

Economic Studies Working Group (ESWG) Maine Power Connector Economic Analyses

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Overview of MPC Preliminary Analysis

- Following slides provide preliminary calculations of the potential economic benefits of Maine Power Connection (“MPC”)
- Analysis is being performed pursuant to request by Maine Public Service (“MPS”) and assumes the integration of MPS into New England Control Area, including existing and future wind resources, and the addition of MPS as Participating Transmission Owner (“PTO”)

Overview cont'd...

- Information provided in this presentation is for the purpose of soliciting input from stakeholders on appropriateness of study parameters and modeling assumptions
- Inputs, assumptions and results are **draft-only** and will be updated based on:
 - Stakeholder feedback
 - New information as scope of MPC is further defined and study proceeds

Overview cont'd...

- ISO-NE has taken no position on MPC
 - Studying as requested
 - Scope of line and benefits are still under review
- Transmission planning engineers from MPS, CMP and the ISO continue to develop detailed design plan for MPC
 - Economic study assumptions will change as details become better defined
- Assessment of whether MPC would meet criteria for a Market Efficiency Transmission Upgrade conditional on:
 - Having a well-defined project scope
 - Knowing the effects on the transmission network
 - Determining the costs of building MPC

Overview cont'd...

- Assessment limited to Attachment N criteria for Market Efficiency Transmission Upgrades and does not include evaluation of MPC as Regional Benefit Upgrade for cost recovery

Objectives of the ESWG Analysis

- Simulate the production of the New England generation system over the 10-year planning period (2009-2018)
- Produce annual system estimates of key metrics
 - Total production costs
 - Total Load Serving Entity (LSE) costs
- Quantify economic impact of transmission congestion
- Simulate for cases with reference assumptions and several key sensitivities
 - Fuel prices
 - Transmission expansion
 - RGGI CO₂ allowance prices

Outline of Presentation

- Review of assumptions
 - Many have been discussed previously at PAC, Power Supply Planning Committee (PSPC) Environmental Advisory Group (EAG) and ESWG
 - Demand and Installed Capacity Requirement (ICR)
 - Resource additions
 - Environmental
 - Fuel prices
 - Modeling wind and demand resources (DR)
 - Dispatch costs
- Cases simulated
- Results
 - Production cost
 - Load Serving Entity (LSE) Energy Expense

Assumptions – Demand & ICR

- Load forecast: ISO's 2008 10-year annual forecast
- ICR based on RSP08 indicative values
 - Expansion will be based on Representative ICR without Hydro Quebec Interconnection Capability Credits (HQICC)
 - Capacity modeled includes firm capacity imports and exports

Year	Annual Peak	ICR	HQICC	ICR w/o HQICC	Capacity Export	Needed Capacity	Modeled Capacity	Surplus / (Shortage)
2009/10	28,480	32,813	1,200	31,613	100	31,713	33,735	2,022
2010/11	28,955	33,277	1,400	31,877	100	31,977	33,735	1,758
2011/12	29,405	33,856	1,400	32,456	100	32,556	33,735	1,179
2012/13	29,820	34,390	1,400	32,990	100	33,090	33,735	646
2013/14	30,190	34,879	1,400	33,479	100	33,579	33,735	156
2014/15	30,510	35,280	1,400	33,880	100	33,980	34,018	38
2015/16	30,790	35,638	1,400	34,238	100	34,338	34,529	191
2016/17	31,035	35,951	1,400	34,551	100	34,651	34,978	327
2017/18	31,250	36,231	1,400	34,831	100	34,931	34,978	48
2018/19	31,466	36,512	1,400	35,112	100	35,212	35,691	479

Note: 2018/19 requirements were extrapolated from previous year's growth rate

Assumptions – New Resources

- New England resources were added based on
 - Forward Capacity Market (FCM) buying only enough capacity to meet Representative ICR
 - CELT April 2008
 - Existing resources
 - Forward Capacity Auction #1 (FCA1) cleared resources
 - Queue resources also added based on
 - Adding those with I.3.9 approval
 - According to “Proposed Commercial operation date”
 - Added as needed to satisfy ICR requirements
 - Adding those without I.3.9 approval only if needed to satisfy Representative ICR
 - According to “Proposed Commercial Operation Date”
 - Added as needed to satisfy ICR requirements

Assumptions – Resource Additions

- Resources added as required for reliability
 - Wind total capacity reflects nameplate ratings
 - Wind Capacity Derate reflects 20 percent capacity value

Fuel Type	2010	2011	2012	2013	2014	2015	2016	2017	2018
Coal	2,651	0	0	0	0	0	0	0	0
Residual	6,132	0	0	0	0	0	0	0	0
Distillate	1,313	0	0	0	34	18	0	0	0
Renewable	999	0	0	0	0	92	0	0	0
Gas	12,184	0	0	0	205	401	449	0	620
Nuclear	4,665	0	0	0	0	0	0	0	0
Water	3,011	0	0	0	0	0	0	0	0
Wind (Nameplate)	96	0	0	0	220	0	0	0	462
Purchases	482	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0
DSM	2,279	0	0	0	0	0	0	0	0
Total	33,812	0	0	0	459	511	449	0	1,082
Wind Capacity Derate	-77	0	0	0	-176	0	0	0	-370
Total After Wind Derate	33,735	33,735	33,735	33,735	34,018	34,529	34,978	34,978	35,691

Maine Public Service (MPS) Assumptions

- Load in 2011
 - Summer peak 126 MW
 - Winter Peak 141 MW
 - Annual Energy 799 MW
 - Hourly load profile is congruent with the RSP model for BHE loads
- Existing Resources
 - Distillate 12 MW
 - Hydro 36 MW
 - Wind 42 MW
 - Biomass 87 MW
- Future Resources
 - 800 MW of wind generation

Maritimes Resource Additions

- A limited model has been implemented for the Maritimes
 - Approximately equal to existing capacity plus wind resources
 - Wind resources use same profile as wind resources in Maine
 - About 900 MW by 2012
 - No energy interchange between Quebec and Maritimes
- No internal transmission constraints included
- Resource based on latest NPCC Triennial Review
 - Accepted by NPCC in Spring 2008

Transmission Assumptions

- Transmission modeled using transportation limits
 - Based on N-1 limits with all facilities in service
 - Transmission enhancements for reliability included
 - Southwestern Connecticut Phase II project (2010)
 - New England East West Solution, NEEWS (2013)
 - Interface limits for unit commitment (N-1-1) not included
 - Effect of unit commitment on economics and emissions not modeled

Transmission Interface Assumptions

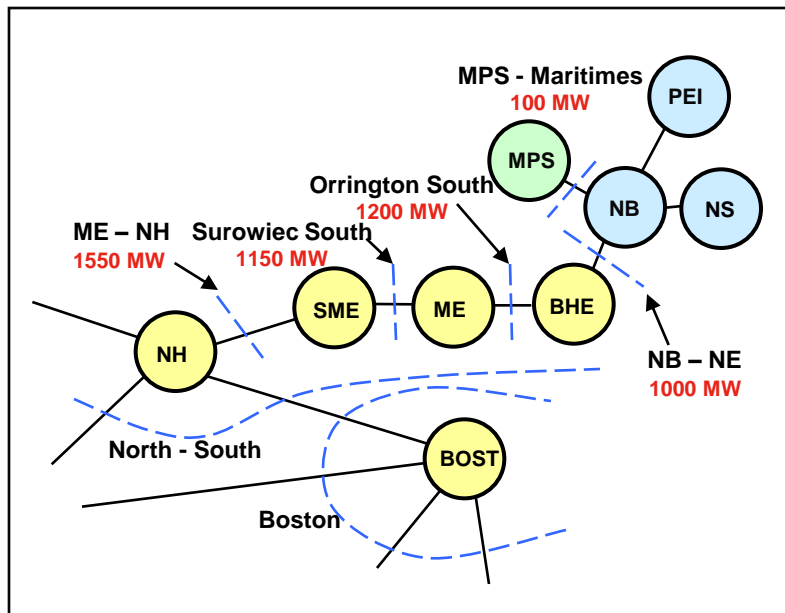
Single-value summer peak transmission interface limits for use in subarea transportation models

Interface	2009	2010	2011	2012	2013	2014	2015	2016	2017
New Brunswick-New England	1000	1000	1000	1000	1000	1000	1000	1000	1000
Orrington South Export	1200	1200	1200	1200	1200	1200	1200	1200	1200
Surowiec South	1150	1150	1150	1150	1150	1150	1150	1150	1150
Maine-New Hampshire	1600	1600	1575	1550	1525	1500	1475	1450	1450
MPRP - Orrington South Export	1200	1200	1200	1200	1700	1700	1700	1700	1700
MPRP - Surowiec South	1150	1150	1150	1150	1650	1650	1650	1650	1650
MPRP - Maine-New Hampshire	1600	1600	1575	1550	2450	2450	2450	2450	2450
North-South	2700	2700	2700	2700	2700	2700	2700	2700	2700
Boston Import	4900	4900	4900	4900	4900	4900	4900	4900	4900
SEMA Export	No Limit	No Limit	No Limit	No Limit	No Limit	No Limit	No Limit	No Limit	No Limit
SEMA/RI Export	3000	3000	3000	3000	3300	3300	3300	3300	3300
East-West	2800	2800	2800	2800	3500	3500	3500	3500	3500
Connecticut Import	2500	2500	2500	2500	3600	3600	3600	3600	3600
Southwest Connecticut Import	2350	3650	3650	3650	3650	3650	3650	3650	3650
Norwalk / Stamford	1300	1650	1650	1650	1650	1650	1650	1650	1650
Cross-Sound Cable (CSC) (Out)	330	330	330	330	330	330	330	330	330
Cross-Sound Cable (CSC) (In)	346	346	346	346	346	346	346	346	346
NY-NE Summer	1525	1525	1525	1525	1525	1525	1525	1525	1525
NY-NE Winter	1600	1600	1600	1600	1600	1600	1600	1600	1600
NE-NY Summer	1200	1200	1200	1200	1200	1200	1200	1200	1200
NE-NY Winter	1325	1325	1325	1325	1325	1325	1325	1325	1325
HQ-NE (Highgate)	200	200	200	200	200	200	200	200	200
HQ-NE (Phase II)	1400	1400	1400	1400	1400	1400	1400	1400	1400

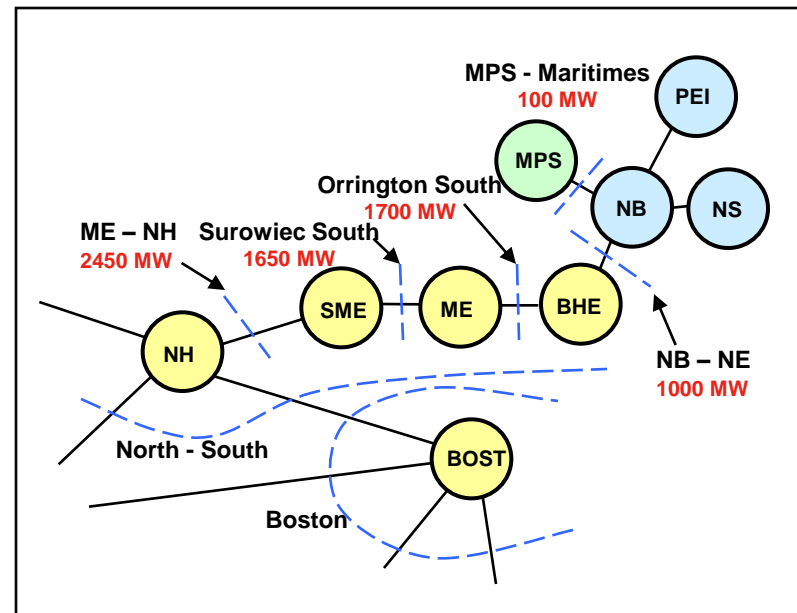
MPRP
MPRP
MPRP

Base Transmission Modeled with MPRP

- MPRP Assumed to be in-service 01/2013
 - Increased transfer capability is preliminary and may change
 - 500 MW increase on Orrington South and Surowiec South
 - 900 MW increase on Maine – New Hampshire



