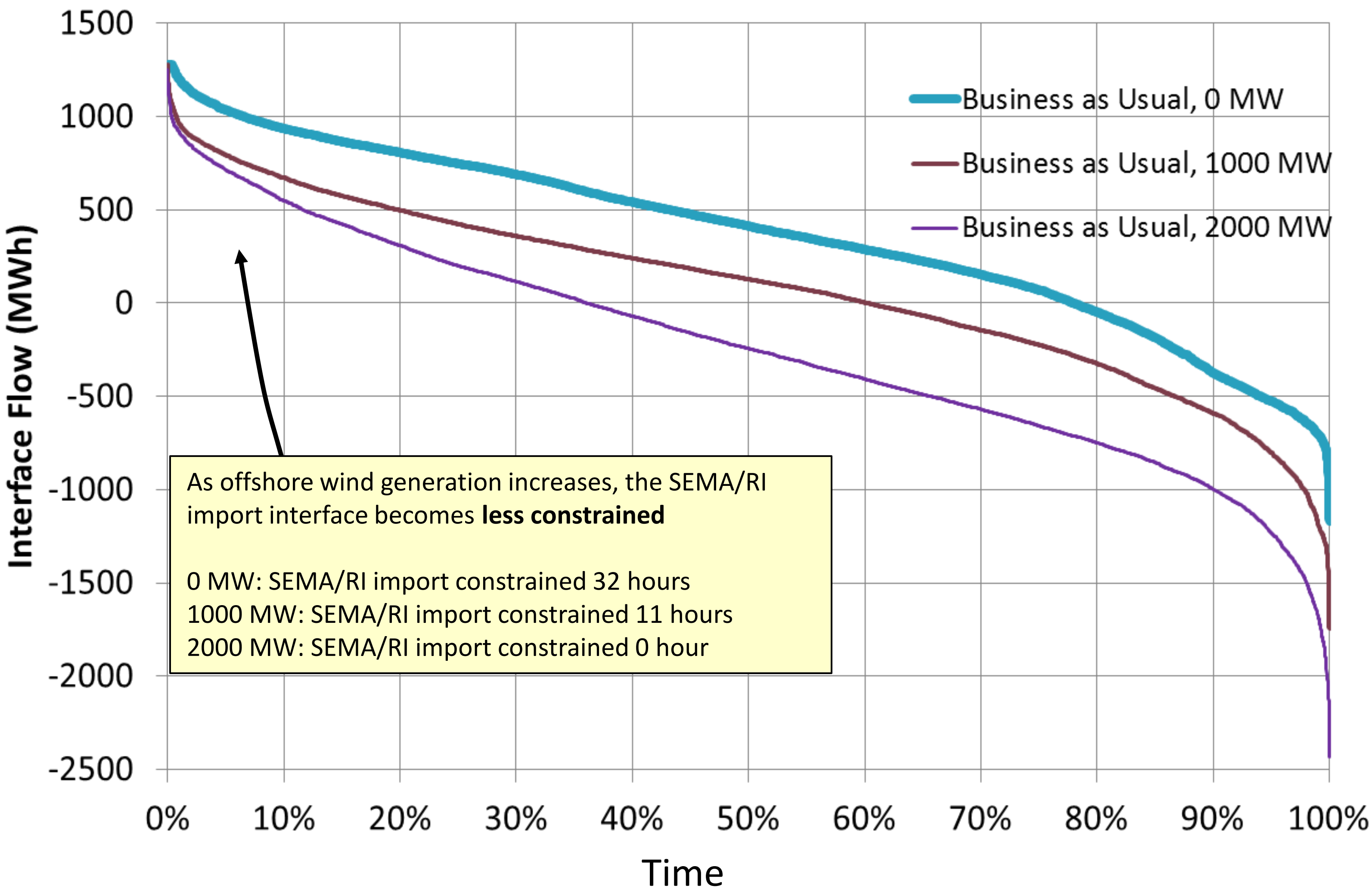
2015 Historical Interface Flow (MW)

SEMA/RI (Negative – power flowing into SEMA/RI)



