



SEPTEMBER 12, 2014

2014 IRP Technical Conference Analysis Results

Table of Contents

Schedule for Remainder of IRP Process – slide 3

Development Since Previous IRPs – slide 4

Objective of the 2014 IRP – slide 5

Executive Summary – slide 6

Candidate Resource Plans – slide 7

Schedule of Firm Supply – slide 8

Key Observations – slide 9

Metrics for Evaluating the Path Forward – slide 13

Rate Influencers Graphs – slide 15

Comparison of Sensitivities – slide 18

Draft Action Plan Items – slide 19

CRP Sensitivity Matrix – slide 23

TRC / Utility Cost and Ranking – slide 26

NPV Horizons Graphical Comparison (TRC) – slide 27

Energy Source by Plan – slide 31

Planning Reserve Margin Analysis – slide 34

DSM Programs Energy and Costs – slide 35

Sustaining Capital Adjustment – slide 40

Operational Test of Select CRPs in Plexos Hourly System Model – slide 43

Schedule for Remainder of IRP Process

Sep 12: Technical Conference

Sep 19: Feedback from Intervenors/Stakeholders (for incorporation in final report)

Sep 30: Issue Draft Final Report and Action Plan to Intervenors/Stakeholders

Oct 7: Comments on Draft Final Report received from Intervenors/Stakeholders

Oct 15: Final Report and Action Plan to UARB

Development Since Previous IRPs

Regulatory and legislative initiatives:

RES target set at 40% in 2020

Legislation limiting biomass consumption in the province

Air emissions equivalency agreement

Demand and supply side investment:

DSM Administrator (2008/9 – 2013)	\$165 million	128 MW – 632 GWh
Tufts Cove 6 (HR with duct firing)	\$93 million	49 MW
Port Hawkesbury Biomass	\$209 million	45 MW – 350 GWh
Wind Energy	\$308 million (NSPI)	81 MW – 256 GWh (NSPI) 447 MW – 964 GWh (IPP)
Maritime Link	\$1,500 million	153 MW – 1,000 GWh

System load:

Loss of industrial load	~165MW – 1,100 GWh
Industrial load on load retention tariff	~185 MW – 1,050 GWh

Fuel expense recovery:

FAM Process instated	Deferred fuel expense: \$89 million
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Objective of the 2014 IRP

From Terms of Reference: *“To develop a long-term Preferred Resource Plan that establishes the direction for NS Power to meet customer demand and energy requirements, and environmental obligations in a cost-effective, safe and reliable manner across a reasonable range of foreseeable futures; and to develop an Action Plan describing the major tasks required to implement a no regrets strategy that aligns with the Preferred Resource Plan during the first five years of the planning horizon.”*

The IRP study was designed to examine a broad spectrum of outcomes considering major existing and future resource drivers:

- Demand growth
- Demand side management
- Asset management of existing resources
- Addition of new conventional and renewable resources

The major decision drivers were combined into Candidate Resource Plans (CRPs), which were examined under a number of sensitivities including: possible future emissions regulations, fuel costs and possible technology advancements.

Executive Summary

We have been successful in building renewables and investing in DSM to meet environmental obligations since the last IRP. The results from this IRP show there is a near-term window* where limited incremental investment is required.

It appears there are opportunities to minimize short term rate impacts without compromising longer term environmental and economic benefits.

Environmental compliance and capacity planning is heavily reliant on DSM performing as forecasted.

For the next 4-5 years a flexible action plan which minimizes capacity additions is appropriate.

There is a range of potential preferred resource plans based on the NPVs and other metrics; however, the company believes that alleviating rate pressure in the near term is in the interest of the customers.

* Near term refers to the period before 2020.

Candidate Resource Plan Descriptions

CRP	DSM	WIND	COAL
World 1 - REFERENCE			
CRP1-1-FGD	50% of LOW	BASE	MAX
CRP2-1	BASE	BASE	MAX
CRP2-17-FGD	BASE	BASE	MAX
CRP3-1	BASE	MED	MAX
CRP4-1	BASE	BASE	MED
CRP4-1-FGD	BASE	BASE	MED
CRP5-1	HIGH	BASE	MAX
CRP6-1	HIGH	HIGH	MIN
CRP7-1	HIGH	MED	MIN
CRP8-1	BASE	HIGH	MIN
CRP9-1	BASE	MED	MIN
CRP9WC	BASE	MED (Optimistic Capacity Credit)	MIN
CRP10-1	BASE	MED	MED
CRP31-1	BASE - 50% Peak 100% Energy	MED	MAX
World 2- HIGH LOAD			
CRP21-1 (FGD WIND)	BASE	MED (Optimize)	MAX
CRP32-1 (FGD PPA)	BASE -50% Peak 100% Energy	MED (Optimize)	MAX

	Max Retirement Strategy
	Med Retirement Strategy
	Min Retirement Strategy
	Max Retirement Strategy - High Load

Preliminary Results

Schedule of Firm Supply

Candidate Resource Plans - Schedule of Changes to Supply-side and Demand-side Resources (Firm MWs)

	CRP1-1 FGD	CRP2-1	CRP2-17 FGD	CRP3-1	CRP4-1	CRP4-1 FGD	CRP5-1	CRP6-1	CRP7-1	CRP8-1	CRP9-1	CRP9WC*	CRP10-1	CRP31-1	CRP21-1 (FGD WIND)	CRP32-1 (FGD PPA)
Load	Base	Base	Base	Base	Base	Base	Base	Base	Base	Base	Base	Base	Base	Base	High	High
DSM Profile	Half Low	Base	Base	Base	Base	Base	High	High	High	Base	Base	Base	Base	Base	Base	Base
Wind	Base	Base	Base	Med	Base	Base	Base	High	Med	High	Med	Med	Med	Med	Med	Base
Retirement Strategy	Max	Max	Max	Max	Med	Med	Max	Min	Min	Min	Min	Min	Med	Max	Max	Max
New Resources 2015-2020																
DSM	62	156	156	156	156	156	241	241	241	156	156	156	156	80	156	80
Maritime Link	153	153	153	153	153	153	153	153	153	153	153	153	153	153	153	153
DR	0	0	0	0	19	19	0	0	19	10	19	19	19	0	0	10
Mersey	15	0	0	0	0	0	0	0	0	15	15	15	15	0	15	0
Wind	0	0	0	0	0	0	0	0	0	0	0	70	0	0	18	0
PPA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100
PHBM	0	0	0	0	0	0	0	52	52	52	52	52	0	0	0	0
NG CT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	99	0
NG CC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FGD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-8	-8
Retirements																
Coal	-153	-153	-153	-153	-153	-153	-153	-306	-306	-306	-306	-306	-153	-153	-153	-153
NG/Oil	0	0	0	0	-81	-81	0	0	0	0	0	0	0	0	0	0
Subtotal	77	156	156	156	94	94	241	140	159	80	89	158	190	80	280	182
New Resources 2021-2039																
DSM	202	510	510	510	510	510	643	643	643	510	510	510	510	254	510	254
DR	0	0	0	0	67	67	0	0	67	52	67	67	67	0	0	52
Mersey	15	0	0	0	0	0	0	0	0	15	15	15	15	0	15	0
Wind	0	0	0	18	0	0	0	36	18	36	18	36	18	18	0	0
PPA	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PHBM	52	52	52	52	0	0	52	0	0	0	0	0	52	52	45	45
NG CT	315	99	149	99	216	99	0	296	197	444	296	364	265	330	148	397
NG CC	145	0	0	0	290	145	0	0	0	0	145	0	0	145	0	145
FGD	-8	0	-8	0	0	-8	0	0	0	0	0	0	0	0	0	0
Retirements																
Coal	-303	-303	-303	-303	-614	-303	-303	-613	-613	-613	-613	-613	-613	-614	-303	-303
NG/Oil	-174	-174	-174	-174	-240	-240	-174	-174	-174	-174	-174	-174	-174	-174	-174	-174
Subtotal	344	183	226	201	229	270	218	188	138	270	264	205	139	322	242	417
Total Additional Firm Supply & Demand MW's Over Planning Period																
Total	421	340	382	358	323	364	459	328	297	350	353	364	329	402	521	599

See Notes on next slide

Preliminary Results

Schedule of Firm Supply

Notes for Schedule of Changes to Supply-side and Demand-side Resources (Firm MWs)

- DSM - capacity refers to reduction in firm demand (net of interruptible industrial portion)
- DR (Demand Response) - capacity refers to reduction in firm demand
- Mersey - incremental capacity upgrade
- Wind - firm contribution of incremental wind above planned and committed wind of 582 MW
 - * for CRP9WC the firm contribution of planned /committed wind and incremental wind was increased to 24.1%
- PPA - Large non-emitting, RES compliant Purchased Power Agreement
- PHBM - PH Biomass unit is assumed to transition to a firm capacity resource upon the retirement of a second Lingan unit
- NG CT - Natural Gas Combustion Turbine
- NG CC - Natural Gas Combined Cycle
- FGD - coal retrofit with an FGD (scrubber) results in reduced capacity due to parasitic power

Key Observations

1. The planning done through the 2007 IRP and refined in the 2009 IRP Update has proven robust. Combined with the Maritime Link, continued operation of NS Power's existing assets and investment in renewables and DSM continue as key elements of the 2014 IRP low-cost plans.
2. CRP 2 reflects the Base IRP assumptions and has emerged as the lowest NPV plan over the 25 year period.
3. For CRP 2 and other lower cost plans, it appears there is limited incremental spending required up to 2020 to meet environmental requirements. The spending that is required in this period is largely limited to investment in DSM.
4. Base DSM, as forecasted, would offset Base Load Growth. If DSM delivery beyond 2020 does not meet the DSM forecast then the system will experience reliability and environmental/emissions challenges.

Key Observations

5. A variable DSM¹ spending profile has the potential to lower near term (~5 year) rate pressure while being competitive on a planning period NPV basis. The amount of DSM economically justified over this period and across the planning period remains a matter to be addressed through negotiations between NS Power and ENSC and the subsequent regulatory proceeding.
6. Uncertainty in the outer years may make it more beneficial to concentrate on nearer term IRP metrics.
7. FGD at Lingan 3 and 4 appears economic in several Base Load CRPs and in all High Load World (flat net load) CRPs based on the international price of HS coal.
8. Capacity additions are required for High Load World CRPs in the early 2020s.

¹ A variable DSM spending profile refers to DSM programming that could be modified from year to year to have lower spending in the near term and higher spending post 2020.