Existing Transmission Before MPRP

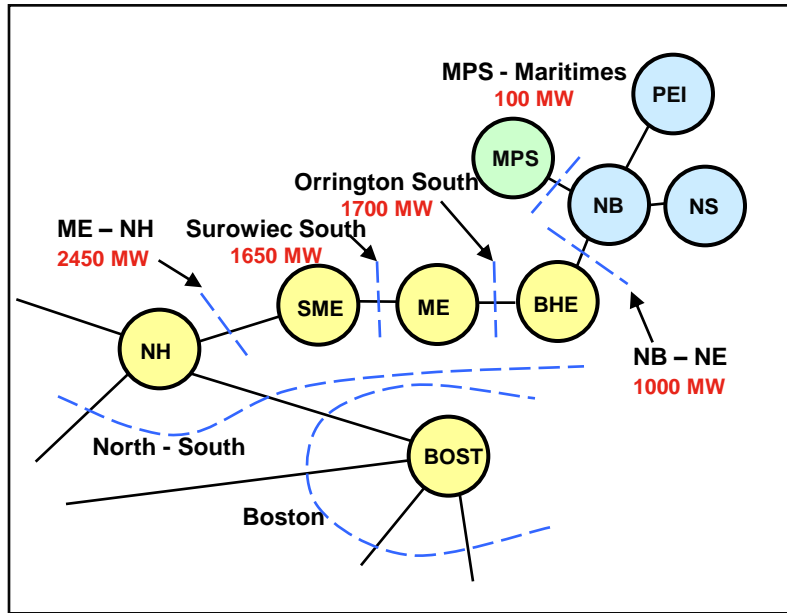


Transmission After MPRP

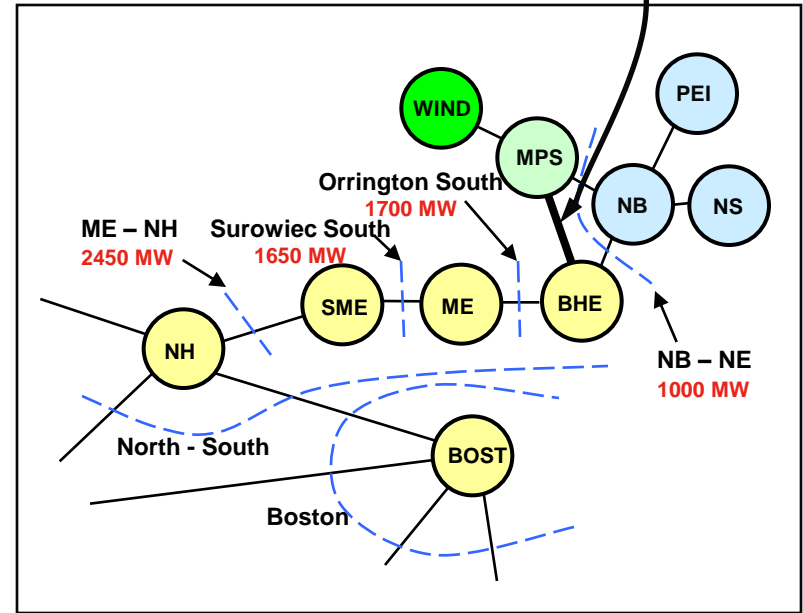
Preliminary

Base Transmission Modeled

Maine Power Connection (MPC)



Base Transmission with MPRP



Base Transmission with MPC

Assumptions – Environmental Compliance

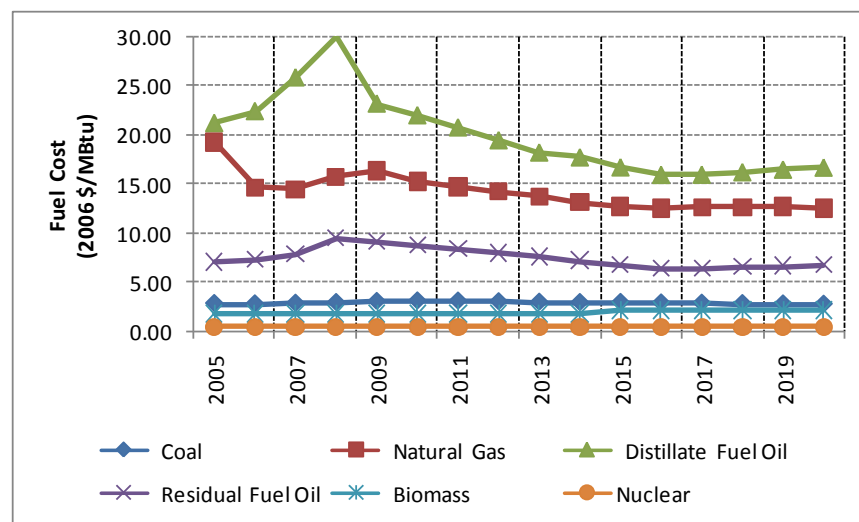
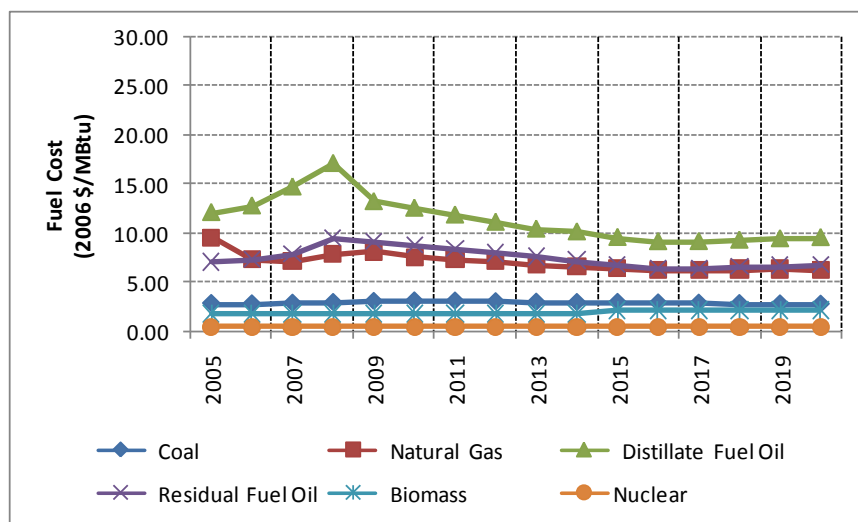
- Compliance with evolving air emission requirements
 - Reflected in the cost of SO₂, NO_x and CO₂ allowances
 - Expressed in 2006 \$ per short ton of regulated air emissions
 - NO_x ozone season allowance requirement (CAIR) only applies to CT, MA , but is assumed to apply also to RI and NH
 - Allowance prices assigned to Maritimes also to reflect ‘leakage’
- Compliance technologies
 - Limited retrofits with SO₂ scrubbers
 - Reflected unit specific NO_x reductions for MA, NH and RI units as appropriate

	Environmental Allowances (\$/ton)		
	CO2	SO2	NOx
2009	10	190	700
2010	10	118	700
2011	10	198	700
2012	10	254	700
2013	10	318	700
2014	10	369	700
2015	10	277	700
2016	10	302	700
2017	10	333	700
2018	10	348	700

Preliminary

Assumptions – Fuel Price Relationships

- Price forecast based on Energy Information Administration (EIA) 2008 Annual Energy Outlook
 - No price differentiation of residual oil or coal by sulfur content
 - Annual Energy Outlook (AEO) does not provide any information on nuclear and renewables
 - These two fuel categories are for units that are base loaded
 - Price magnitude of these fuel categories do not affect dispatch
- Sensitivity cases consist of
 - Doubling natural gas (NG) prices and
 - Distillate oil kept more expensive than NG by multiplying by 1.75

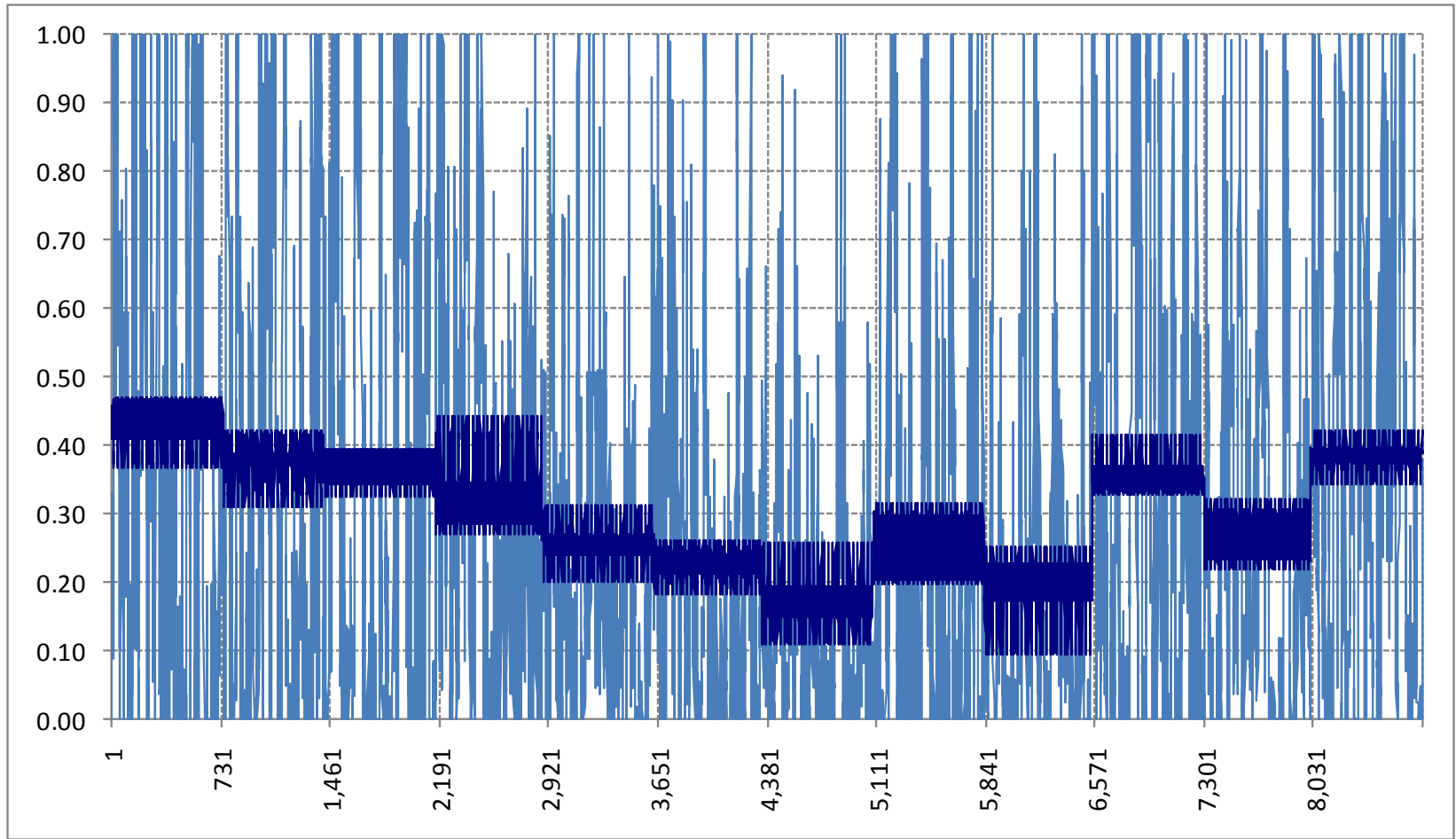


Modeling Wind Profiles

- “Typical” power output of wind resources is informative
 - Expected annual capacity factor would be around 30% percent
 - Highest “typical” output for a 10 MW (nameplate) wind resource would be 4.7 MW
 - This representation may underestimate effect of transmission loading
- Wind power output is much more variable than “typical”
 - Modifying the wind model to reflect actual volatility is desirable
 - Wind energy estimates based on measured data would be preferable
 - Volatility adjustment for analysis was hypothesized
 - Obtain New England Eight City average hourly wind data
 - Define a wind-to-power-output relationship ($P = aV^3 \mid_{V > 8 \text{ mph}}$)
 - Adjust coefficients until capacity factor matches typical output