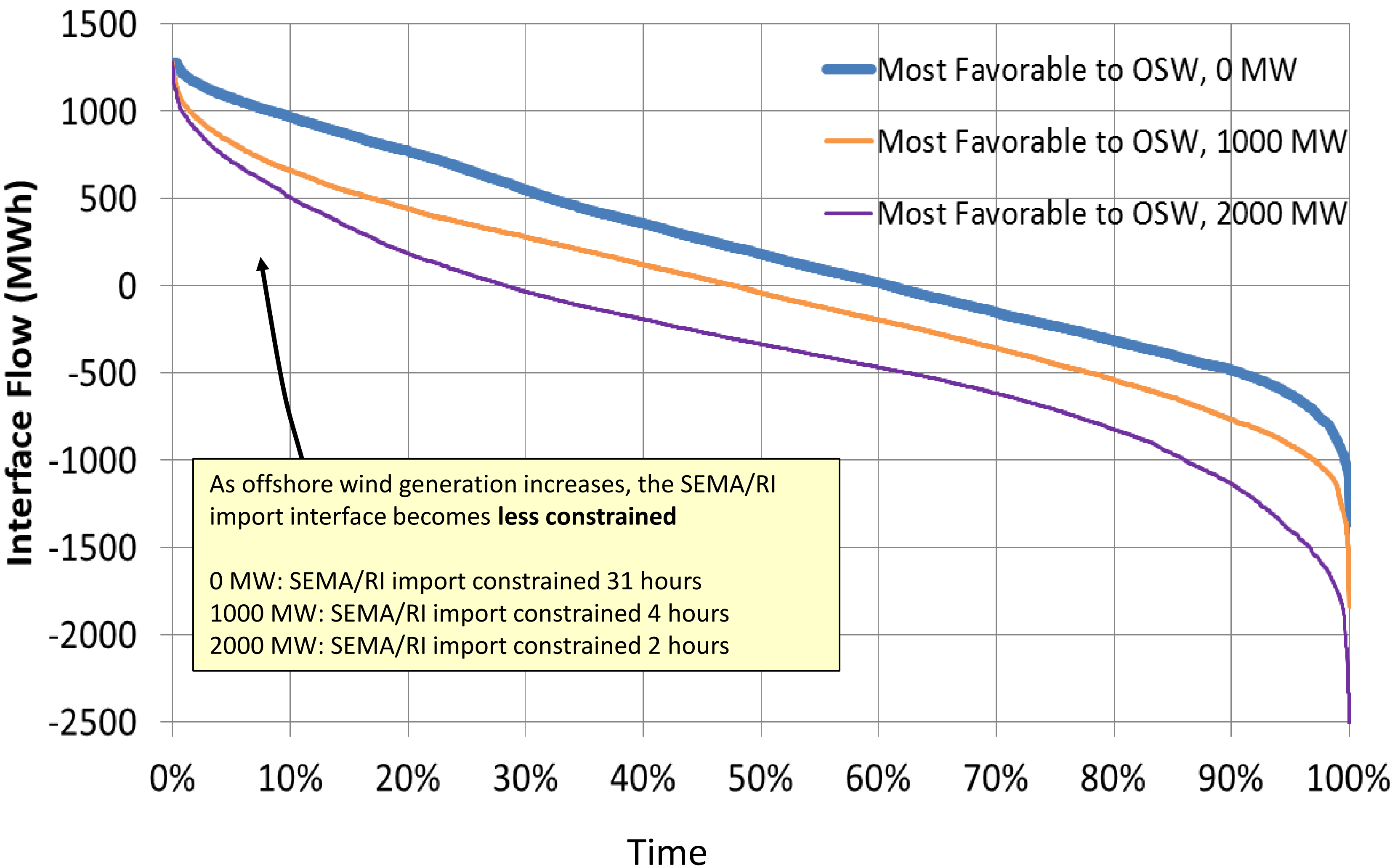
Interface: SEMA/RI Import, Business as Usual

Duration Curve (SEMA/RI import limit: 1280 MW)