Key Observations

9. Environmental regulations can be most economically met over the 25 year planning period by maintaining wind penetration at current levels.
10. High DSM plans present the greatest near-term rate pressure.
11. All plans respond similarly over the range of sensitivities, which is a reflection of resource flexibility of the NSPI system.
12. All other things being equal, a 60-year life retirement schedule for the coal fleet (Max Coal) is the most economic over the planning period.
13. Tested against the Base Assumptions, Emissions scenarios do not show major movement in NPVs.

Criteria for Evaluating the Path Forward

The indicators available from Strategist and other sources:

- **NPV:** Cross-section of near and long term NPVs including end effects NPVs
- **Rate Effects:** Relative time-series revenue requirements
- **Risk:** Relative complexity and risks inherent in CRPs
- **Flexibility:** Diversity of technological solutions
- **Robustness:** Results of sensitivity tests
- **Future Regulatory emissions outlook**

The best performing aspects of several CRPs may be combined to inform development of a robust resource plan that is adaptable to future regulatory, supply, and demand side requirements, while being sensitive to accuracy of system assumptions in the outer years.

Metrics for Evaluating the Path Forward (NPV)

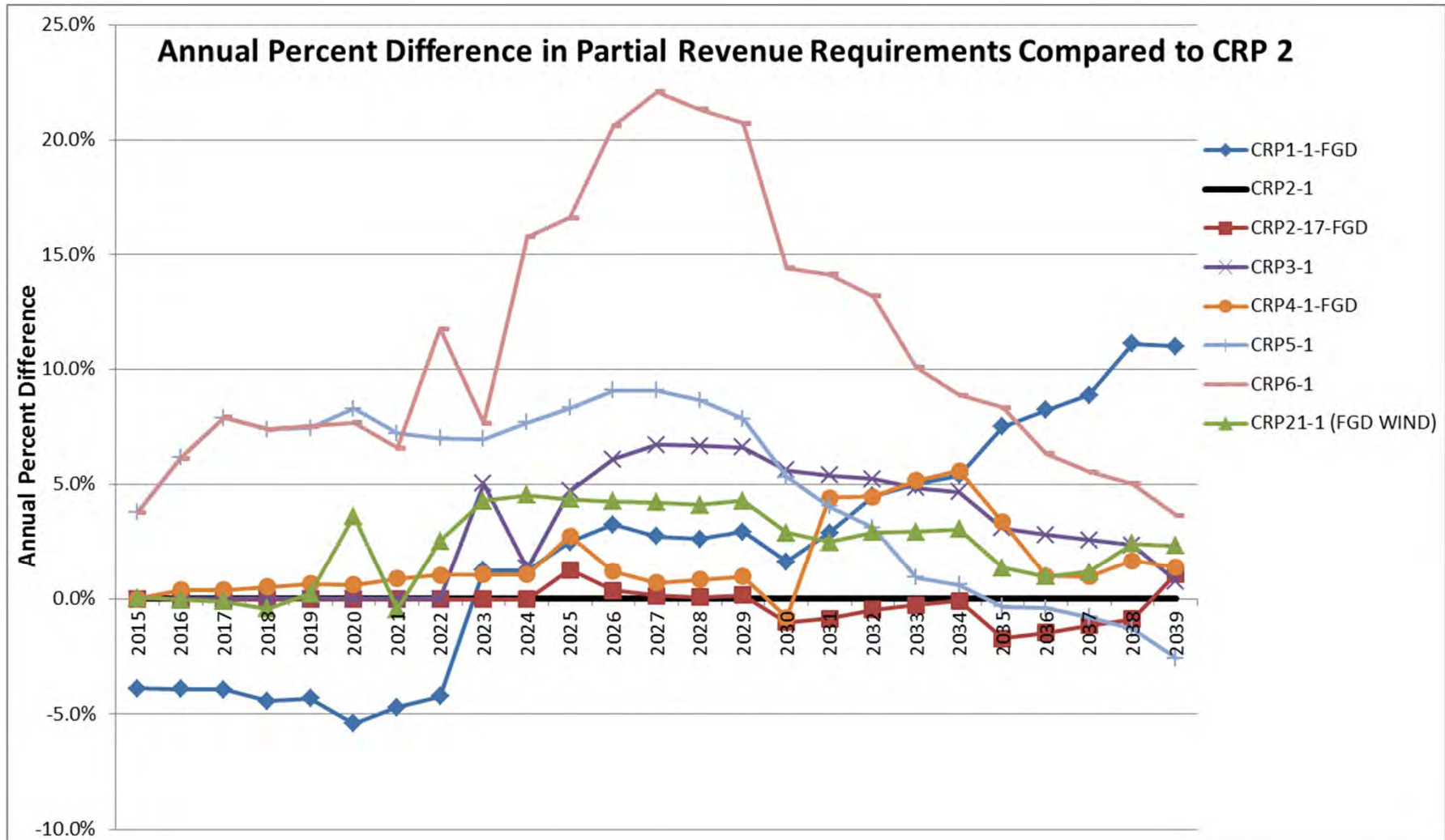
Net Present Value of Candidate Resource Plans are presented for four periods, Derived from the significant milestones horizons in the regulatory/legislative framework as well as standard modeling horizons.

NPV Horizon	Description
Short term period leading to 40% RES requirement (2020)	NPV considering short term rate impact concentrating on evaluating CRPs with near term system assumptions.
Legislated Emissions Regulations Period (2030)	NPV considering only presently active emissions regulations without speculating on future legislative direction.
Planning Period (2039)	Planning Period NPV will include sustaining capital overlays in order to provide equalized comparison base for plans with early and late asset retirement schedules.
Study Period (Infinity)	This NPV takes in account costs beyond 2039 in the end effects. The model determines the end effects costs internally as a single net present value calculation and adds it to the planning period costs to give the study period costs. Study period NPVs are not comparable across retirement horizons.

Comparison of Partial Revenue Requirements Graphs

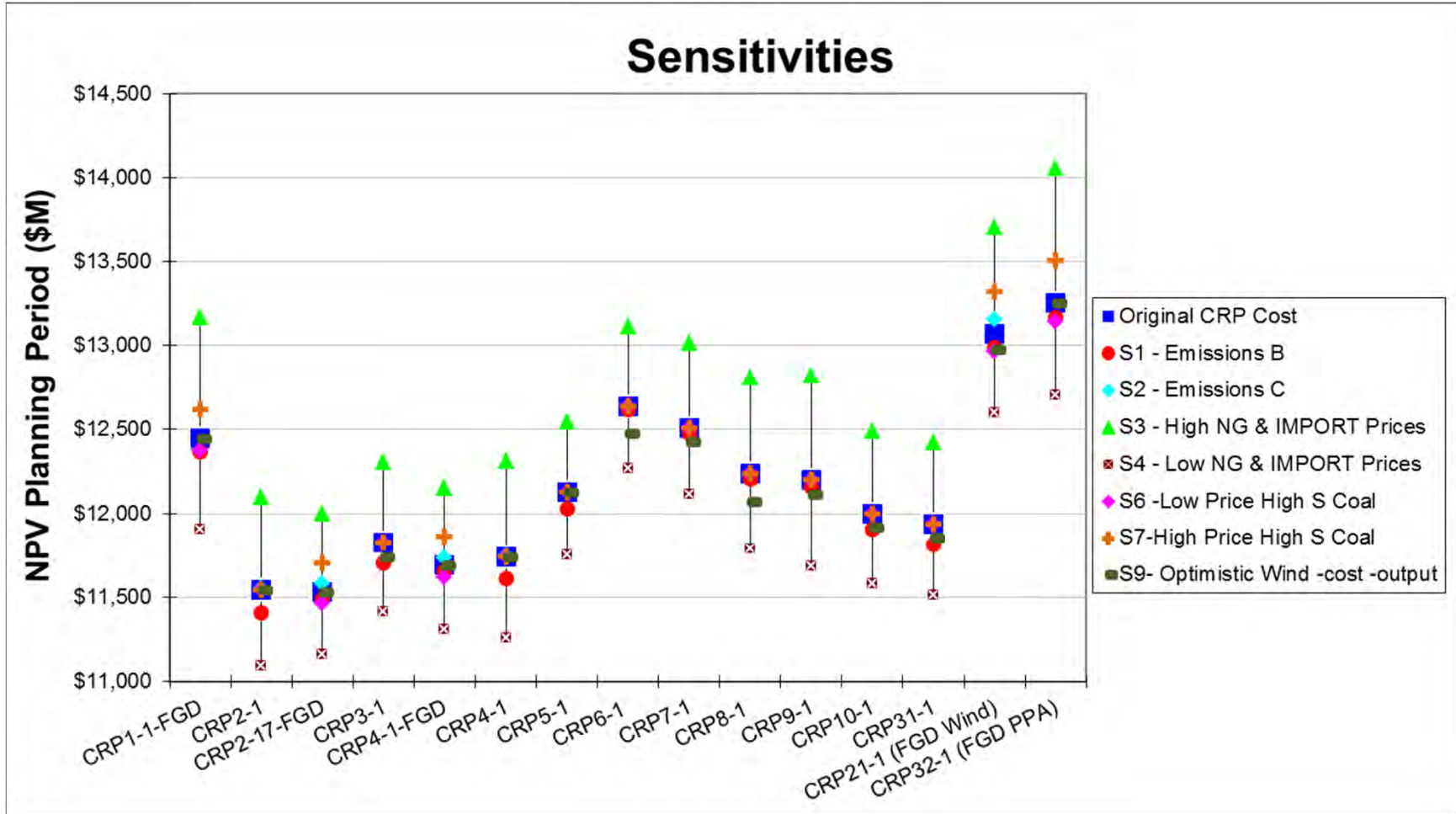
- NS Power believes customers are concerned with affordability particularly in the short term.
- The following two graphs present a CRP comparison based on the partial revenue requirements.
- The partial revenue requirements are those costs which have been included in the Strategist modeling as well as the adjustment for sustaining capital costs completed outside of the model.
- These costs do not encompass NS Power's total revenue requirement. They include only a portion of the costs such as fuel and purchased power, thermal and hydro unit O&M, capital costs for new resources added in the CRP and DSM program administrator costs.
- The graphs do not include other cost items that would be common among all CRPs such as remaining O&M, regulatory adjustments/amortizations, interest and tax impacts.
- These partial revenue requirements were adjusted by load to put the CRPs on an equal basis for comparison. The graphs show the annual percent difference compared to CRP 2.
- Since the total revenue requirement is not reflected in these partial costs, the graphs provide an indication of relative cost pressures among CRPs rather than an increase in rates.
- These graphs present a relative comparison among CRPs. They do not provide a comparison relative to NS Power's currently approved revenue requirement.