Comparison of Average and Volatile Wind

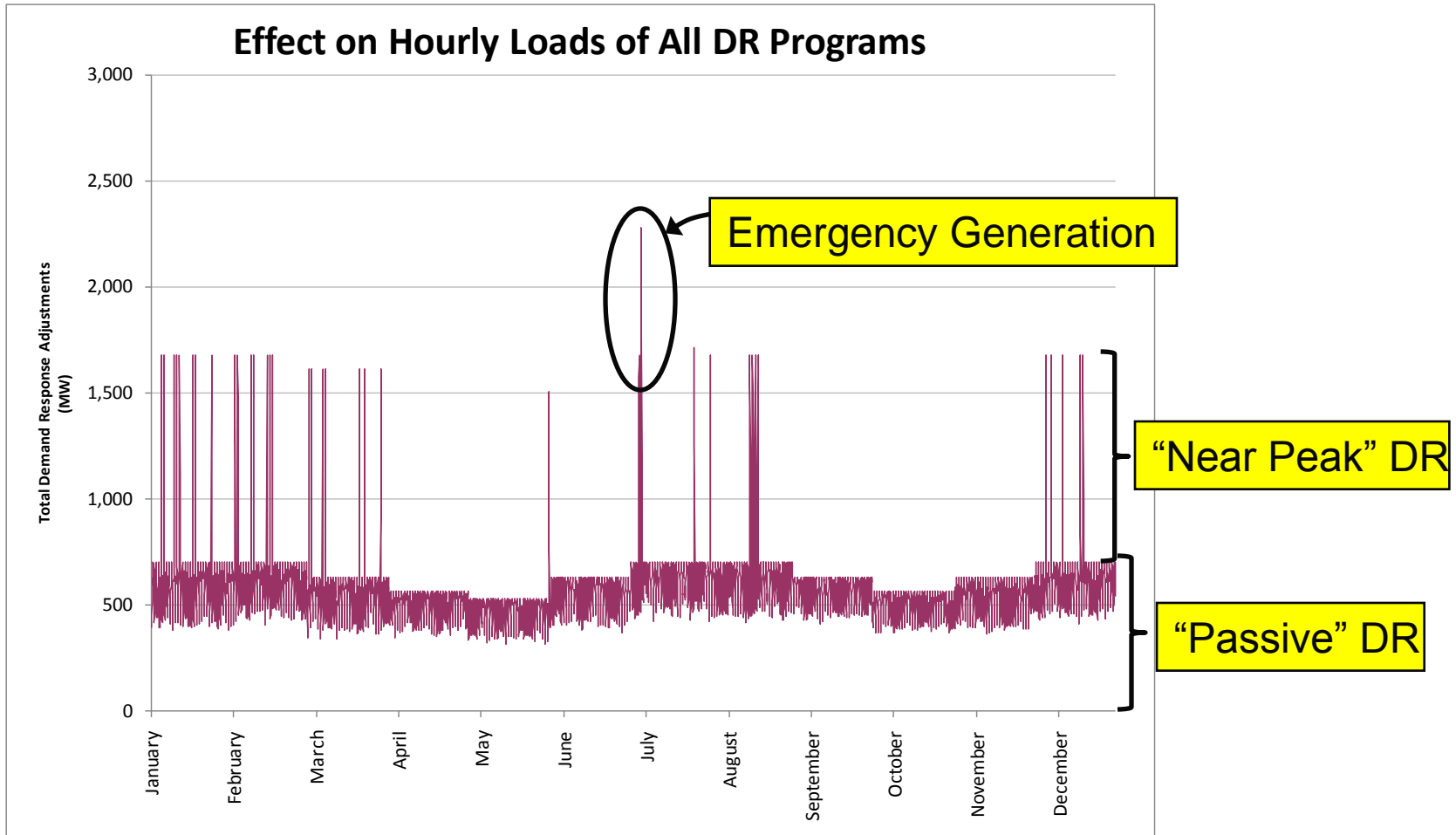
Typical wind is shown as dark blue. Actual wind is shown as light blue



Modeling Demand Resources

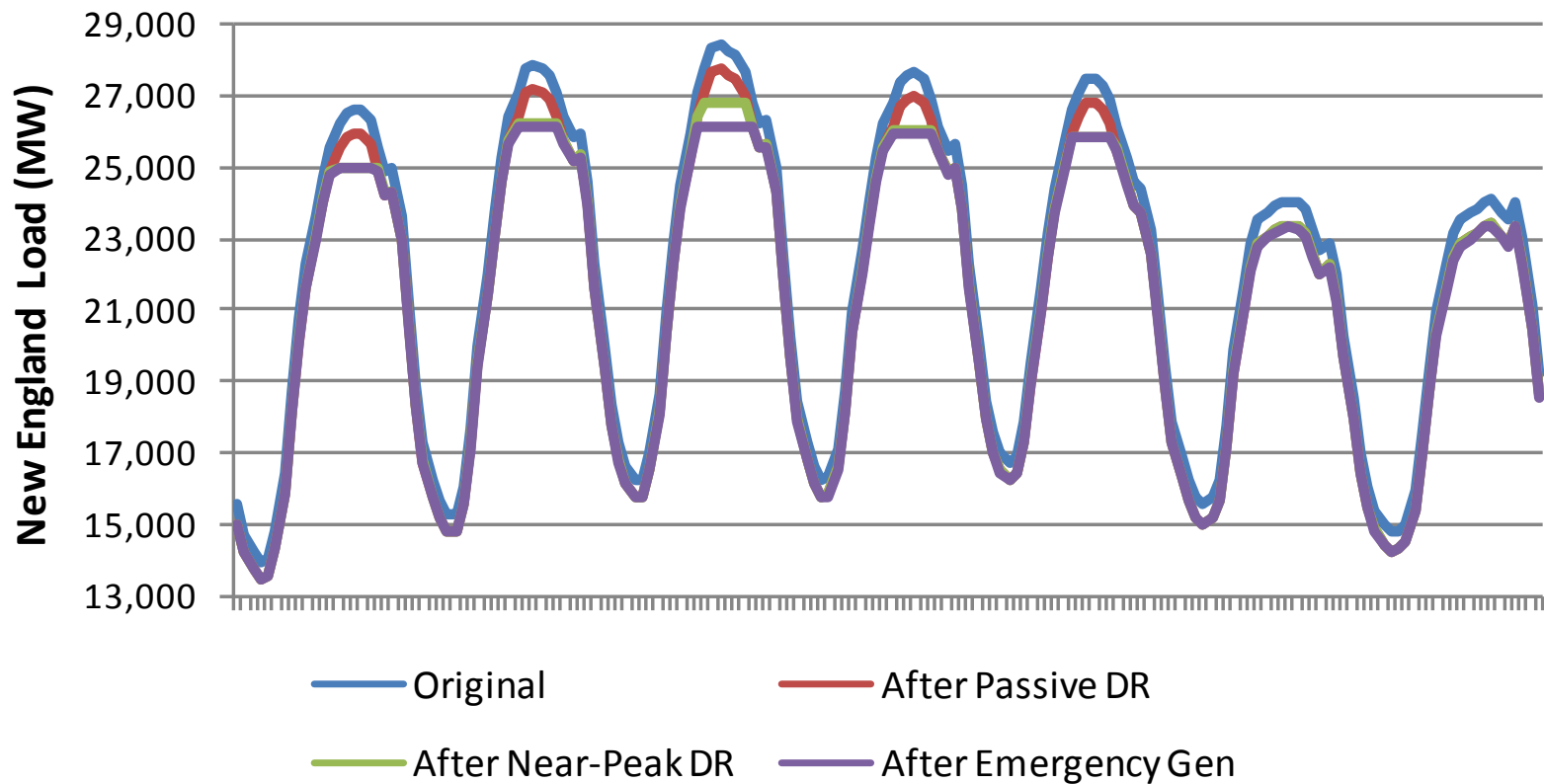
- “Passive” Demand Resources (explicit profile)
 - 700 MW in Base Case
 - On-Peak Demand Resources = 554 MW accepted in FCA1
 - Seasonal Peak Demand Resources = 146 MW accepted in FCA1
 - Energy Efficiency profile developed for Scenario Analysis used
 - Assumes a ~78% capacity factor
- “Near Peak” Demand Resources (explicit profile)
 - 979 MW in Base Case
 - Real-Time Demand Resources = 874 MW accepted in FCA1
 - Critical Peak Demand Resources = 105 MW accepted in FCA1
- Emergency Generation (explicit profile)
 - 600 MW modeled
 - 874 MW accepted, but a maximum of 600 MW is assumed

Effect of All Demand Resources Programs



Load Modifications During Peak Week

Effect of Demand Resources on Loads



New England Interchange Assumptions

- Assumed purchases modeled as price takers
 - Vermont Joint Owner (VJO) (371 MW summer 418 MW winter)
 - New York Power Authority (NYPA) (85 MW)
 - Citizens Block Load (26 MW)
- Assumed economic purchases from Quebec
 - 300 MW priced as Natural Gas (NG) based Combined Cycle (CC) at 8400 Btu/kWh heat rate
 - 300 MW priced as NG based Steam at 10340 Btu/kWh heat rate
 - 300 MW priced as Distillate Fuel Oil (DFO) based on Combustion Turbine (CT) at 12600 Btu/kWh heat rate
- No explicit purchases from New Brunswick
- Export on Cross Sound Cable
 - 100 MW Firm Export

Development of Dispatch Costs

- Dispatch costs based on
 - Variable costs of production expressed on a \$/MWh basis
 - Fuel procurement cost
 - Conversion efficiency (heat rate)
 - Environmental adders to reflect air emissions allowance values for SO₂, NO_x, and CO₂
 - Not included
 - Variable Operations and Maintenance (O&M) costs
 - Explicit modeling of production cost offsets
 - Production cost offsets applied to resources qualifying for Renewable Portfolio Standards (RPS) treatment
 - Subtraction of production cost offsets from dispatch cost would
 - Effectively make RPS resources price takers
 - Resource resembles a base-load or self-scheduled resource

Production Cost Metric

- Production cost metric
 - Summation of dispatch costs times energy produced
 - Calculated for all units used to serve customer demands
- Effect of baseload units on production cost metric
 - Same MWhs and dispatch cost in between cases
 - Negligible effect
- Effect of marginal units on production cost metric
 - Different MWhs with same dispatch cost between cases
 - Effect may, or may not, be negligible

Other Metrics

- Other metrics are presented
 - Load Serving Entity (LSE) Expense
 - Hourly marginal energy cost (e.g., Locational Marginal Price (LMP)) in an RSP area
 - Multiplied by hourly load in a respective RSP area
 - New England's total LSE Expense is summation of each RSP area's LSE Expense
 - Transmission congestion can cause price separation in adjacent RSP areas
- Currently only New England costs and expense are included
 - Effect of Maritimes not included
 - Effect on MPS not included
 - Effect on changes in Quebec production cost not included

Cases Investigated

- Twelve cases conceptualized
 - Effect of transmission changes can be seen
 - Only MPC
 - Only MPRP
 - Combinations
 - “Higher Fuel” and “Higher RGGI CO2 Allowances” need their own reference case

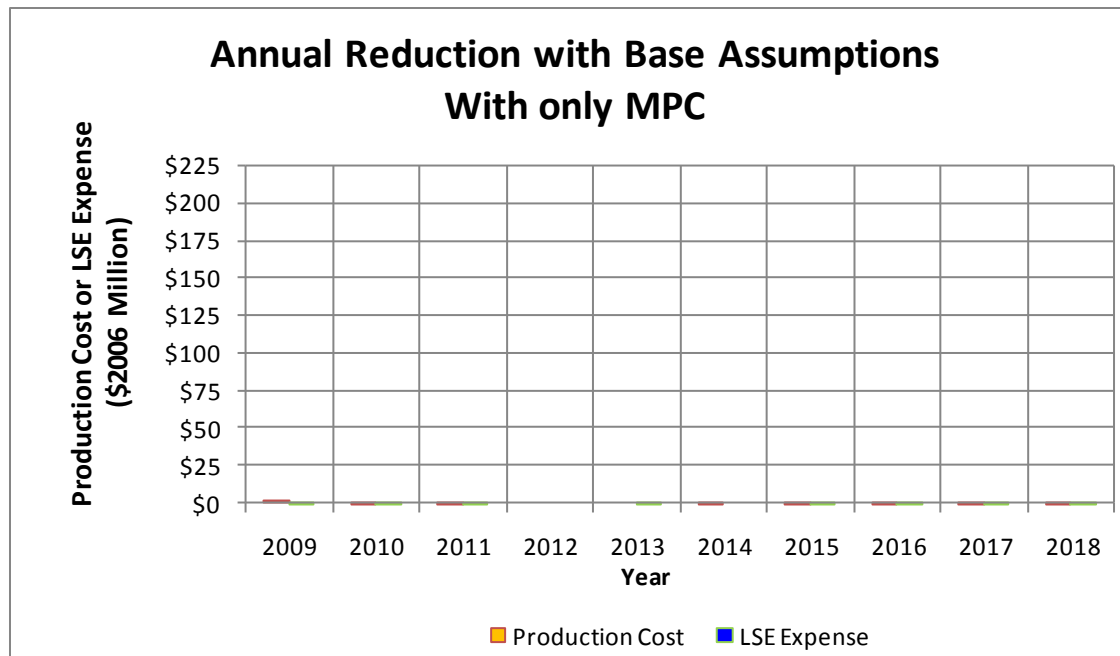
Matrix of Cases Analyzed

ID	Case Name	New MPS Wind (MW)	New MPS Wind (GWh)	MPC Included	MPRP Included	RGGI CO2 Allowance Values	Fuel Price Sensitivity
1	MPC_BASE	0	0	-	-	-	-
2	MPC_BASE_W_MPC_ONLY	0	0	YES	-	-	-
3	MPC_BASE_MPRP_ONLY	0	0	-	YES	-	-
4	MPC_BASE_W_AROS	800	832	-	-	-	-
5	MPC_BASE_W_MPC	800	2051	YES	-	-	-
6	MPC_BASE_W_MPRP	800	2051	YES	YES	-	-
7	MPC_BASE_W_MPRP_22	800	1574	YES	YES	-	-
8	MPC_BASE_W_MPRP_14	800	1035	YES	YES	-	-
9	MPC_BASE_RGGI40	0	0	-	-	40	-
10	MPC_BASE_W_MPRP_RGGI40	800	2051	YES	YES	40	-
11	MPC_BASE_FUHI	0	0	-	-	-	HIGH
12	MPC_BASE_W_MPRP_FUHI	800	2051	YES	YES	-	HIGH