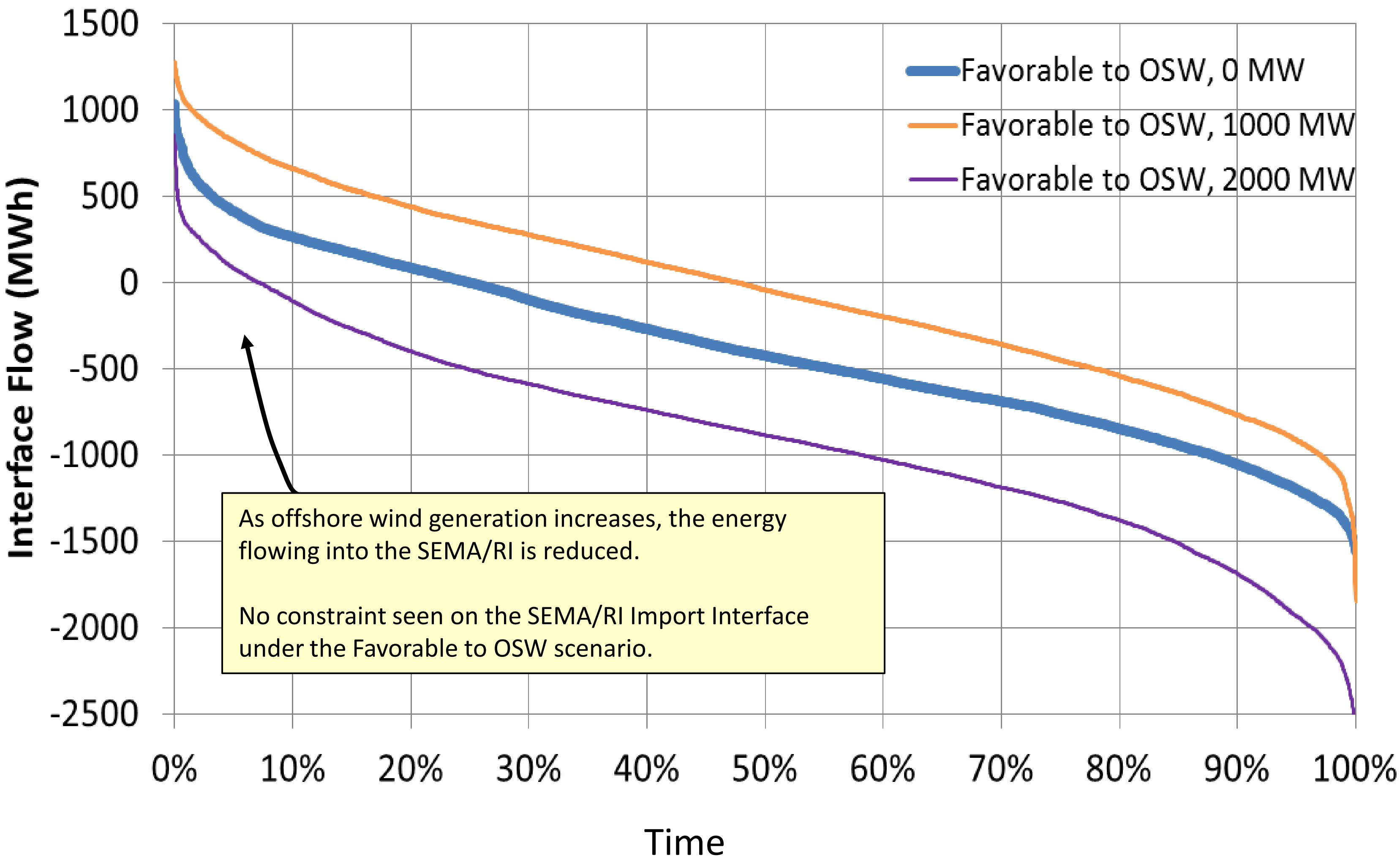
Interface: SEMA/RI Import, Most Favorable to OSW