Preliminary Results Annual Percent Difference (Select Group of CRP's)



Preliminary Results

CRP Comparison of Sensitivities



Draft Action Plan Items

- Demand Side Management
 - Engage with ENSC and stakeholders to develop 3 year plan and file for UARB approval
 - Engage with stakeholders and ENSC to monitor DSM performance and options
 - Pursue cost-effective Demand Response opportunities

- Renewable Resources
 - Pursue the study of further intermittent generation to determine appropriate capacity value and Network Resource Interconnection Service (NRIS) and Energy Resource Interconnection Service (ERIS) capacity by Q4 2016
 - Monitor ongoing developments of tidal energy and report to the UARB as part of the 10 Year System Outlook
 - Complete the integration of the Maritime Link
 - Undertake Mersey (base) Redevelopment Capital Application for filing with the UARB
 - Continue to develop an understanding of the operational challenges associated with variable generation and report to the UARB as part of the 10 Year System Outlook
 - File Renewable to Retail Tariff Application
 - Report to the UARB on the status of the need for flexible resources to integrate additional variable generation in the 10 Year System Outlook Report

Draft Action Plan Items (cont'd)

- Regional Opportunities
 - Monitor cost-effective market opportunities (imports and exports) as well as enhancements in regional balancing and interconnection and report on developments in the 10 Year System Outlook Report

- Existing Thermal Resources
 - Within 24 months of the IRP, produce a report on industry best practices regarding sustaining capital
 - Report on the status of sustaining capital expenditures for 5 year periods in the Annual Capital Expenditure Plan
 - Present current retirement forecast in 10 Year System Outlook Report
 - Study the economic potential of an FGD in combination with opportunities to optimize solid fuel use
 - Analyze potential optimal capital spending plans for the existing thermal fleet given peak load and annual energy paths that would align with “high” levels of DSM spending and associated high levels of firm peak reduction. This includes devising capital investment plans that reduce the level of “surplus” planning reserve margin that would exist with, e.g., CRP 5-1.

Draft Action Plan Items (cont'd)

- Transmission
 - Execute the Maritime Link transmission investments
 - Monitor and report on regional transmission integration opportunities by the end of Q2 2016

- Planning Reserve Margin
 - Report on the ongoing evaluation of the appropriate planning reserve margin for the power system in the 10 Year System Outlook Report

- Regulatory
 - Monitor renewable and emissions related legislative/regulatory developments
 - Report to the UARB on legislative/regulatory changes that may have a material impact on the Action Plan - one update to be sent in Q3 2016



SEPTEMBER 12, 2014

Supporting Materials

Preliminary Results

CRP Sensitivity Matrix

These results include the NPV adders for Sustaining Capital
 Study period NPV's can only be compared within the same unit retirement strategies (e.g. all maximum coal)

		50% Low DSM	High DSM	Base DSM	Base DSM- 50% PEAK, 100% ENERGY	Cost unchanged from Original Case											
All Values in \$M		Original Data		S1 - Emissions B		S2 - Emissions C		S3 - High NG & IMPORT Prices		S4 - Low NG & IMPORT Prices		S6 - Low Price High S Coal		S7 - High Price High S Coal		S9 - Optimistic Wind - cost-output	
CRP	Planning Period	Study Period	Planning Period	Study Period	Planning Period	Study Period	Planning Period	Study Period	Planning Period	Study Period	Planning Period	Study Period	Planning Period	Study Period	Planning Period	Study Period	
	Cost	Cost	Cost	Cost	Cost	Cost	Cost	Cost	Cost	Cost	Cost	Cost	Cost	Cost	Cost	Cost	
World 1 - REFERENCE																	
CRP1-1-FGD	\$12,449	\$19,774	\$12,370	\$19,617			\$13,166	\$21,288	\$11,899	\$18,331	\$12,372	\$19,600	\$12,619	\$20,203	\$12,449	\$19,774	
CRP2-1	\$11,544	\$17,103	\$11,405	\$16,802	\$11,551	\$17,192	\$12,097	\$18,216	\$11,090	\$15,993	\$11,544	\$17,103	\$11,544	\$17,103	\$11,544	\$17,103	
CRP2-17-FGD	\$11,530	\$17,200	\$11,489	\$17,102	\$11,580	\$17,391	\$11,996	\$18,280	\$11,157	\$16,259	\$11,460	\$17,093	\$11,704	\$17,484	\$11,530	\$17,200	
CRP3-1	\$11,825	\$17,419	\$11,704	\$17,150			\$12,308	\$18,392	\$11,406	\$16,412	\$11,825	\$17,419	\$11,825	\$17,419	\$11,742	\$17,199	
CRP4-1	\$11,736	\$17,643	\$11,609	\$17,436	\$11,743	\$17,686	\$12,309	\$18,807	\$11,253	\$16,258	\$11,736	\$17,643	\$11,736	\$17,643	\$11,736	\$17,643	
CRP4-1-FGD	\$11,692	\$17,469	\$11,654	\$17,343	\$11,734	\$17,594	\$12,156	\$18,563	\$11,305	\$16,401	\$11,622	\$17,326	\$11,863	\$17,713	\$11,692	\$17,469	
CRP5-1	\$12,125	\$17,076	\$12,027	\$16,849			\$12,548	\$17,900	\$11,746	\$16,185	\$12,125	\$17,076	\$12,125	\$17,076	\$12,125	\$17,076	
CRP6-1	\$12,638	\$17,829	\$12,617	\$17,808	\$12,638	\$17,829	\$13,110	\$18,735	\$12,264	\$16,965	\$12,638	\$17,829	\$12,638	\$17,829	\$12,478	\$17,405	
CRP7-1	\$12,512	\$17,666	\$12,479	\$17,633			\$13,016	\$18,653	\$12,108	\$16,727	\$12,512	\$17,666	\$12,512	\$17,666	\$12,430	\$17,452	
CRP8-1	\$12,240	\$18,095	\$12,205	\$18,059	\$12,240	\$18,095	\$12,811	\$19,263	\$11,784	\$16,991	\$12,240	\$18,095	\$12,240	\$18,095	\$12,075	\$17,651	
CRP9-1	\$12,200	\$18,091	\$12,158	\$18,049	\$12,200	\$18,091	\$12,824	\$19,396	\$11,680	\$16,770	\$12,200	\$18,091	\$12,200	\$18,091	\$12,117	\$17,870	
CRP9WC	\$12,101	\$17,968	\$12,059	\$17,926	\$12,101	\$17,968	\$12,718	\$19,281	\$11,600	\$16,736	\$12,101	\$17,968	\$12,101	\$17,968	\$12,017	\$17,742	
CRP10-1	\$12,000	\$17,731	\$11,904	\$17,566			\$12,490	\$18,733	\$11,576	\$16,694	\$12,000	\$17,731	\$12,000	\$17,731	\$11,919	\$17,515	
CRP31-1	\$11,934	\$17,831	\$11,815	\$17,563			\$12,424	\$18,822	\$11,505	\$16,690	\$11,934	\$17,831	\$11,934	\$17,831	\$11,856	\$17,620	
World 2- HIGH LOAD																	
CRP21-1 (FGD)	\$13,071	\$19,852	\$12,990	\$19,712	\$13,157	\$20,289	\$13,706	\$21,267	\$12,593	\$18,690	\$12,962	\$19,685	\$13,322	\$20,246	\$12,979	\$19,624	
CRP32-1 (FGD PPA)	\$13,256	\$20,585	\$13,166	\$20,389			\$14,056	\$22,161	\$12,697	\$19,067	\$13,143	\$20,371	\$13,508	\$21,084	\$13,256	\$20,585	

Preliminary Results

Ranking for Sensitivities

		Max Retirement Strategy				Med Retirement Strategy				Min Retirement Strategy						
CRP	Original Data		S1 - Emissions B		S2 - Emissions C		S3 - High NG & IMPORT Prices		S4 - Low NG & IMPORT Prices		S6 - Low Price High S Coal		S7 - High Price High S Coal		S9 - Optimistic Wind -cost -output	
	Planning Period Rank	** Study Period Rank	Planning Period Rank	** Study Period Rank	Planning Period Rank	** Study Period Rank	Planning Period Rank	** Study Period Rank	Planning Period Rank	** Study Period Rank	Planning Period Rank	** Study Period Rank	Planning Period Rank	** Study Period Rank	Planning Period Rank	** Study Period Rank
World 1 - REFERENCE																
CRP1-1-FGD	12	6	12	6			14	6	12	6	12	6	13	6	13	6
CRP2-1	2	2	1	1	1	1	2	2	1	1	2	3	1	2	2	2
CRP2-17-FGD	1	3	2	3	2	2	1	3	2	3	1	2	2	4	1	4
CRP3-1	5	4	5	4			4	4	5	4	5	4	4	3	5	3
CRP4-1	4	2	3	2	4	2	5	3	3	1	4	2	3	1	4	3
CRP4-1-FGD	3	1	4	1	3	1	3	1	4	2	3	1	5	2	3	1
CRP5-1	9	1	8	2			8	1	10	2	9	1	9	1	11	1
CRP6-1	14	2	14	2	8	1	13	2	14	4	14	2	14	2	14	1
CRP7-1	13	1	13	1			12	1	13	1	13	1	12	1	12	2
CRP8-1	11	5	11	5	7	4	10	3	11	5	11	5	11	5	9	3
CRP9-1	10	4	10	4	6	3	11	5	9	3	10	4	10	4	10	5
CRP9WC	8	3	9	3	5	2	9	4	8	2	8	3	8	3	8	4
CRP10-1	7	3	7	3			7	2	7	3	7	3	7	3	7	2
CRP31-1	6	5	6	5			6	5	6	5	6	5	6	5	6	5
World 2- HIGH LOAD																
*CRP21-1 (FGD)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
*CRP32-1 (FGD PPA)	2	2	2	2			2	2	2	2	2	2	2	2	2	2

* High Load plans (CRP 21 & 32) are ranked separately from Base Load plans.

** CRPs have been grouped by retirement strategy for rankings on Study Period costs. For example, all five CRPs with Min Coal retirement strategy are shaded in blue and have been ranked from 1 to 5.