Comparison of Annual Results

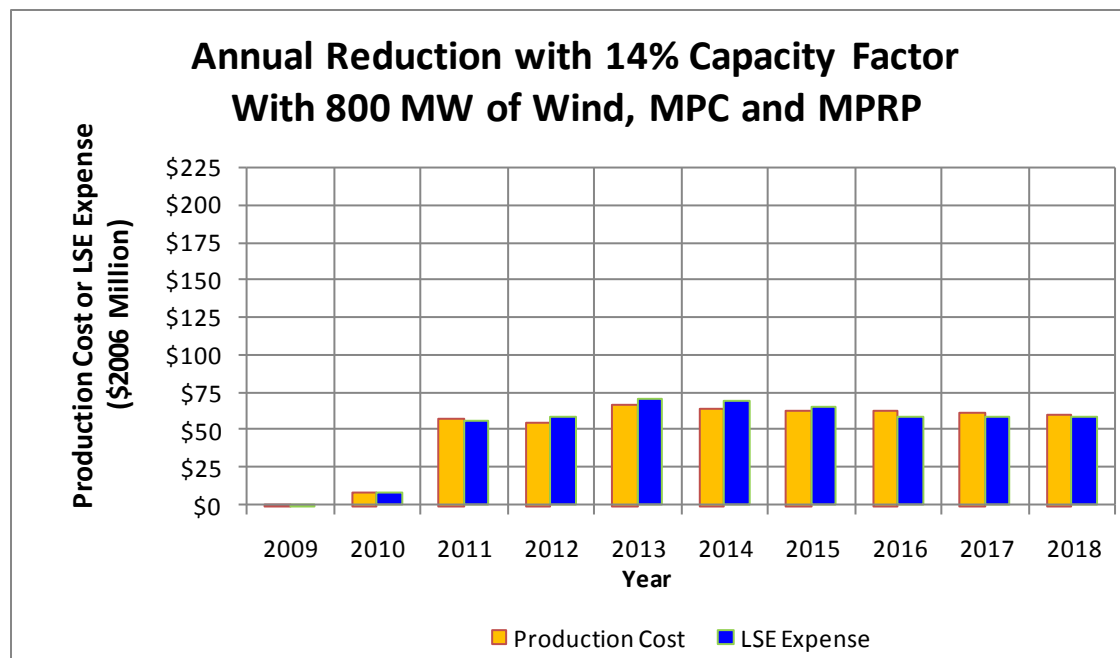
Comparison of Annual Savings Transmission Upgrades Only

- Comparison is based on
 - Undiscounted 2006 dollars



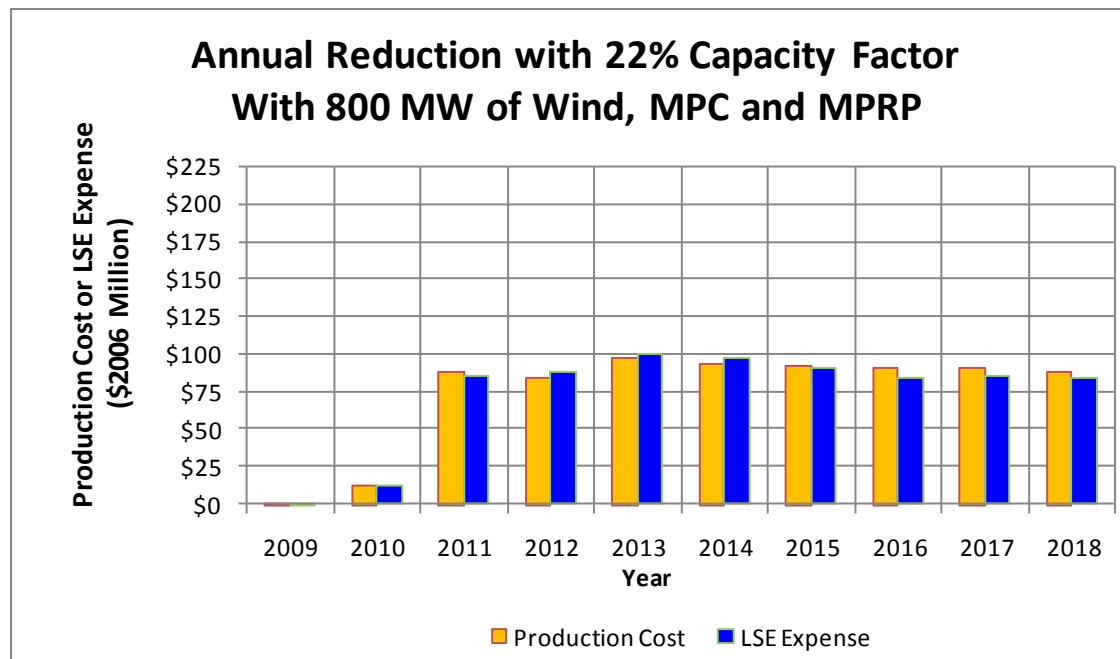
Comparison of Annual Savings Low Wind Capacity Factor

- Comparison is based on
 - Undiscounted 2006 dollars
 - Production cost values shown are not adjusted for REC associated with new wind



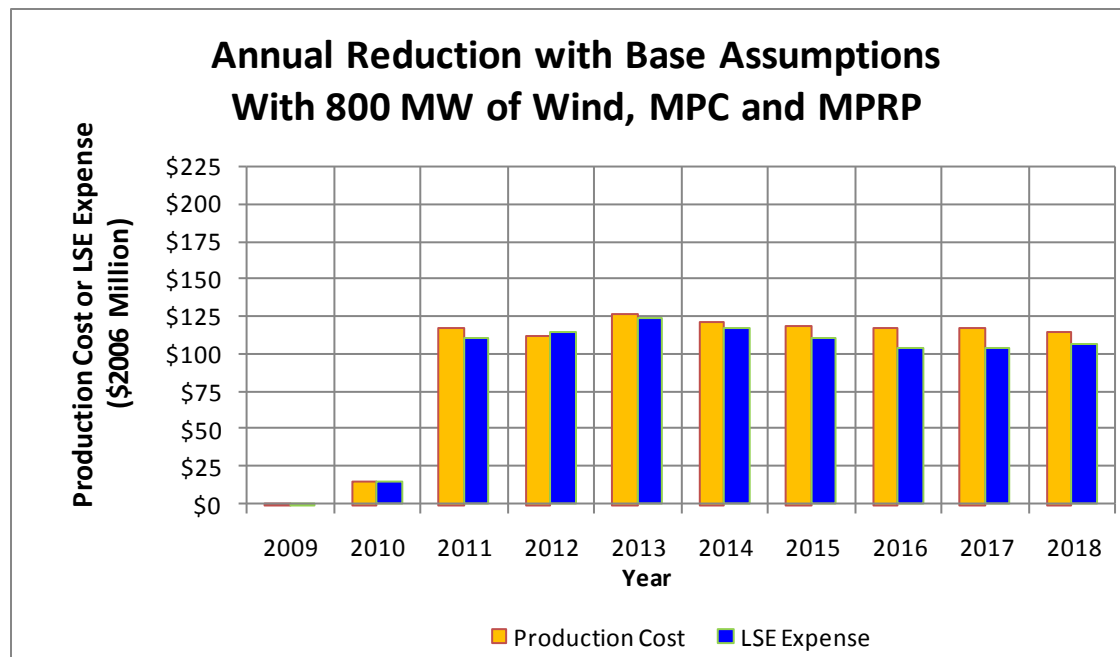
Comparison of Annual Savings Medium Wind Capacity Factor

- Comparison is based on
 - Undiscounted 2006 dollars
 - Production cost values shown are not adjusted for REC associated with new wind



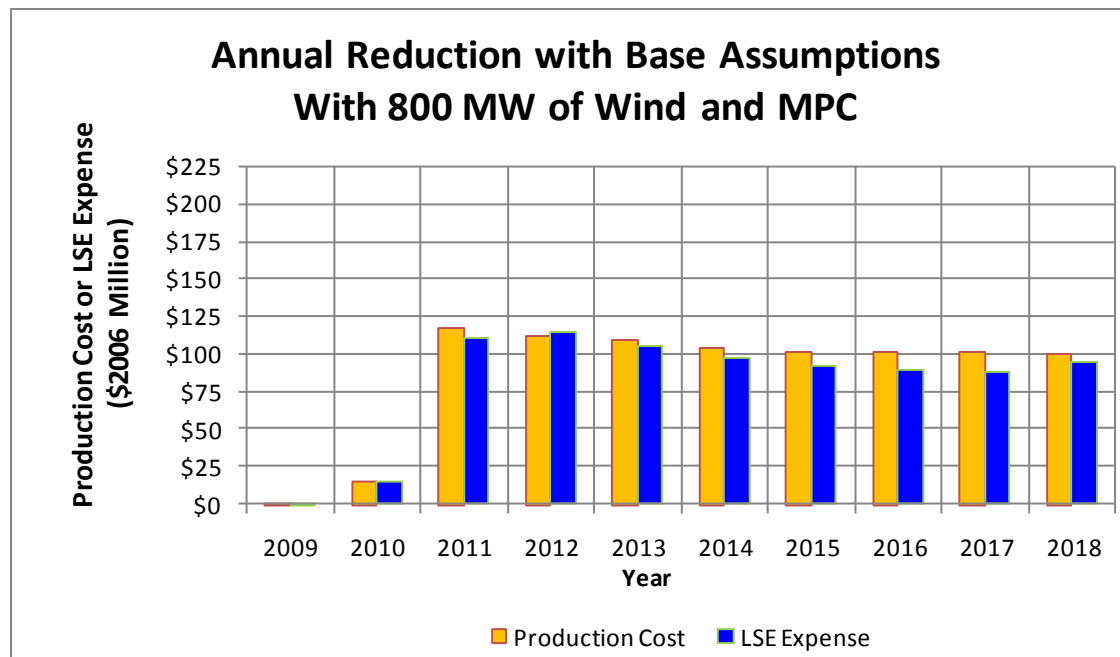
Comparison of Annual Savings Base Wind and Transmission Upgrades

- Comparison is based on
 - Undiscounted 2006 dollars
 - Production cost values shown are not adjusted for REC associated with new wind



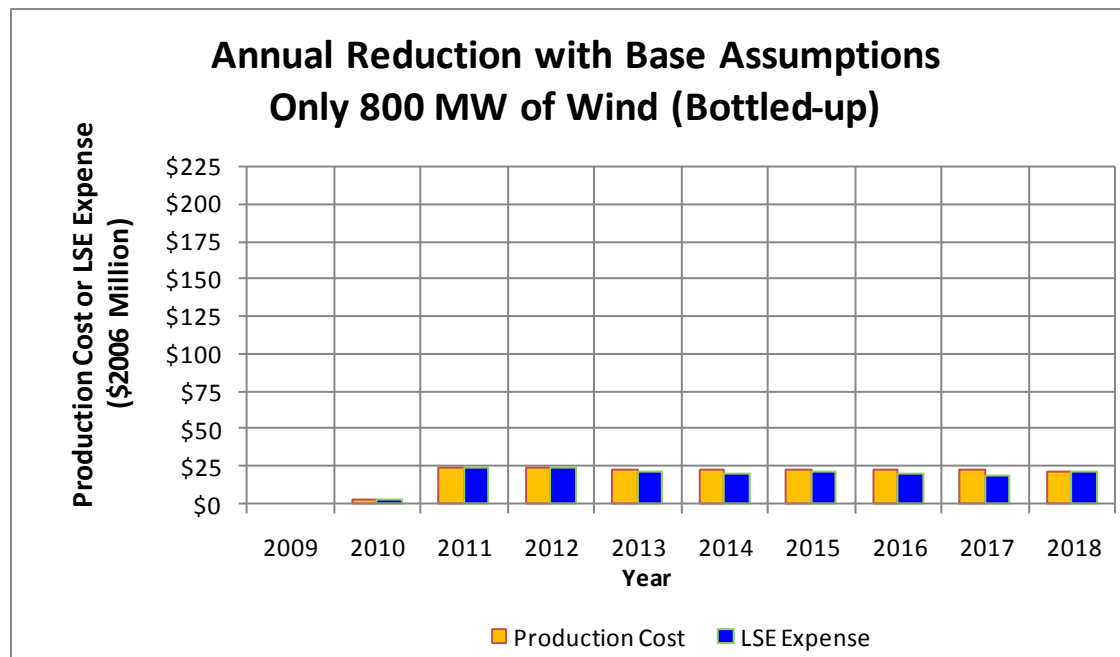
Comparison of Annual Savings Base Wind and Transmission Upgrades