Duration Curve



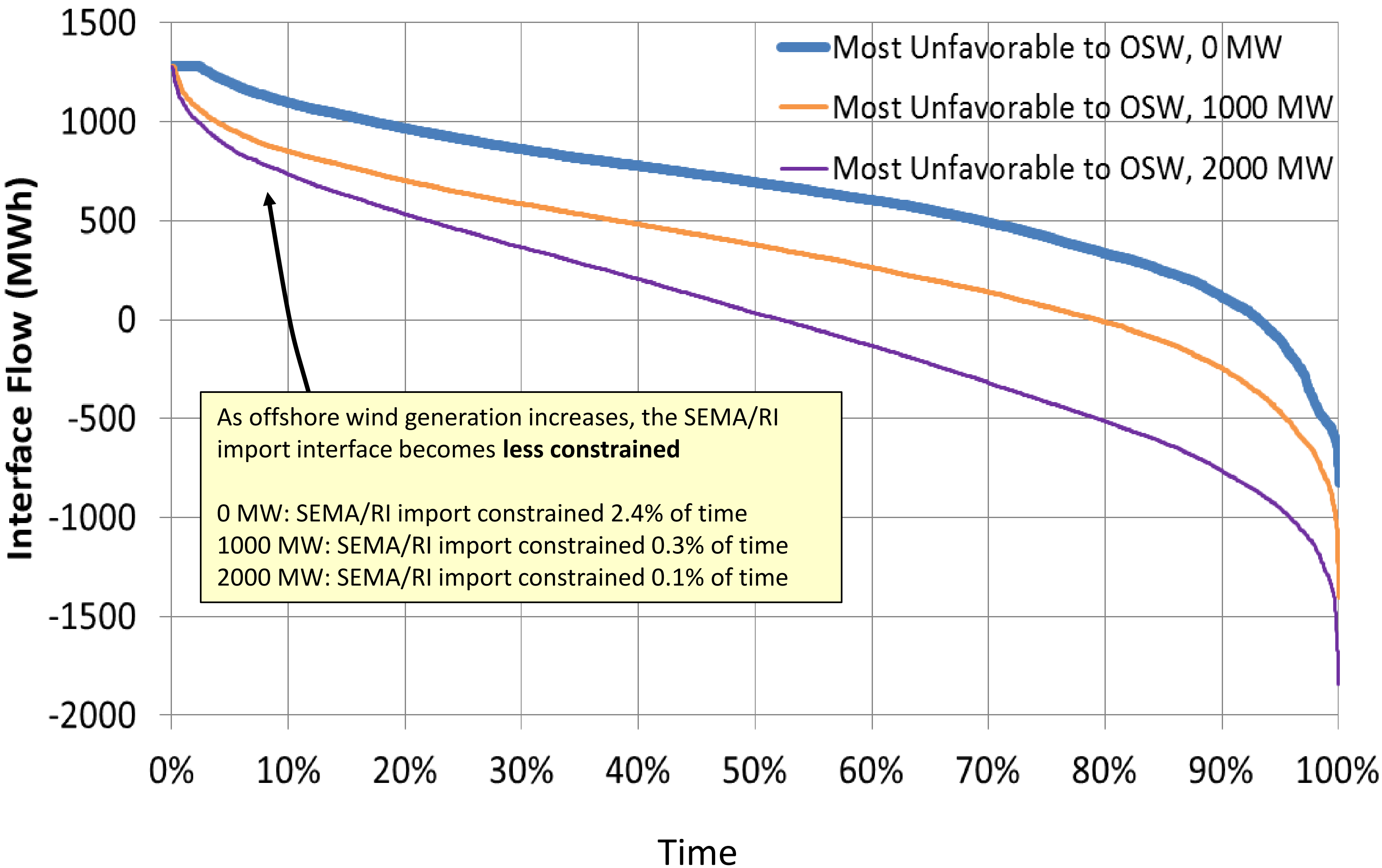
Interface: SEMA/RI Import, Favorable to OSW

Duration Curve



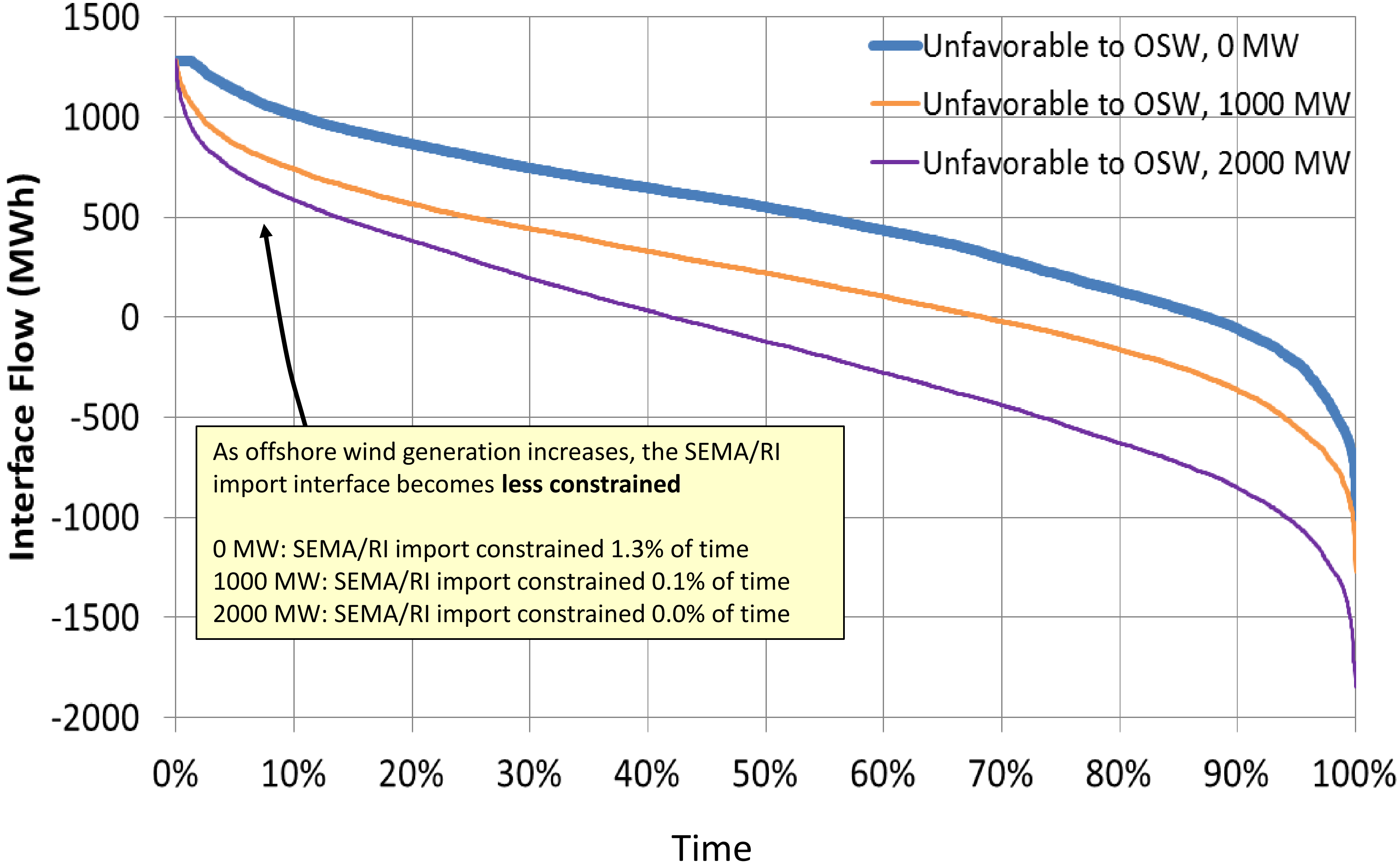
Interface: SEMA/RI Import, Most Unfavorable to OSW