Preliminary Results

% Difference for Sensitivities

		Max Retirement Strategy				Med Retirement Strategy				Min Retirement Strategy							
		Original Data		S1 - Emissions B		S2 - Emissions C		S3 - High NG & IMPORT Prices		S4 - Low NG & IMPORT Prices		S6 - Low Price High S Coal		S7 - High Price High S Coal		S9 - Optimistic Wind -cost -output	
CRP	Planning Period Rank	** Study Period Rank	Planning Period Rank	** Study Period Rank	Planning Period Rank	** Study Period Rank	Planning Period Rank	** Study Period Rank	Planning Period Rank	** Study Period Rank	Planning Period Rank	** Study Period Rank	Planning Period Rank	** Study Period Rank	Planning Period Rank	** Study Period Rank	
World 1 - REFERENCE																	
CRP1-1-FGD	8.0%	15.8%	8.5%	16.8%			9.8%	18.9%	7.3%	14.6%	8.0%	14.8%	9.3%	18.3%	8.0%	15.8%	
CRP2-1	0.1%	0.2%	0.0%	0.0%	0.0%	0.0%	0.8%	1.8%	0.0%	0.0%	0.7%	0.2%	0.0%	0.2%	0.1%	0.2%	
CRP2-17-FGD	0.0%	0.7%	0.7%	1.8%	0.3%	1.2%	0.0%	2.1%	0.6%	1.7%	0.0%	0.1%	1.4%	2.4%	0.0%	0.7%	
CRP3-1	2.6%	2.0%	2.6%	2.1%			2.6%	2.7%	2.8%	2.6%	3.2%	2.0%	2.4%	2.0%	1.8%	0.7%	
CRP4-1	1.8%	1.0%	1.8%	0.5%	1.7%	0.5%	2.6%	1.3%	1.5%	0.0%	2.4%	1.8%	1.7%	0.0%	1.8%	1.0%	
CRP4-1-FGD	1.4%	0.0%	2.2%	0.0%	1.6%	0.0%	1.3%	0.0%	1.9%	0.9%	1.4%	0.0%	2.8%	0.4%	1.4%	0.0%	
CRP5-1	5.2%	0.0%	5.5%	0.3%			4.6%	0.0%	5.9%	1.2%	5.8%	0.0%	5.0%	0.0%	5.2%	0.0%	
CRP6-1	9.6%	0.9%	10.6%	1.0%	9.4%	0.0%	9.3%	0.4%	10.6%	1.4%	10.3%	0.9%	9.5%	0.9%	8.2%	0.0%	
CRP7-1	8.5%	0.0%	9.4%	0.0%			8.5%	0.0%	9.2%	0.0%	9.2%	0.0%	8.4%	0.0%	7.8%	0.3%	
CRP8-1	6.2%	2.4%	7.0%	2.4%	6.0%	1.5%	6.8%	3.3%	6.3%	1.6%	6.8%	2.4%	6.0%	2.4%	4.7%	1.4%	
CRP9-1	5.8%	2.4%	6.6%	2.4%	5.6%	1.5%	6.9%	4.0%	5.3%	0.3%	6.5%	2.4%	5.7%	2.4%	5.1%	2.7%	
CRP9WC	4.9%	1.7%	5.7%	1.7%	4.8%	0.8%	6.0%	3.4%	4.6%	0.1%	5.6%	1.7%	4.8%	1.7%	4.2%	1.9%	
CRP10-1	4.1%	1.5%	4.4%	1.3%			4.1%	0.9%	4.4%	2.7%	4.7%	2.3%	3.9%	0.1%	3.4%	0.3%	
CRP31-1	3.5%	4.4%	3.6%	4.5%			3.6%	5.2%	3.7%	4.4%	4.1%	4.4%	3.4%	4.4%	2.8%	3.2%	
World 2 - HIGH LOAD																	
*CRP21-1 (FGD)	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%	0.0%	0.0%	
*CRP32-1 (FGD PPA)	1.4%	3.7%	1.4%	3.4%			2.6%	4.2%	0.8%	2.0%	1.4%	3.5%	1.4%	4.1%	2.1%	4.9%	

* High Load plans (CRP 21 & 32) are ranked separately from Base Load plans.

** CRPs have been grouped by retirement strategy for rankings on Study Period costs. For example, all five CRPs with Min Coal retirement strategy are shaded in blue and have been ranked from 1 to 5.

Preliminary Results (with Sustaining Capital)

TRC and Ranking / Utility Cost and Ranking

	CRP1-1 FGD	CRP2-1	CRP2-17 FGD	CRP3-1	CRP4-1	CRP4-1 FGD	CRP5-1	CRP6-1	CRP7-1	CRP8-1	CRP9-1	CRP9WC	CRP10-1	CRP31-1	* CRP21-1 (FGD WIND)	* CRP32-1 (FGD PPA)
Load	Base	Base	Base	Base	Base	Base	Base	Base	Base	Base	Base	Base	Base	Base	High	High
DSM Profile	Half Low	Base	Base	Base	Base	Base	High	High	High	Base	Base	Base	Base	Base 50% Peak 100% Energy	Base	Base 50% Peak 100% Energy
Wind	Base	Base	Base	Med	Base	Base	Base	High	Med	High	Med	Med	Med	Med	Med	Base
Retirement Strategy	Max	Max	Max	Max	Med	Med	Max	Min	Min	Min	Min	Min	Med	Max	Max	Max
TRC \$ M																
NPV 2020	\$3,907	\$4,049	\$4,049	\$4,049	\$4,065	\$4,065	\$4,491	\$4,489	\$4,507	\$4,062	\$4,072	\$4,072	\$4,075	\$4,050	\$4,194	\$4,195
NPV 2030	\$9,025	\$8,777	\$8,780	\$8,959	\$8,836	\$8,838	\$9,547	\$9,864	\$9,790	\$9,203	\$9,182	\$9,113	\$9,063	\$8,963	\$9,764	\$9,761
Planning Period	\$12,449	\$11,544	\$11,530	\$11,825	\$11,737	\$11,693	\$12,125	\$12,638	\$12,512	\$12,240	\$12,200	\$12,101	\$12,000	\$11,933	\$13,070	\$13,256
** Study Period	\$19,775	\$17,103	\$17,201	\$17,419	\$17,643	\$17,469	\$17,076	\$17,829	\$17,666	\$18,095	\$18,091	\$17,968	\$17,731	\$17,831	\$19,851	\$20,585
TRC Rank																
NPV 2020	1	3	2	3	7	7	13	12	14	6	9	9	11	5	1	2
NPV 2030	7	1	2	5	3	4	12	14	13	11	10	9	8	6	2	1
Planning Period	12	2	1	5	4	3	9	14	13	11	10	8	7	6	1	2
Avg. Rank	6.7	2.0	1.7	4.3	4.7	4.7	11.3	13.3	13.3	9.3	9.7	8.7	8.7	5.7	1.25	1.75
** Study Period	6	2	3	4	2	1	1	2	1	5	4	3	3	5	1	2
Utility Cost \$ M																
NPV 2020	\$3,784	\$3,858	\$3,857	\$3,858	\$3,874	\$3,874	\$4,054	\$4,051	\$4,069	\$3,871	\$3,880	\$3,880	\$3,883	\$3,859	\$4,002	\$4,003
NPV 2030	\$8,762	\$8,416	\$8,420	\$8,599	\$8,475	\$8,478	\$8,672	\$8,989	\$8,915	\$8,843	\$8,822	\$8,753	\$8,703	\$8,603	\$9,403	\$9,401
Planning Period	\$12,086	\$11,069	\$11,055	\$11,350	\$11,262	\$11,218	\$11,087	\$11,601	\$11,475	\$11,765	\$11,725	\$11,626	\$11,525	\$11,458	\$12,595	\$12,781
** Study Period	\$19,270	\$16,471	\$16,568	\$16,786	\$17,010	\$16,836	\$15,846	\$16,599	\$16,436	\$17,462	\$17,458	\$17,336	\$17,098	\$17,198	\$19,219	\$19,953
Utility Cost Rank																
NPV 2020	1	3	2	3	7	7	13	12	14	6	9	9	11	5	1	2
NPV 2030	10	1	2	5	3	4	7	14	13	12	11	9	8	6	2	1
Planning Period	14	2	1	6	5	4	3	10	8	13	12	11	9	7	1	2
Avg. Rank	8.3	2.0	1.7	4.7	5.0	5.0	7.7	12.0	11.7	10.3	10.7	9.7	9.3	6.0	1.25	1.75
** Study Period	6	2	3	4	2	1	1	2	1	5	4	3	3	5	1	2