- Comparison is based on
 - Undiscounted 2006 dollars
 - Production cost values shown are not adjusted for REC associated with new wind



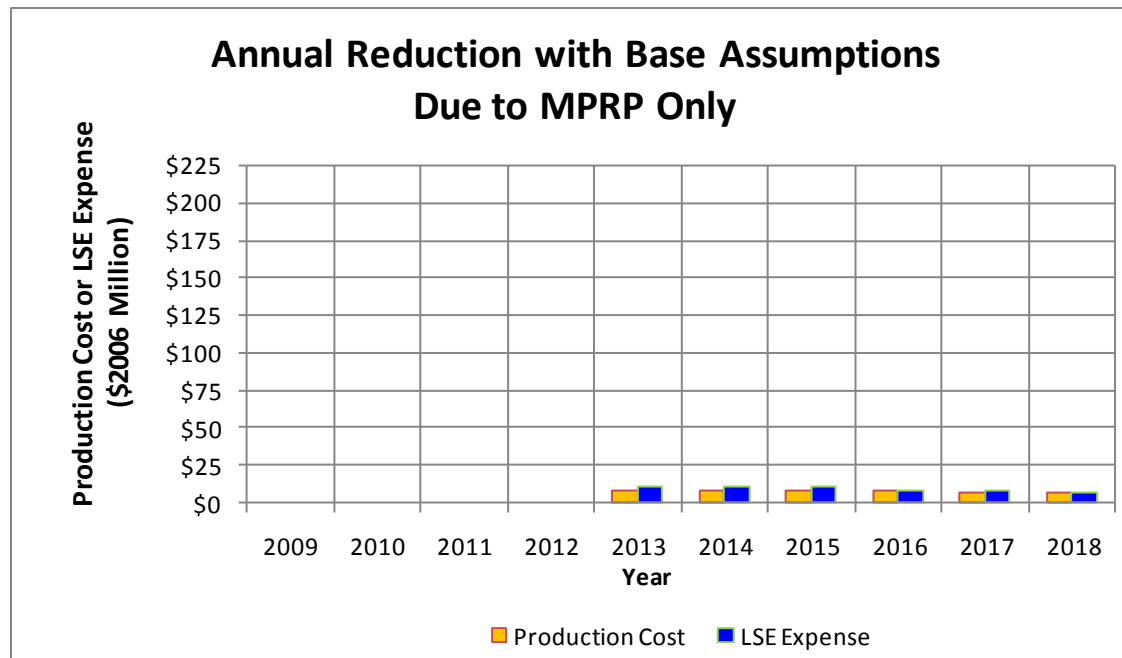
Comparison of Annual Savings Base Wind and No Transmission

- Comparison is based on
 - Undiscounted 2006 dollars
 - Production cost values shown are not adjusted for REC associated with new wind



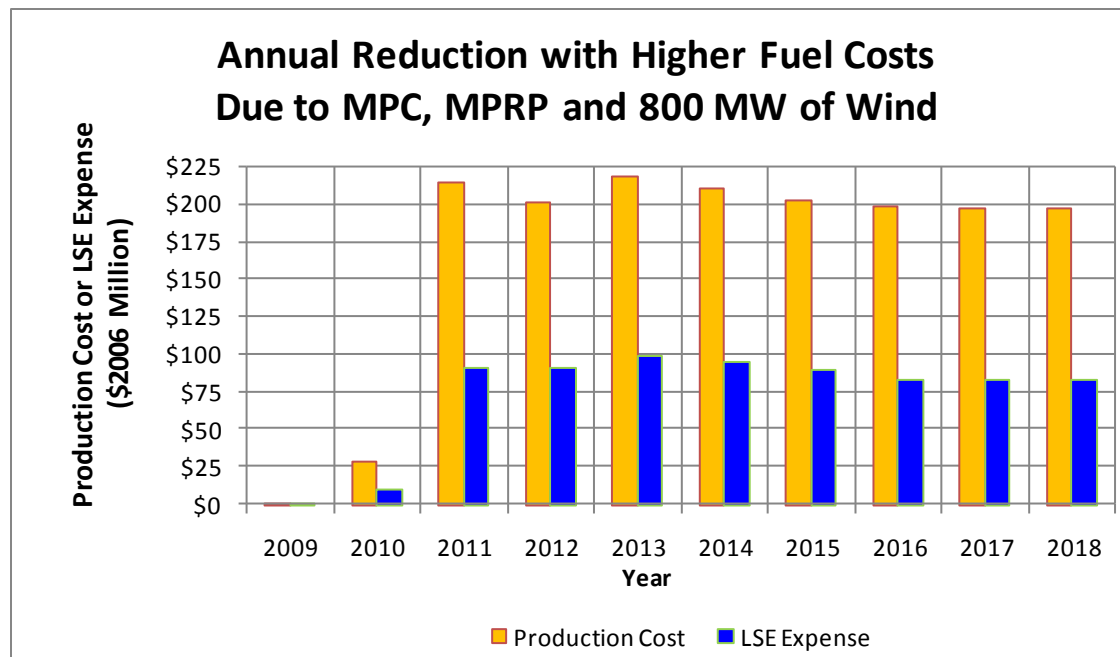
Comparison of Annual Savings Transmission Upgrades Only

- Comparison is based on
 - Undiscounted 2006 dollars
 - Production cost values shown are not adjusted for REC associated with new wind



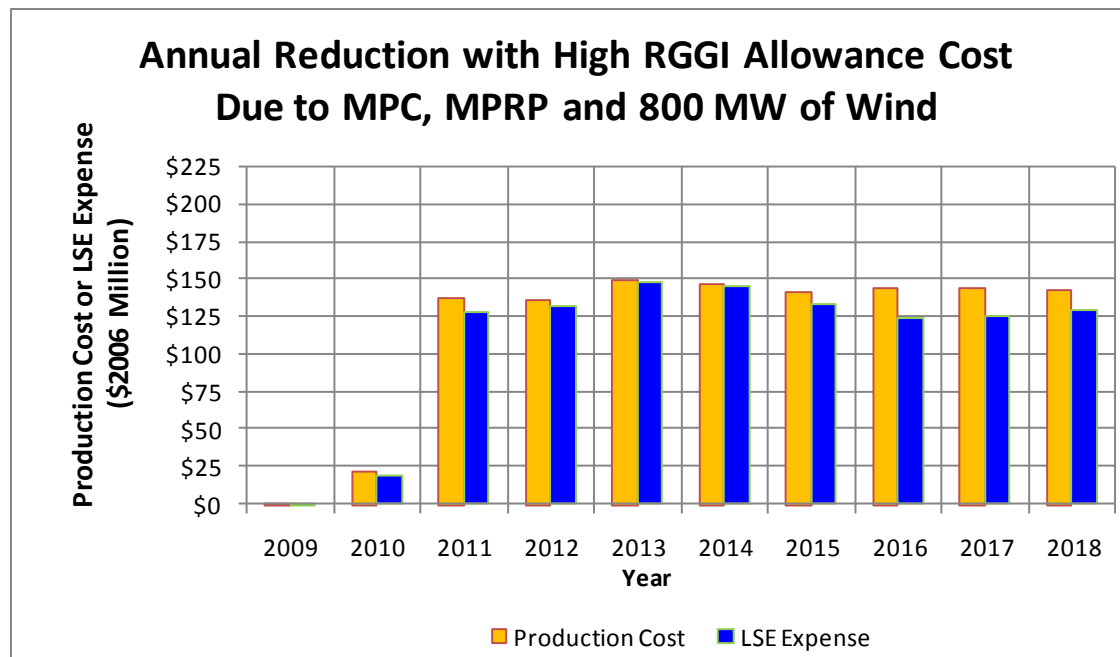
Comparison of Annual Savings Higher Fuel Costs

- Comparison is based on
 - Undiscounted 2006 dollars
 - Production cost values shown are not adjusted for REC associated with new wind



Comparison of Annual Savings Higher RGGI CO2 Allowance Values

- Comparison is based on
 - Undiscounted 2006 dollars
 - Production cost values shown are not adjusted for REC associated with new wind



Comparison of Total Results

Comparison of Totals: Base Case vs. Wind and Transmission Upgrades Cases

- Comparison is based summation for 2009 - 2018
 - Undiscounted 2006 dollars
 - Production cost values shown are not adjusted for REC associated with new wind

Summation over ten years (Millions of 2006 Dollars)

ID	Case Name	New MPS Wind (MW)	New MPS Wind (GWh)	MPC Included	MPRP Included	RGGI CO2 Allowance Values	Fuel Price Sensitivity	Production Cost			LSE Energy Expense		
								With Wind Only	With Wind and MPC	With Wind, MPC and MPRP	29 % Capacity Factor	22 % Capacity Factor	14 % Capacity Factor
1	MPC_BASE	0	0	-	-	-	-	\$50,347	\$50,347	\$50,347	\$98,153	\$98,153	\$98,153
2	MPC_BASE_W_MPC_ONLY	0	0	YES	-	-	-						
3	MPC_BASE_MPRP_ONLY	0	0	-	YES	-	-						
4	MPC_BASE_W_AROS	800	832	-	-	-	-	\$50,162			\$97,979		
5	MPC_BASE_W_MPC	800	2051	YES	-	-	-		\$49,482			\$97,346	
6	MPC_BASE_W_MPRP	800	2051	YES	YES	-	-			\$49,382			\$97,247
7	MPC_BASE_W_MPRP_22	800	1574	YES	YES	-	-						
8	MPC_BASE_W_MPRP_14	800	1035	YES	YES	-	-						
9	MPC_BASE_RGGI40	0	0	-	-	40	-						
10	MPC_BASE_W_MPRP_RGGI40	800	2051	YES	YES	40	-						
11	MPC_BASE_FUHI	0	0	-	-	-	HIGH						
12	MPC_BASE_W_MPRP_FUHI	800	2051	YES	YES	-	HIGH						
								\$185	\$865	\$965	\$174	\$807	\$906

Comparison of Totals: Base Case vs. Transmission Upgrades Only Cases

- Comparison is based summation for 2009 - 2018
 - Undiscounted 2006 dollars
 - Production cost values shown are not adjusted for REC associated with new wind

Summation over ten years (Millions of 2006 Dollars)

ID	Case Name	New MPS Wind (MW)	New MPS Wind (GWh)	MPC Included	MPRP Included	RGGI CO2 Allowance Values	Fuel Price Sensitivity	Production Cost		LSE Energy Expense	
								With MPC Only	With MPRP Only	With MPC Only	With MPRP Only
1	MPC_BASE	0	0	-	-	-	-	\$50,347	\$50,347	\$98,153	\$98,153
2	MPC_BASE_W_MPC_ONLY	0	0	YES	-	-	-	\$50,346		\$98,154	
3	MPC_BASE_MPRP_ONLY	0	0	-	YES	-	-		\$50,300		\$98,099
4	MPC_BASE_W_AROS	800	832	-	-	-	-				
5	MPC_BASE_W_MPC	800	2051	YES	-	-	-				
6	MPC_BASE_W_MPRP	800	2051	YES	YES	-	-				
7	MPC_BASE_W_MPRP_22	800	1574	YES	YES	-	-				
8	MPC_BASE_W_MPRP_14	800	1035	YES	YES	-	-				
9	MPC_BASE_RGGI40	0	0	-	-	40	-				
10	MPC_BASE_W_MPRP_RGGI40	800	2051	YES	YES	40	-				
11	MPC_BASE_FUHI	0	0	-	-	-	HIGH				
12	MPC_BASE_W_MPRP_FUHI	800	2051	YES	YES	-	HIGH				
								\$1	\$47	-\$1	\$54

Comparison of Totals: Base Case vs. Wind Capacity Factor Cases

- Comparison is based summation for 2009 - 2018
 - Undiscounted 2006 dollars
 - Production cost values shown are not adjusted for REC associated with new wind

Summation over ten years (Millions of 2006 Dollars)