Duration Curve



Interface: SEMA/RI Import, Unfavorable to OSW

Duration Curve



APPENDIX IV

Air Emission Metrics

- *NOx*
- *SO_2*

Systemwide NOx Emission (Short Ton)

Scenarios	Description	NO_x Amount *(Short Ton)*		
		0 MW Offshore Wind	1000 MW Offshore Wind	2000 MW Offshore Wind
A	Business as Usual	9095	8440	7784
B	Most Favorable to OSW	21752	20885	20103
C	Favorable to OSW	9274	8735	8188
D	Most Unfavorable to OSW	6267	6013	5722
E	Unfavorable to OSW	7240	6861	6499

Observation: Higher values of offshore wind (1000 & 2000MW) reduce the systemwide annual NOx Emission amount.

Systemwide Reductions of NOx (Short Ton)

Case Group	Case Description	NO_x Reduction *(Short Ton)*		
		0 MW Offshore Wind	1000 MW Offshore Wind	2000 MW Offshore Wind
A	Business as Usual	Reference	655	1,311
B	Most Favorable to OSW	Reference	866	1,648
C	Favorable to OSW	Reference	539	1,085
D	Most Unfavorable to OSW	Reference	254	545
E	Unfavorable to OSW	Reference	379	740

Note: numbers may not exactly match due to rounding.

Observation: Change in NOx emission ranges from a 4.1% reduction under the Most Unfavorable to OSW scenario to a 7.6% reduction under the Most Favorable to OSW scenario.

Systemwide SO_2 Emission (Short Ton)

Scenarios	Description	SO_2 Amount *(Short Ton)*		
		0 MW Offshore Wind	1000 MW Offshore Wind	2000 MW Offshore Wind
A	Business as Usual	3,165	2,750	2,366
B	Most Favorable to OSW	15,057	14,327	13,672
C	Favorable to OSW	2,435	2,292	2,163
D	Most Unfavorable to OSW	1,203	1,156	1,104
E	Unfavorable to OSW	1,413	1,356	1,299

Observation: Higher values of offshore wind (1000 & 2000MW) reduce the systemwide annual SO_2 Emission amount. Under the Most Favorable to OSW scenario, the total SO_2 Emission amount is biggest because coal plants (heavy SO_2 producers) being economic and in service more frequently with the assumption of double natural gas and oil prices.

Systemwide Reductions of SO_2 (Short Ton)

Case Group	Case Description	SO_2 Reduction *(Short Ton)*		
		0 MW Offshore Wind	1000 MW Offshore Wind	2000 MW Offshore Wind
A	Business as Usual	Reference	415	799
B	Most Favorable to OSW	Reference	730	1,385
C	Favorable to OSW	Reference	143	272
D	Most Unfavorable to OSW	Reference	47	99
E	Unfavorable to OSW	Reference	57	114

Note: numbers may not exactly match due to rounding.

Observation: Change in SO_2 emission ranges from a 3.9% reduction under the Most Unfavorable to OSW scenario to a 9.2% reduction under the Most Favorable to OSW scenario.