Max Retirement Strategy

Med Retirement Strategy

Min Retirement Strategy

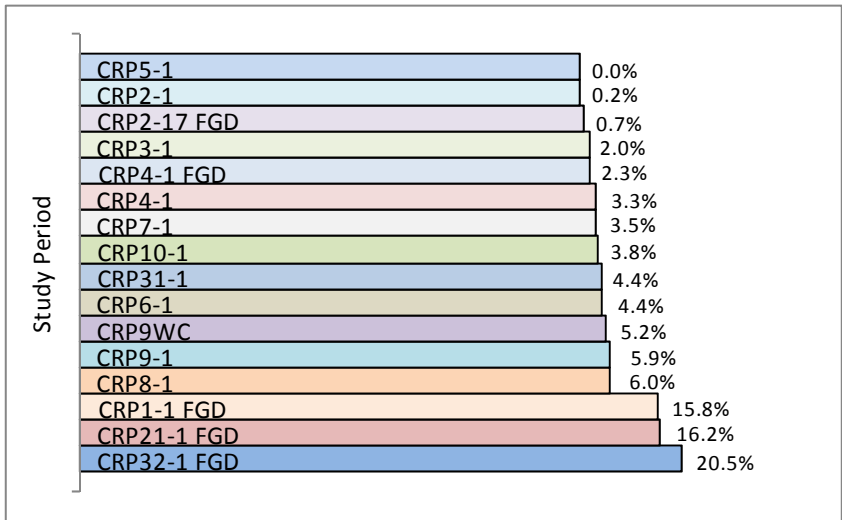
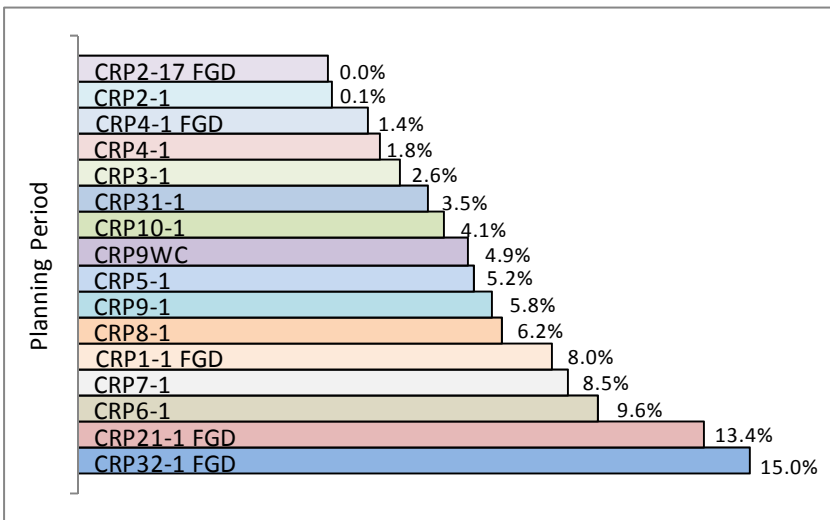
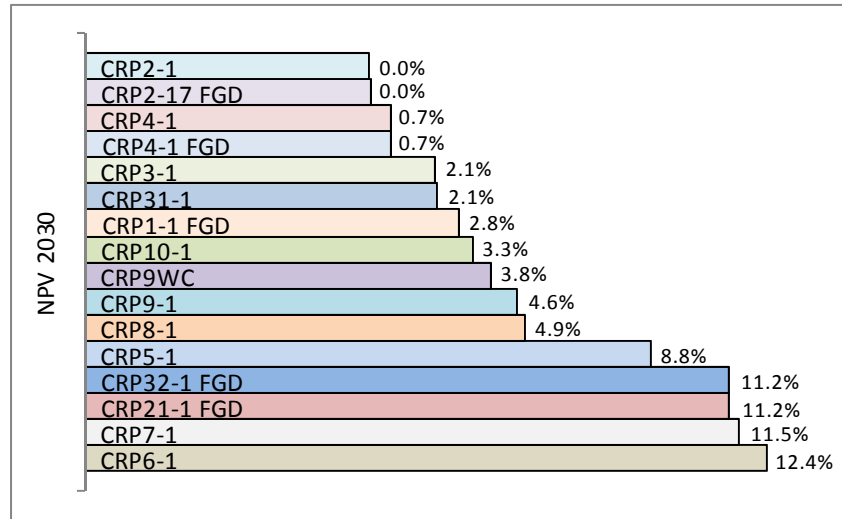
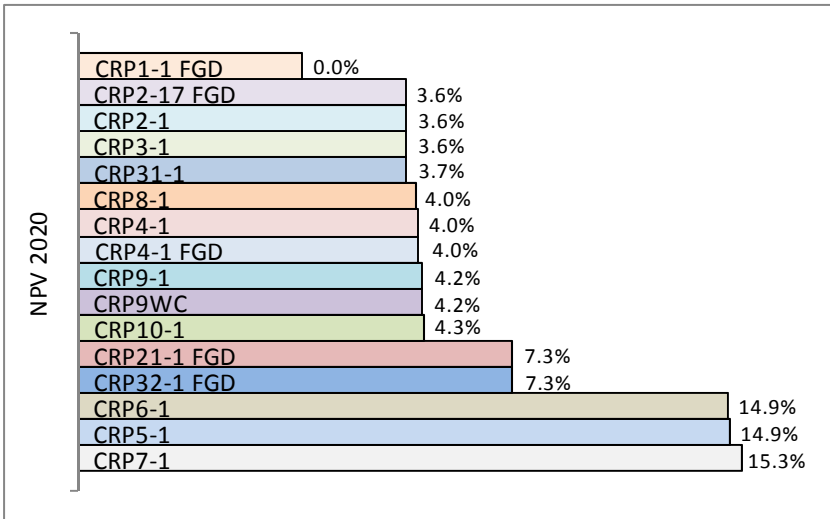
* High Load plans (CRP 21 & 32) are ranked separately from Base Load plans.

26

** CRPs have been grouped by retirement strategy for rankings on Study Period costs. For example, all five CRPs with Min Coal retirement strategy are shaded in blue and have been ranked from 1 to 5.

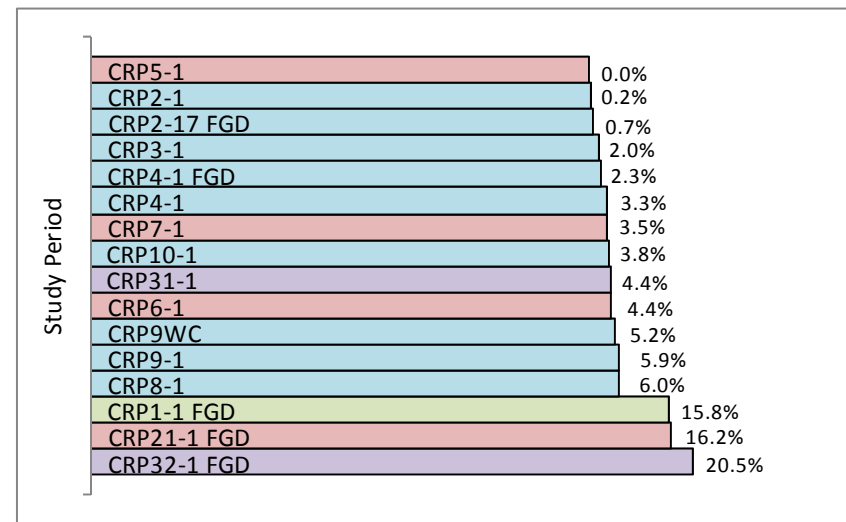
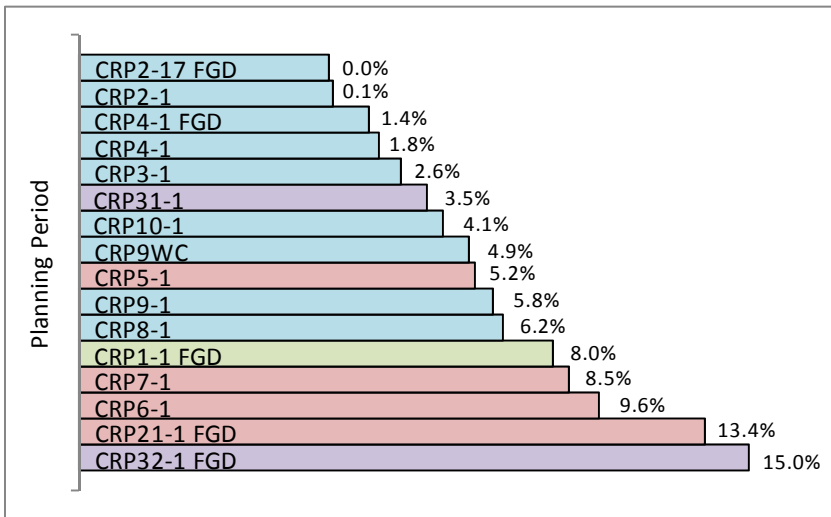
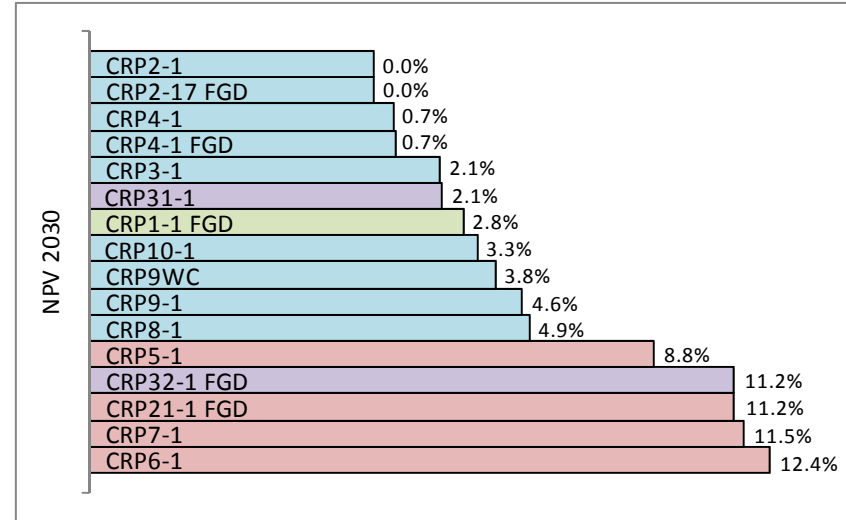
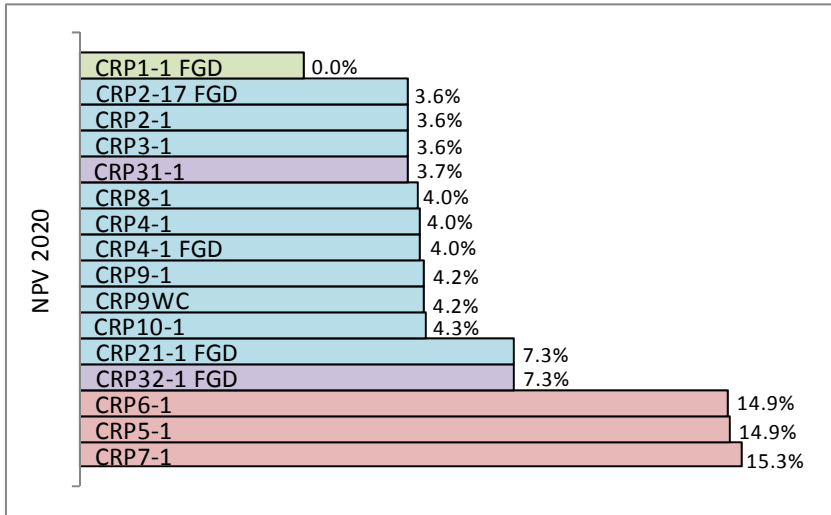
Preliminary Results

TRC – NPV 2020, NPV 2030, Planning and Study Period Costs



Preliminary Results

TRC – NPV 2020, NPV 2030, Planning and Study Period Costs (DSM Load Comparison)