ID	Case Name	New MPS Wind (MW)	New MPS Wind (GWh)	MPC Included	MPRP Included	RGGI CO2 Allowance Values	Fuel Price Sensitivity	Production Cost			LSE Energy Expense		
								29 % Capacity Factor	22 % Capacity Factor	14 % Capacity Factor	29 % Capacity Factor	22 % Capacity Factor	14 % Capacity Factor
1	MPC_BASE	0	0	-	-	-	-	\$50,347	\$50,347	\$50,347	\$98,153	\$98,153	\$98,153
2	MPC_BASE_W_MPC_ONLY	0	0	YES	-	-	-						
3	MPC_BASE_MPRP_ONLY	0	0	-	YES	-	-						
4	MPC_BASE_W_AROS	800	832	-	-	-	-						
5	MPC_BASE_W_MPC	800	2051	YES	-	-	-						
6	MPC_BASE_W_MPRP	800	2051	YES	YES	-	-	\$49,382			\$97,427		
7	MPC_BASE_W_MPRP_22	800	1574	YES	YES	-	-		\$49,604			\$97,428	
8	MPC_BASE_W_MPRP_14	800	1035	YES	YES	-	-			\$49,844			\$97,694
9	MPC_BASE_RGGI40	0	0	-	-	40	-						
10	MPC_BASE_W_MPRP_RGGI40	800	2051	YES	YES	40	-						
11	MPC_BASE_FUHI	0	0	-	-	-	HIGH						
12	MPC_BASE_W_MPRP_FUHI	800	2051	YES	YES	-	HIGH						
								\$965	\$743	\$503	\$726	\$725	\$459

Comparison of Totals: Base Case vs. Higher RGGI Allowance and Fuel Cases

- Comparison is based summation for 2009 - 2018
 - Undiscounted 2006 dollars
 - Production cost values shown are not adjusted for REC associated with new wind

Summation over ten years (Millions of 2006 Dollars)

ID	Case Name	New MPS Wind (MW)	New MPS Wind (GWh)	MPC Included	MPRP Included	RGGI CO2 Allowance Values	Fuel Price Sensitivity	Production Cost		LSE Energy Expense	
								With MPC Only	With MPRP Only	With MPC Only	With MPRP Only
1	MPC_BASE	0	0	-	-	-	-				
2	MPC_BASE_W_MPC_ONLY	0	0	YES	-	-	-				
3	MPC_BASE_MPRP_ONLY	0	0	-	YES	-	-				
4	MPC_BASE_W_AROS	800	832	-	-	-	-				
5	MPC_BASE_W_MPC	800	2051	YES	-	-	-				
6	MPC_BASE_W_MPRP	800	2051	YES	YES	-	-				
7	MPC_BASE_W_MPRP_22	800	1574	YES	YES	-	-				
8	MPC_BASE_W_MPRP_14	800	1035	YES	YES	-	-				
9	MPC_BASE_RGGI40	0	0	-	-	40	-	\$69,354		\$124,310	
10	MPC_BASE_W_MPRP_RGGI40	800	2051	YES	YES	40	-	\$68,189		\$123,223	
11	MPC_BASE_FUHI	0	0	-	-	-	HIGH		\$86,030		\$174,291
12	MPC_BASE_W_MPRP_FUHI	800	2051	YES	YES	-	HIGH		\$84,362		\$173,564
								\$1,165	\$1,668	\$1,087	\$727

Effect of Renewable Energy Credits on Production Cost Metric

- Production cost metric developed via simulations does not include effect of Renewable Energy Credits (REC)
 - RECs for new renewables that can deliver into New England can be added ex-post
 - Affects production cost metric for each MWh produced
 - Not included in these results

Millions of 2006 Dollars

	Undis counted 2006 Dollars			PV at 4 percent 2006 Dollars	
	Production Cost	LSE Expense	Discount Factor	Fuel and Var O&M	LSE Expense
2009	\$1	\$0	0.8890	\$1	\$0
2010	\$16	\$15	0.8548	\$13	\$13
2011	\$117	\$111	0.8219	\$96	\$91
2012	\$112	\$114	0.7903	\$89	\$90
2013	\$127	\$124	0.7599	\$96	\$94
2014	\$122	\$117	0.7307	\$89	\$85
2015	\$119	\$111	0.7026	\$84	\$78
2016	\$118	\$104	0.6756	\$80	\$70
2017	\$118	\$103	0.6496	\$77	\$67
2018	\$115	\$106	0.6246	\$72	\$66
	\$964	\$906		\$696	\$656

Renewable Energy Credit \$20.00 per MWh

Millions of 2006 Dollars

	Wind GWh	Renewable Energy Credits	Undis counted 2006 Dollars			PV at 4 percent 2006 Dollars	
			Production Cost	LSE Expense	Discount Factor	Fuel and Var O&M	LSE Expense
2009	0	\$0	\$1	\$0	0.8890	\$1	\$0
2010	226	\$5	\$20	\$15	0.8548	\$17	\$13
2011	2,051	\$41	\$158	\$111	0.8219	\$130	\$91
2012	2,051	\$41	\$153	\$114	0.7903	\$121	\$90
2013	2,051	\$41	\$168	\$124	0.7599	\$127	\$94
2014	2,051	\$41	\$163	\$117	0.7307	\$119	\$85
2015	2,051	\$41	\$160	\$111	0.7026	\$113	\$78
2016	2,051	\$41	\$159	\$104	0.6756	\$107	\$70
2017	2,051	\$41	\$159	\$103	0.6496	\$103	\$67
2018	2,051	\$41	\$156	\$106	0.6246	\$97	\$66
			\$1,297	\$906		\$936	\$656

Boundary for Economic Analysis: Production Cost of “External” Areas

- Should effects outside of ISO New England be a factor?
- Reduced external area production cost is about 15%

Higher Fuel Cost

Production Cost - Base Case

	New England	Maine	MPS	NBSO	Other
2009	8571.7	988.4	6.1	1044.3	1.9
2010	7950.5	883.0	6.1	1100.9	120.5
2011	7881.2	876.2	6.1	1095.0	110.1
2012	7823.9	875.9	6.1	1114.3	111.5
2013	7677.7	862.7	6.1	1122.2	109.1
2014	7503.3	843.3	6.1	1118.1	102.4
2015	7419.7	820.1	6.1	1099.8	91.9
2016	7404.8	845.7	6.1	1101.0	69.7
2017	7505.4	814.8	6.1	1100.9	63.5
2018	7709.0	772.4	6.1	1093.3	67.3
Total	77447.2	8582.5	61.0	10989.8	847.9

Production Cost - With Wind, MPC and MPRP

	New England	Maine	MPS	NBSO	Other
2009	8571.0	988.3	6.1	1045.0	1.9
2010	7929.9	875.5	6.1	1099.2	119.3
2011	7721.6	821.7	6.1	1069.2	99.1
2012	7676.0	822.8	6.1	1082.1	103.2
2013	7509.6	812.7	6.1	1108.7	100.3
2014	7340.5	795.5	6.1	1104.8	95.5
2015	7260.7	776.3	6.1	1085.9	86.2
2016	7242.7	809.8	6.1	1086.8	64.2
2017	7345.8	777.5	6.1	1085.7	58.5
2018	7552.2	731.7	6.1	1078.2	61.8
Total	76150.0	8211.8	61.0	10845.6	790.0

Differences Between Cases

	New England	Maine	MPS	NBSO	Other
2009	0.7	0.1	0.0	-0.7	0.0
2010	20.6	7.5	0.0	1.7	1.2
2011	159.6	54.5	0.0	25.8	11.0
2012	147.9	53.1	0.0	32.2	8.3
2013	168.1	50.0	0.0	13.5	8.8
2014	162.8	47.8	0.0	13.3	6.9
2015	159.0	43.8	0.0	13.9	5.7
2016	162.1	35.9	0.0	14.2	5.5
2017	159.6	37.3	0.0	15.2	5.0
2018	156.8	40.7	0.0	15.1	5.5
Total	1297.2	370.7	0.0	144.2	57.9

Difference in New England vs. External Areas

	ISO New England	External	Total
2009	0.8	-0.7	0.1
2010	28.1	2.9	31.0
2011	214.1	36.8	250.9
2012	201.0	40.5	241.5
2013	218.1	22.3	240.4
2014	210.6	20.2	230.8
2015	202.8	19.6	222.4
2016	198.0	19.7	217.7
2017	196.9	20.2	217.1
2018	197.5	20.6	218.1
Total	1667.9	202.1	1870.0

Boundary for Economic Analysis: LSE Energy Expense of “External” Areas

- Should effects outside of ISO New England be a factor?
- In this case, external area savings is about 50%

Higher Fuel Cost

LSE Energy Expense - Base Case

	New England	Maine	MPS	NBSO	Other
2009	17834.9	1723.8	105.8	4428.4	369.1
2010	16867.5	1626.9	99.8	4183.2	107.4
2011	16602.0	1598.4	98.1	4073.8	104.4
2012	16347.9	1573.2	96.5	3954.1	101.5
2013	15940.9	1533.4	94.1	3834.1	97.9
2014	15466.6	1487.5	91.4	3691.4	94.3
2015	15038.7	1448.5	89.1	3567.7	91.1
2016	14808.3	1428.3	87.9	3489.6	88.5
2017	14866.1	1434.5	88.6	3502.3	88.5
2018	15195.4	1468.2	91.2	3602.0	90.7
Total	158968.3	15322.7	942.5	38326.6	1233.4

LSE Energy Expense - With Wind, MPC and MPRP

	New England	Maine	MPS	NBSO	Other
2009	17834.2	1723.5	105.4	4429.4	369.1
2010	16858.7	1626.0	99.2	4181.1	107.3
2011	16524.0	1585.8	95.2	3990.0	103.9
2012	16270.0	1560.0	93.3	3863.7	101.0
2013	15852.2	1523.1	92.7	3811.0	97.4
2014	15380.8	1477.8	90.1	3668.2	93.8
2015	14958.2	1439.0	87.8	3545.0	90.6
2016	14735.1	1418.0	86.5	3467.1	88.1
2017	14793.5	1423.6	87.1	3477.6	88.1
2018	15125.2	1455.7	89.2	3577.6	90.4
Total	158331.9	15232.5	926.5	38010.7	1229.7

Differences Between Cases

	New England	Maine	MPS	NBSO	Other
2009	0.7	0.3	0.4	-1.0	0.0
2010	8.8	0.9	0.6	2.1	0.1
2011	78.0	12.6	2.9	83.8	0.5
2012	77.9	13.2	3.2	90.4	0.5
2013	88.7	10.3	1.4	23.1	0.5
2014	85.8	9.7	1.3	23.2	0.5
2015	80.5	9.5	1.3	22.7	0.5
2016	73.2	10.3	1.4	22.5	0.4
2017	72.6	10.9	1.5	24.7	0.4
2018	70.2	12.5	2.0	24.4	0.3
Total	636.4	90.2	16.0	315.9	3.7

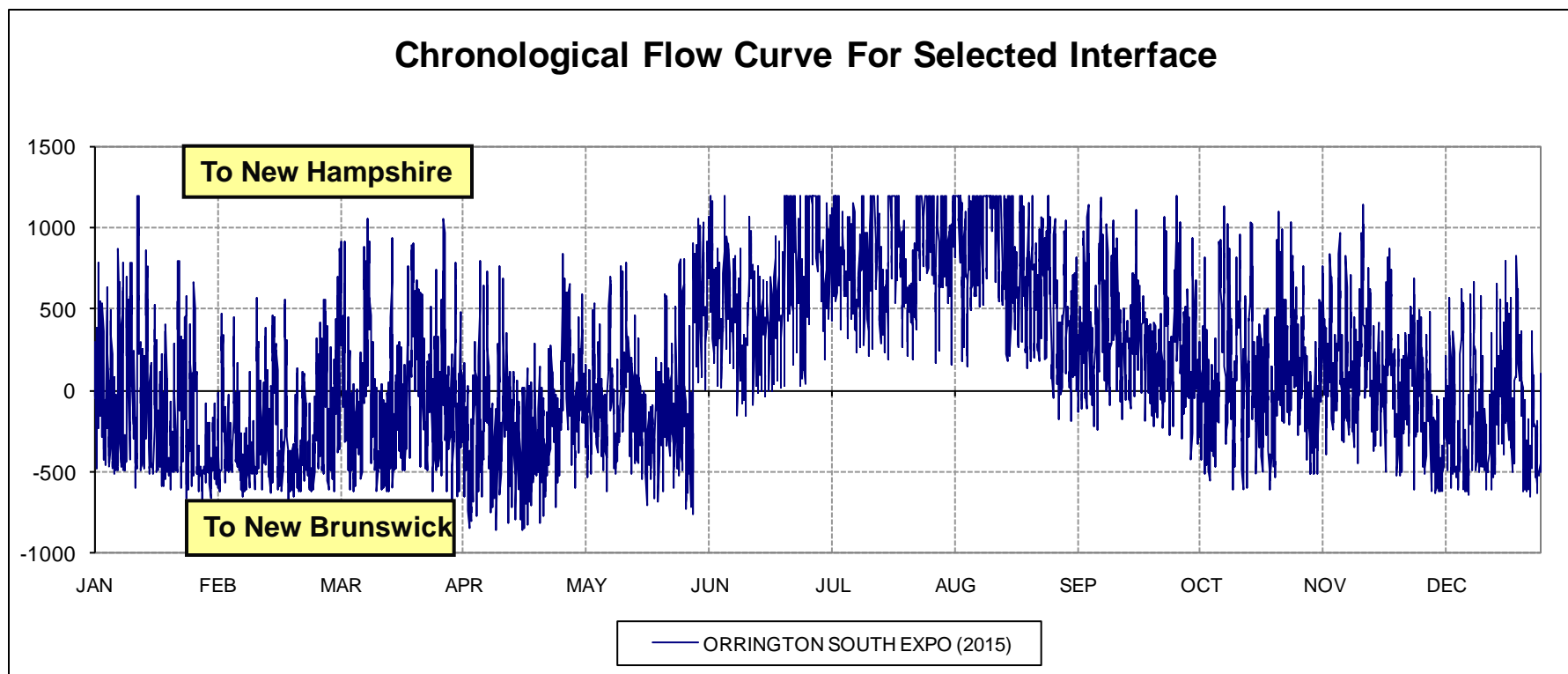
Difference in New England vs. External Areas