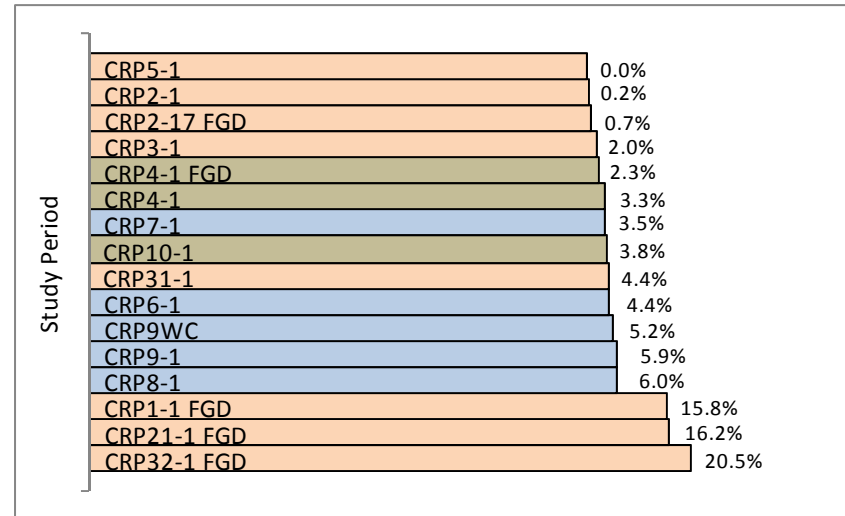
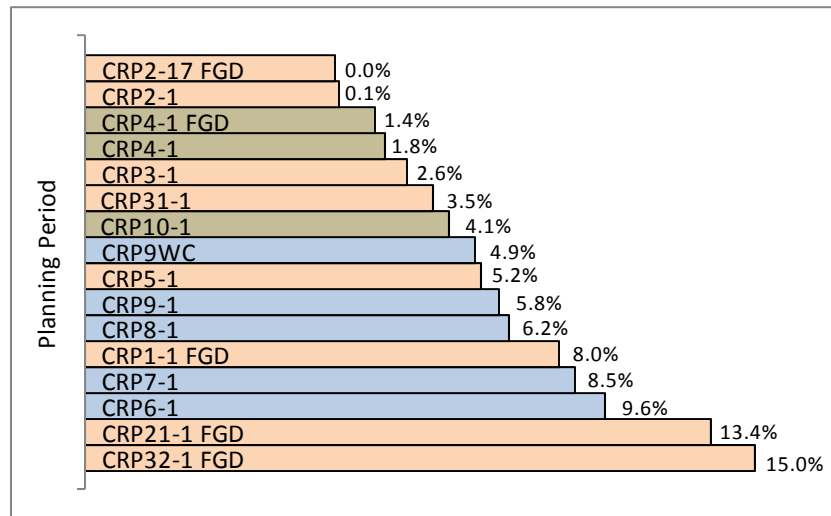
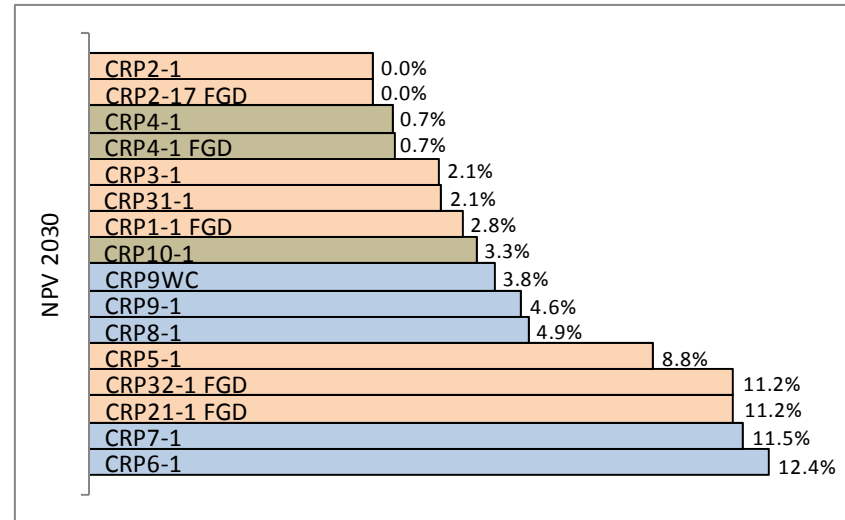
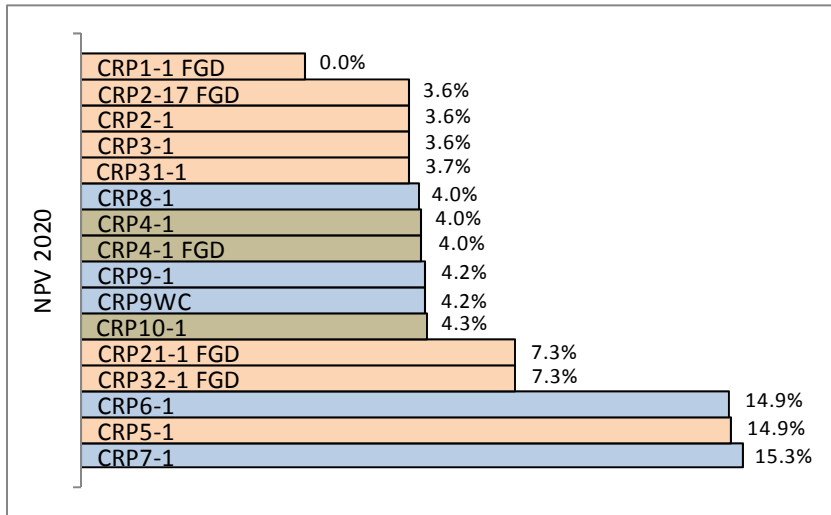


DSM load comparison: Half Low (light green), Base (light blue), High (light red). Base 50% Peak 100% Energy (light purple).



Preliminary Results

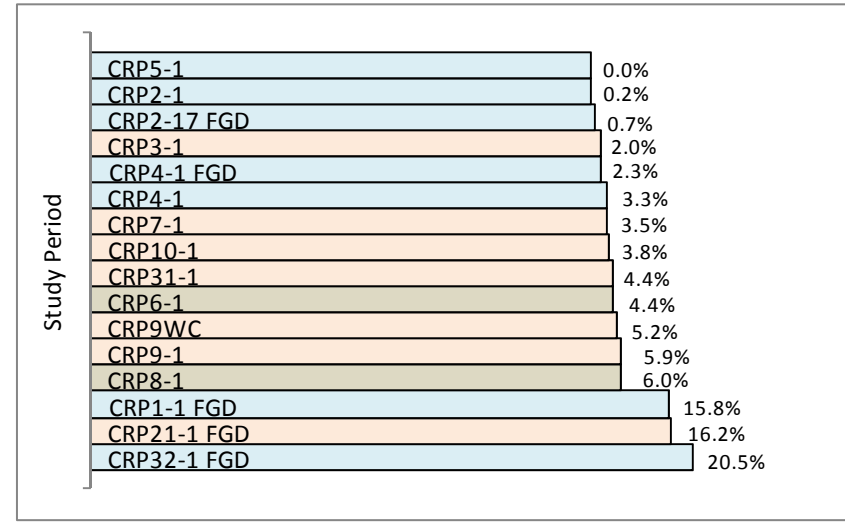
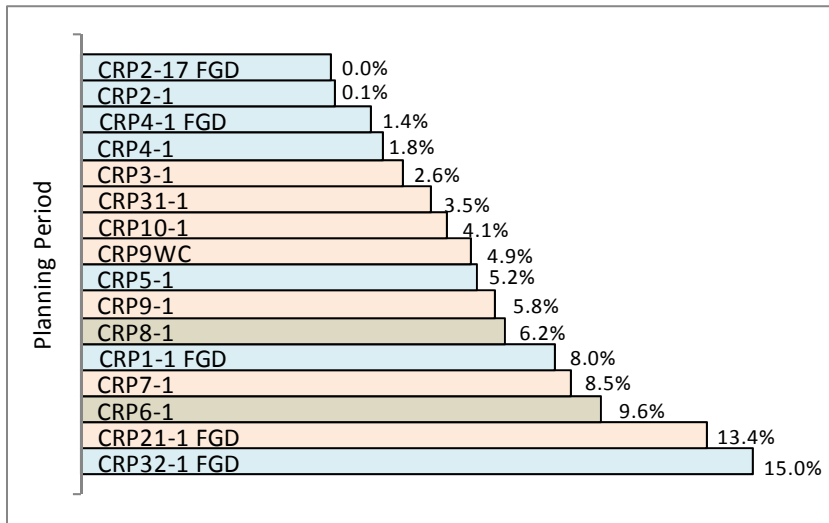
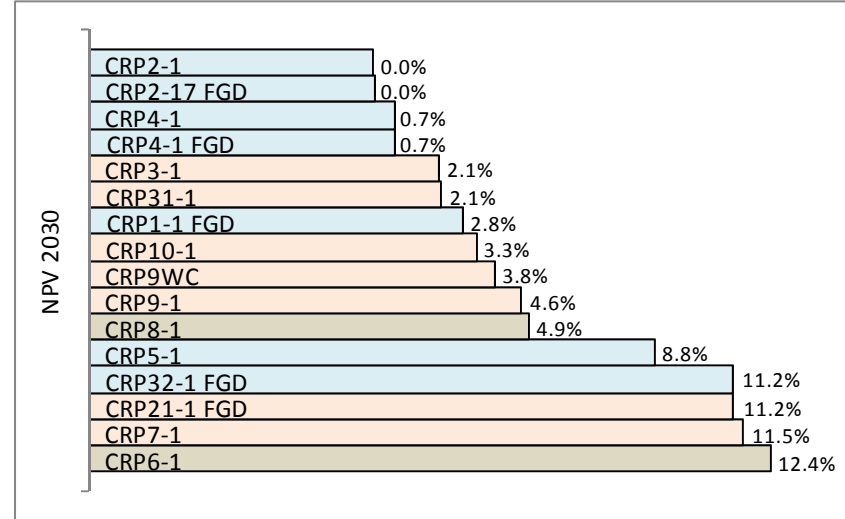
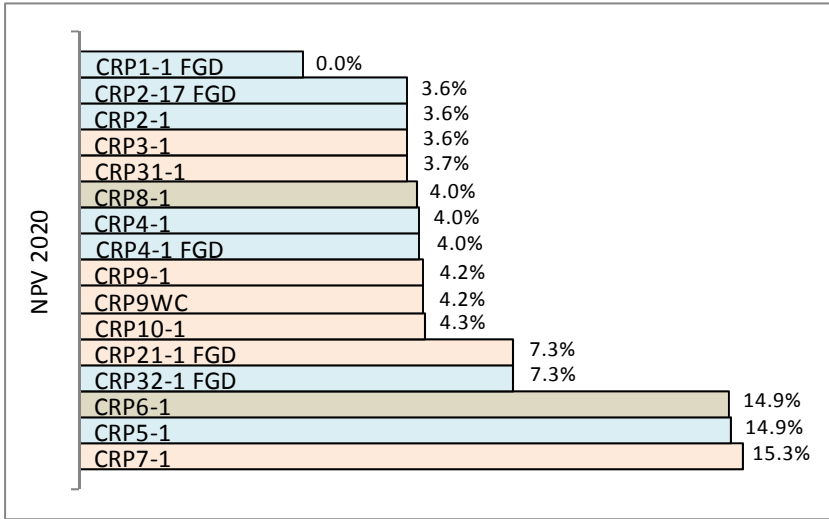
TRC – NPV 2020, NPV 2030, Planning and Study Period Costs (Retirement Comparison)



Retirement comparison
 Min
 Med
 Max

Preliminary Results

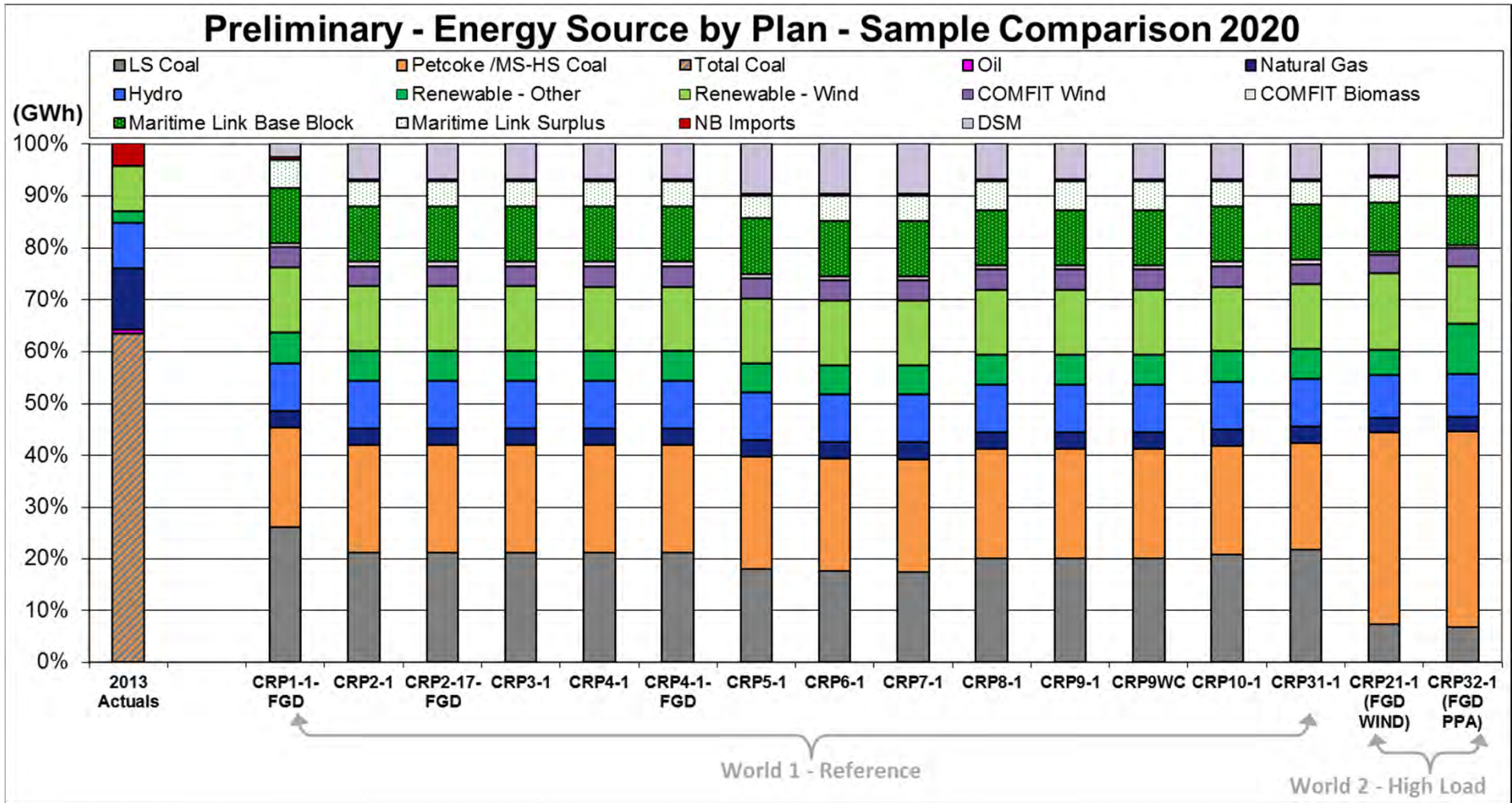
TRC – NPV 2020, NPV 2030, Planning and Study Period Costs (Wind Comparison)