	ISO New England	External	Total
2009	1.0	-0.6	0.4
2010	9.7	2.8	12.5
2011	90.6	87.2	177.8
2012	91.1	94.1	185.2
2013	99.0	25.0	124.0
2014	95.5	25.0	120.5
2015	90.0	24.5	114.5
2016	83.5	24.3	107.8
2017	83.5	26.6	110.1
2018	82.7	26.7	109.4
Total	726.6	335.6	1062.2

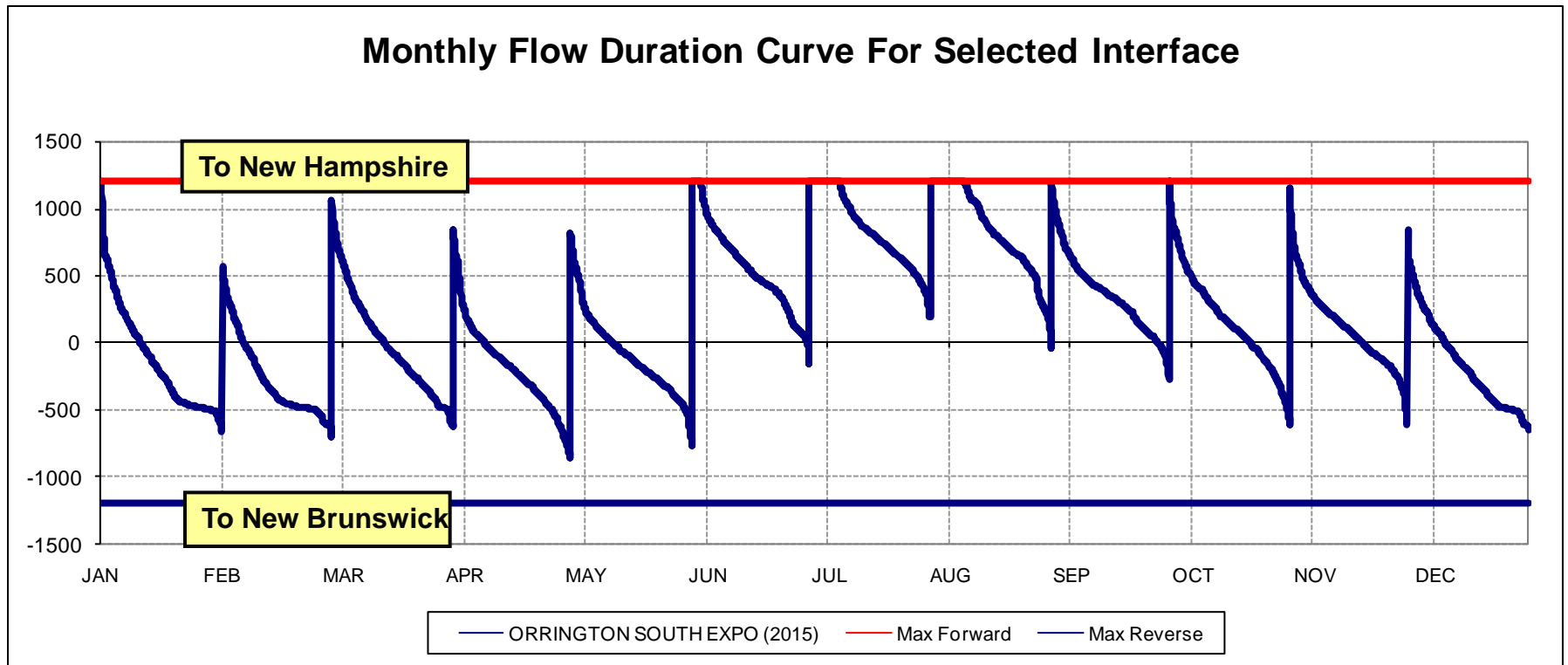
Preliminary

Selected Flow Duration Curves

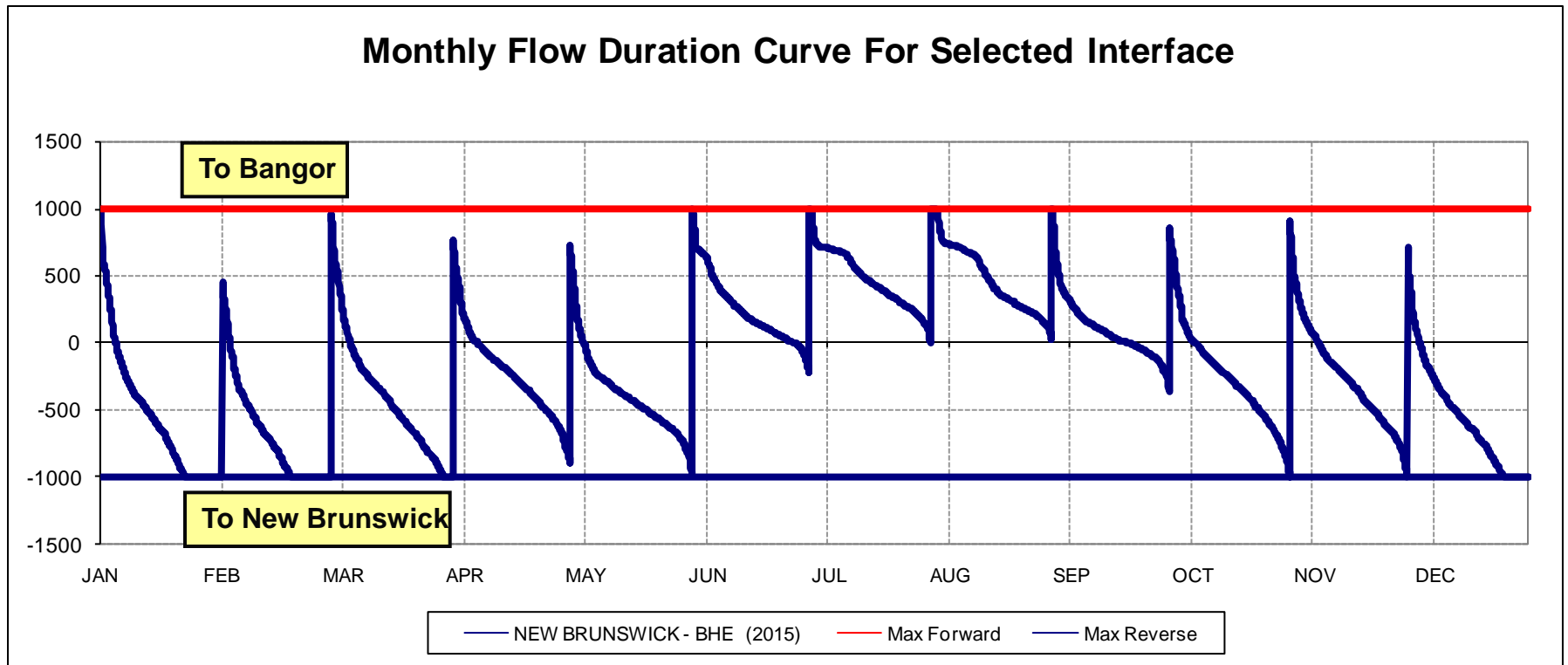
Orrington South Interface Chronological As-Is, 0 MW Wind in 2015



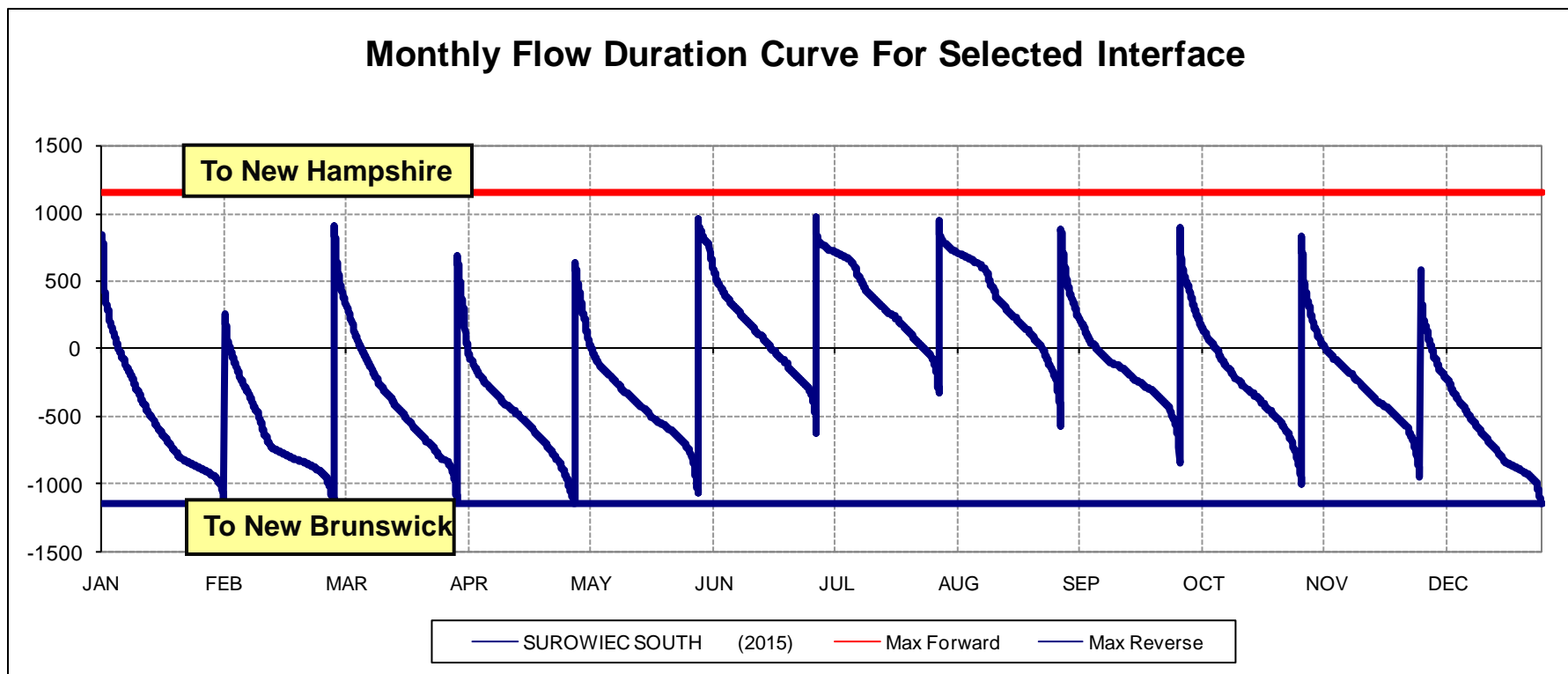
Orrington South Interface Flow Duration As-Is, 0 MW Wind in 2015



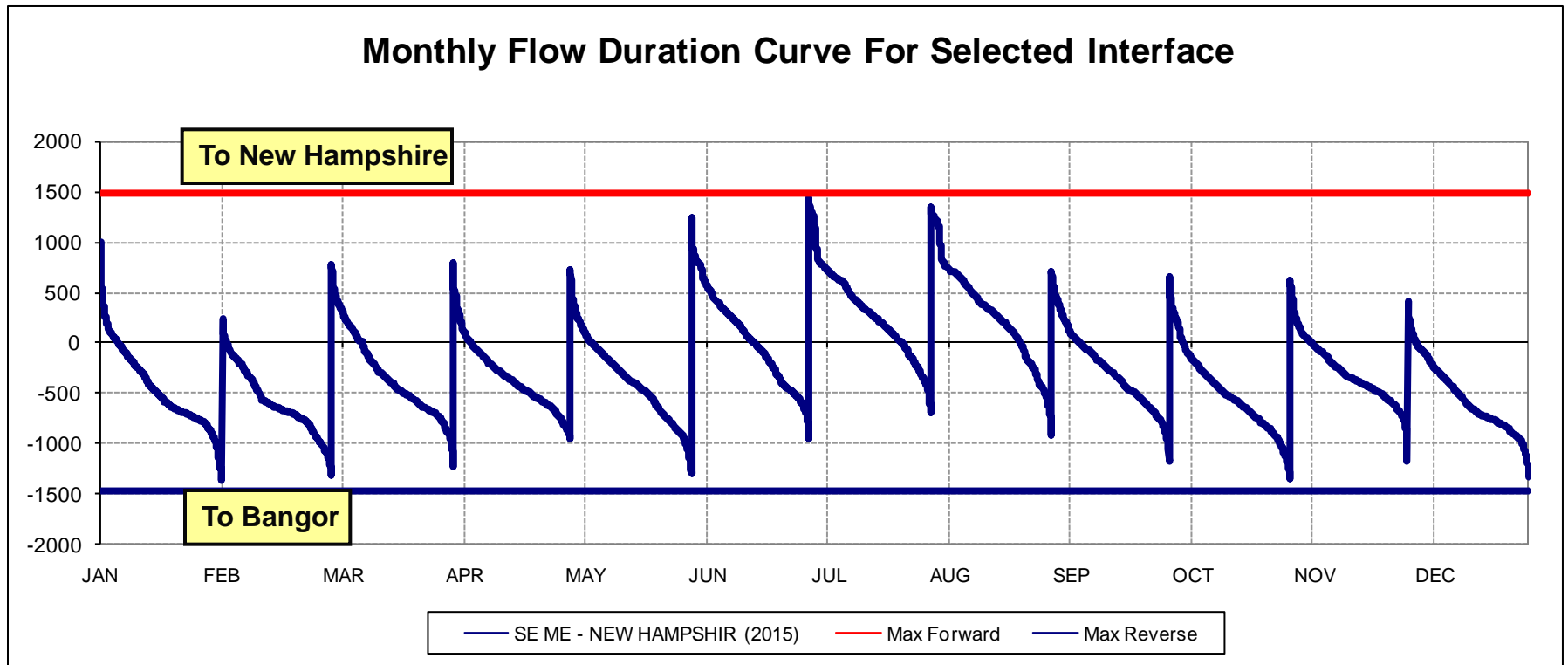
New Brunswick Interface Flow Duration As-Is, 0 MW Wind in 2015



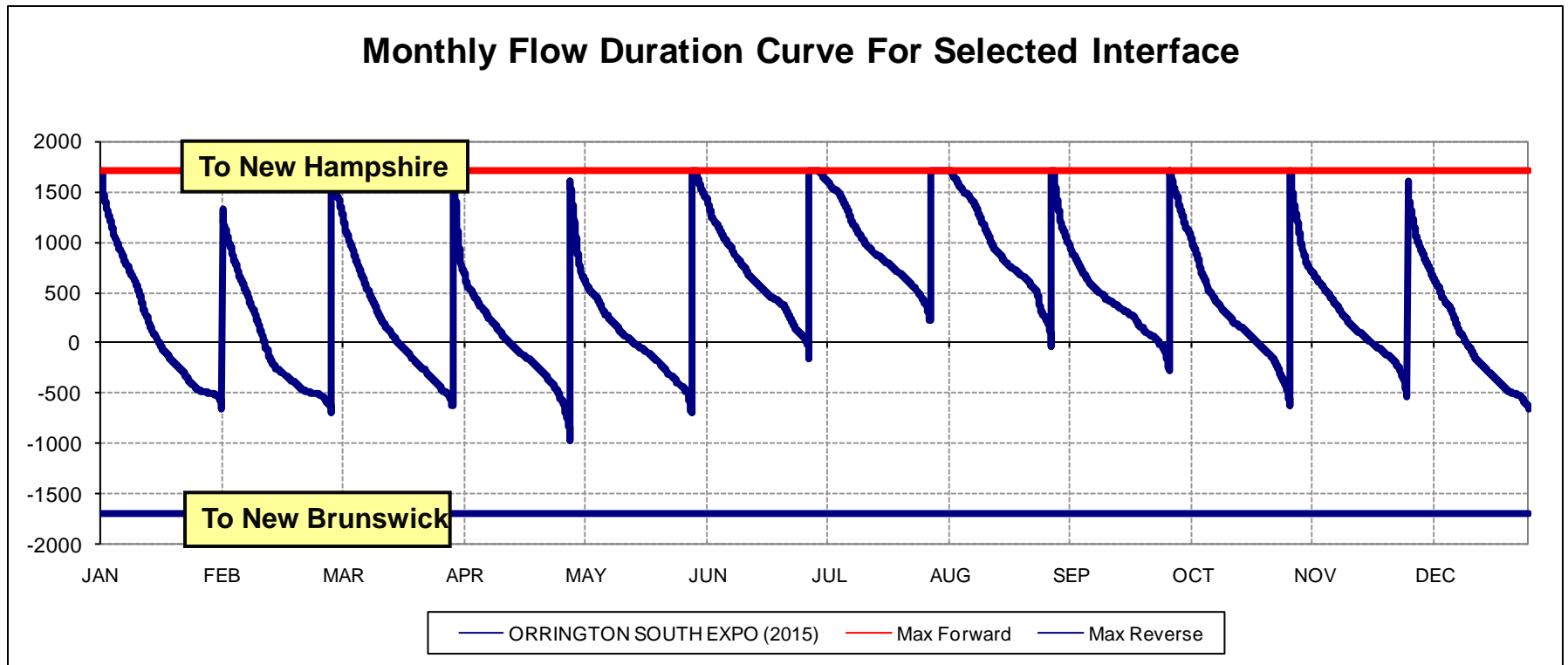
Surowiec South Interface Flow Duration As-Is, 0 MW Wind in 2015



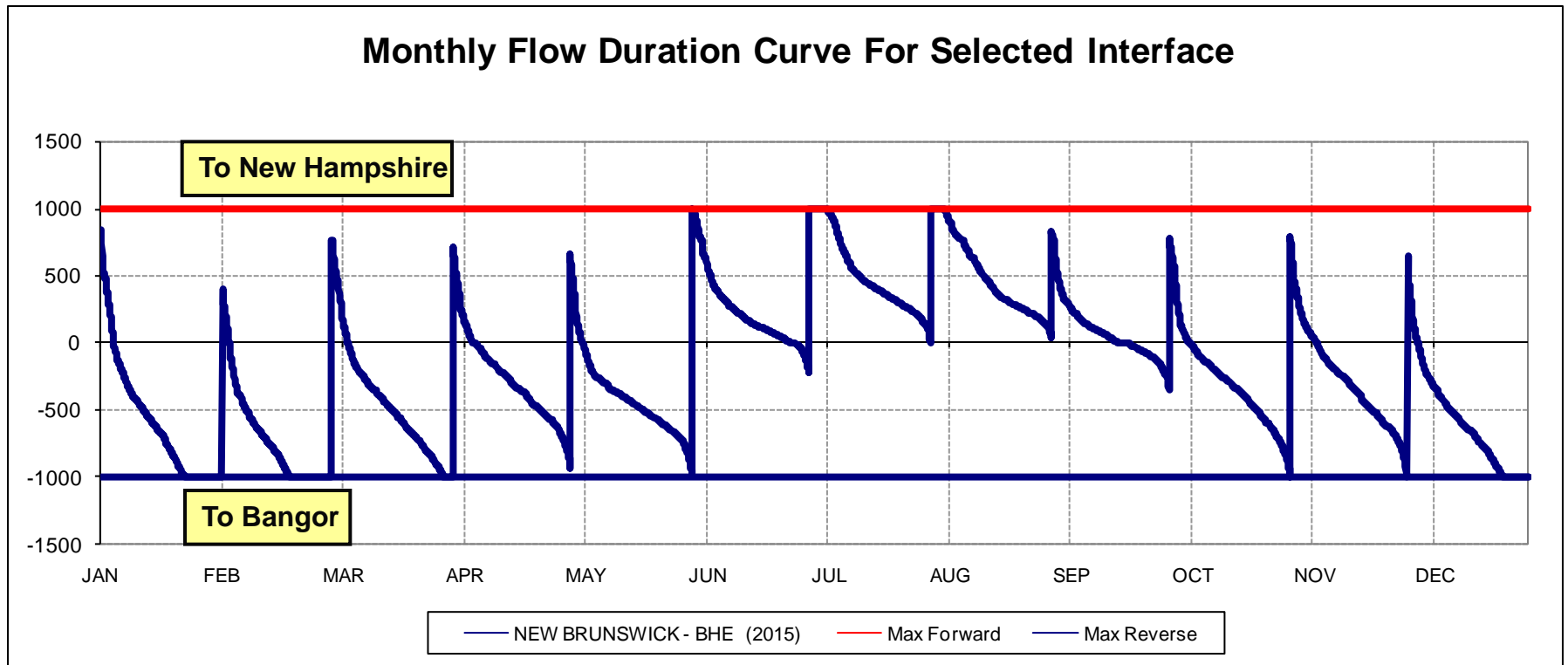
Maine / NH Interface Flow Duration As-Is, 0 MW Wind in 2015



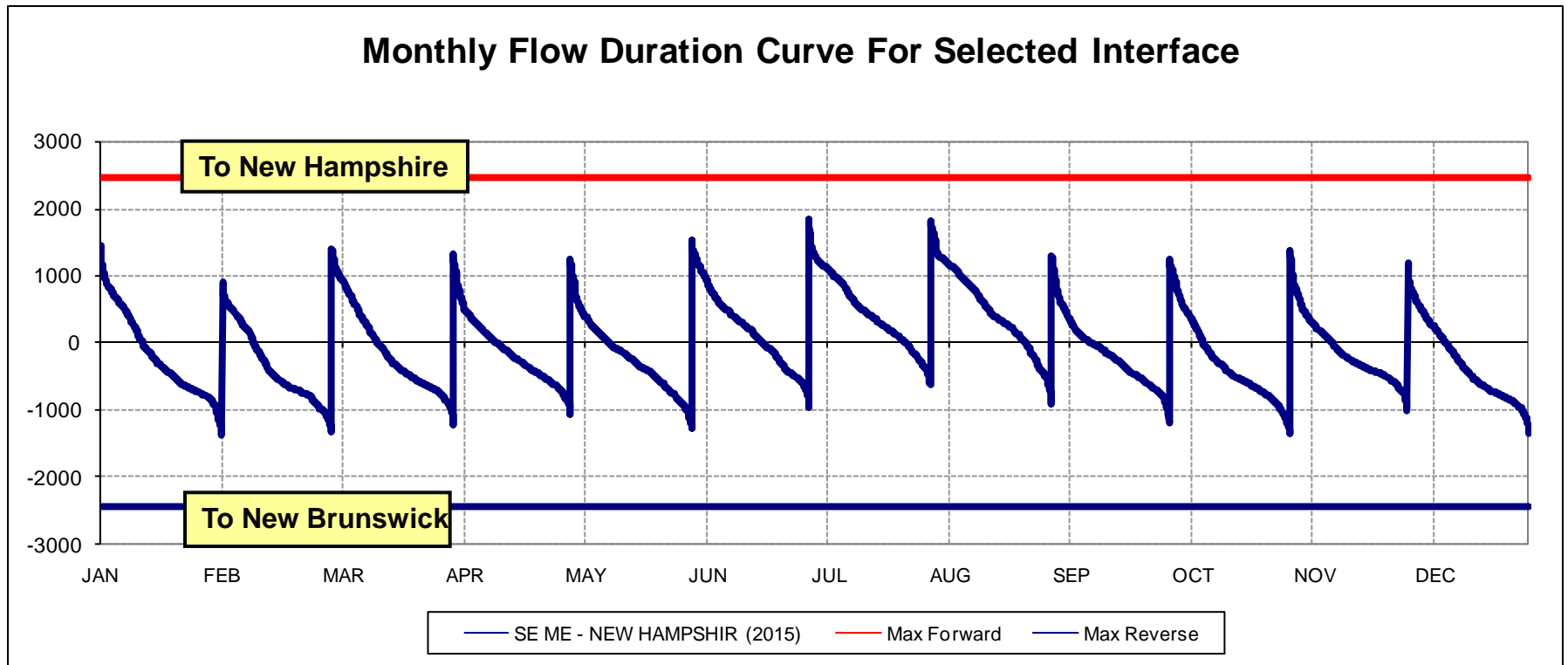
Orrington South Interface Flow Duration 800 MW Wind, MPC and MPRP in 2015



New Brunswick Interface Flow Duration 800 MW Wind, MPC and MPRP in 2015



Maine / NH Interface Flow Duration 800 MW Wind, MPC and MPRP in 2015



Next Steps and Comments

- Plan to refine modeling and results
 - Will present updated results in June
- Suggestions
 - What other scenarios?
 - How can we better summarize and present the data?
 - Should there be accounting for external area production cost impacts?
- These numbers will change as we update the analysis