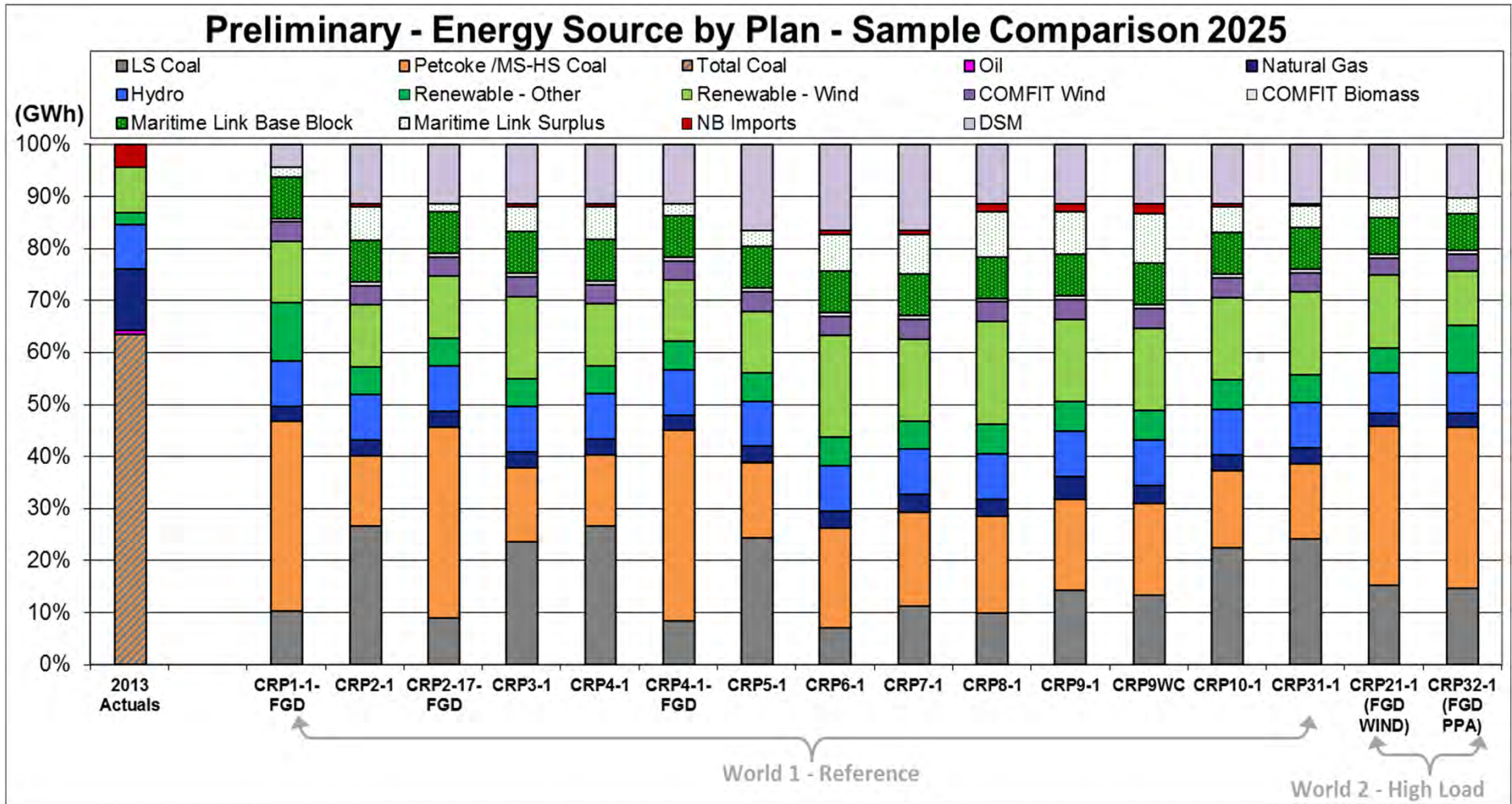
Wind comparison
 Base
 Med
 High



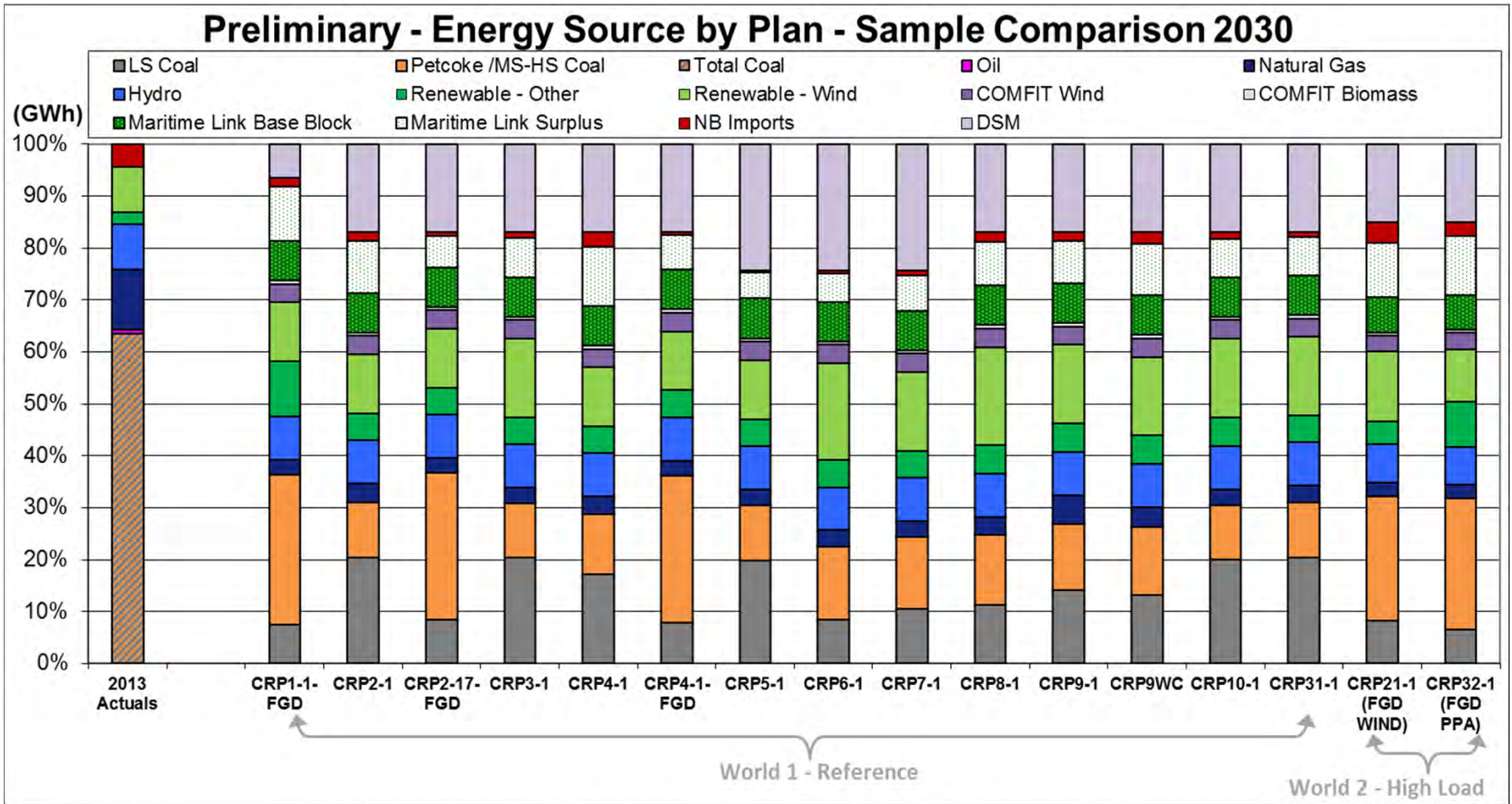
Preliminary Energy Source by Plan – Sample Comparison 2020



Preliminary Energy Source by Plan – Sample Comparison 2025

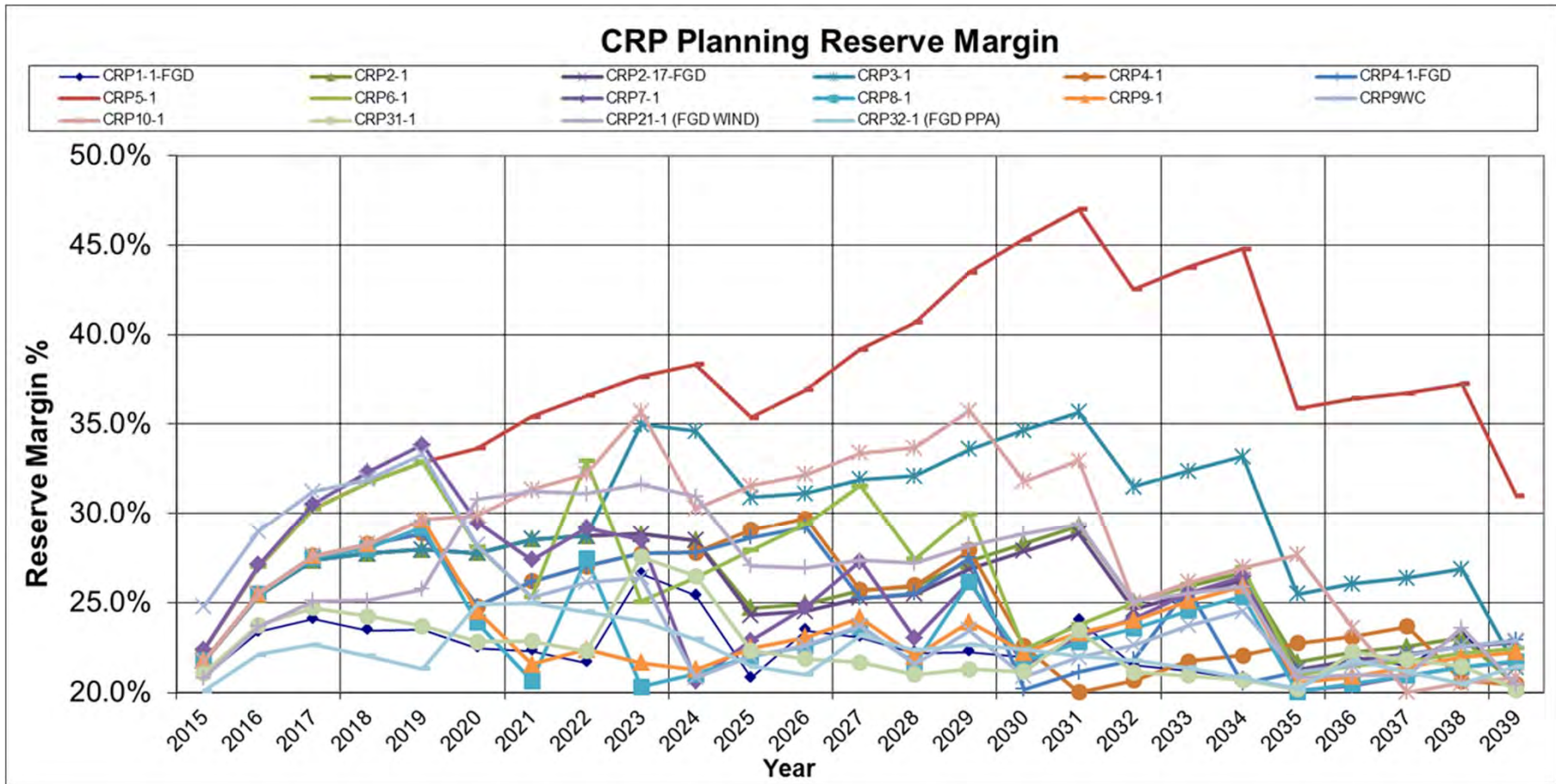


Preliminary Energy Source by Plan – Sample Comparison 2030



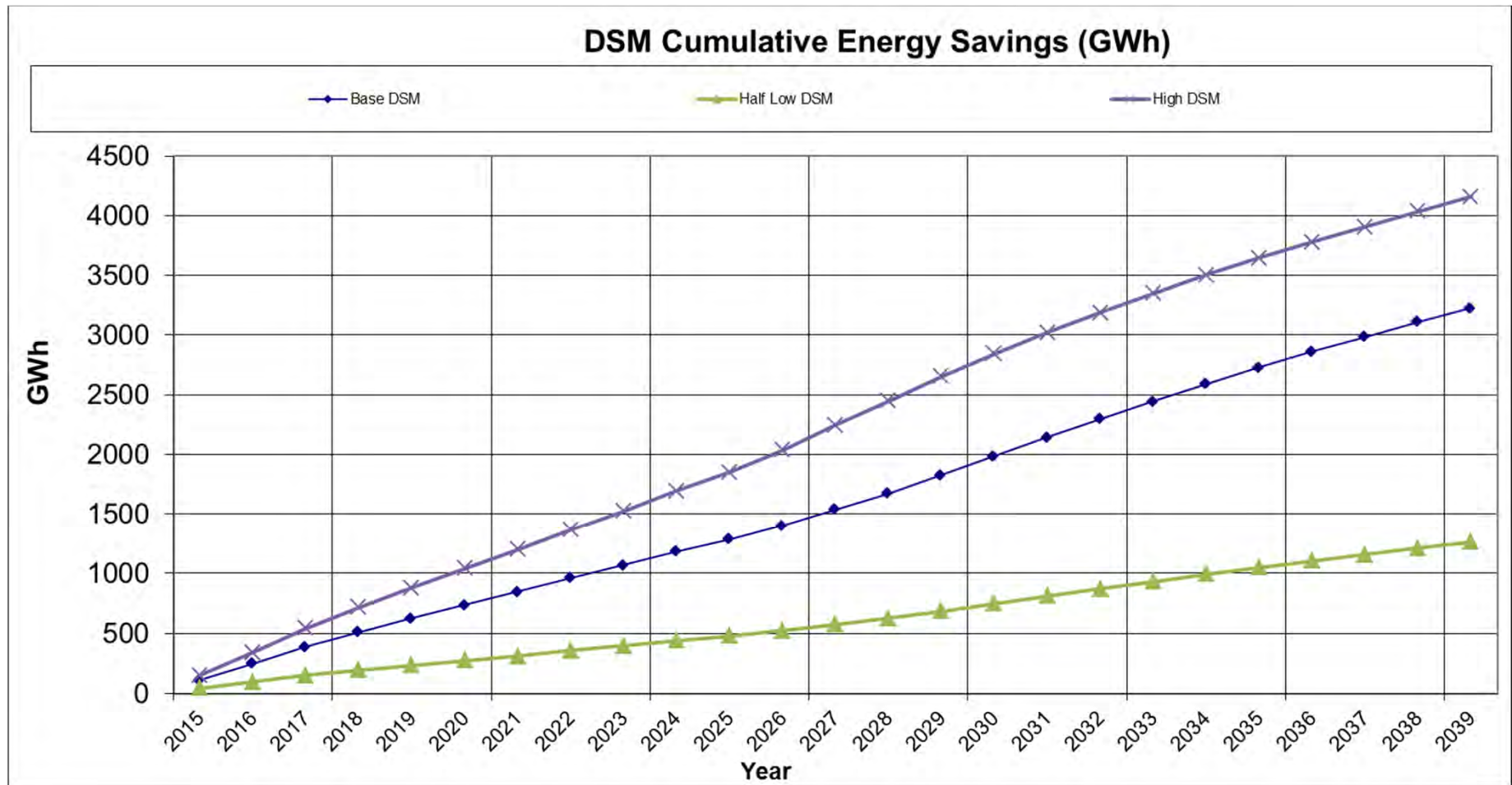
Preliminary Results

CRP Planning Reserve



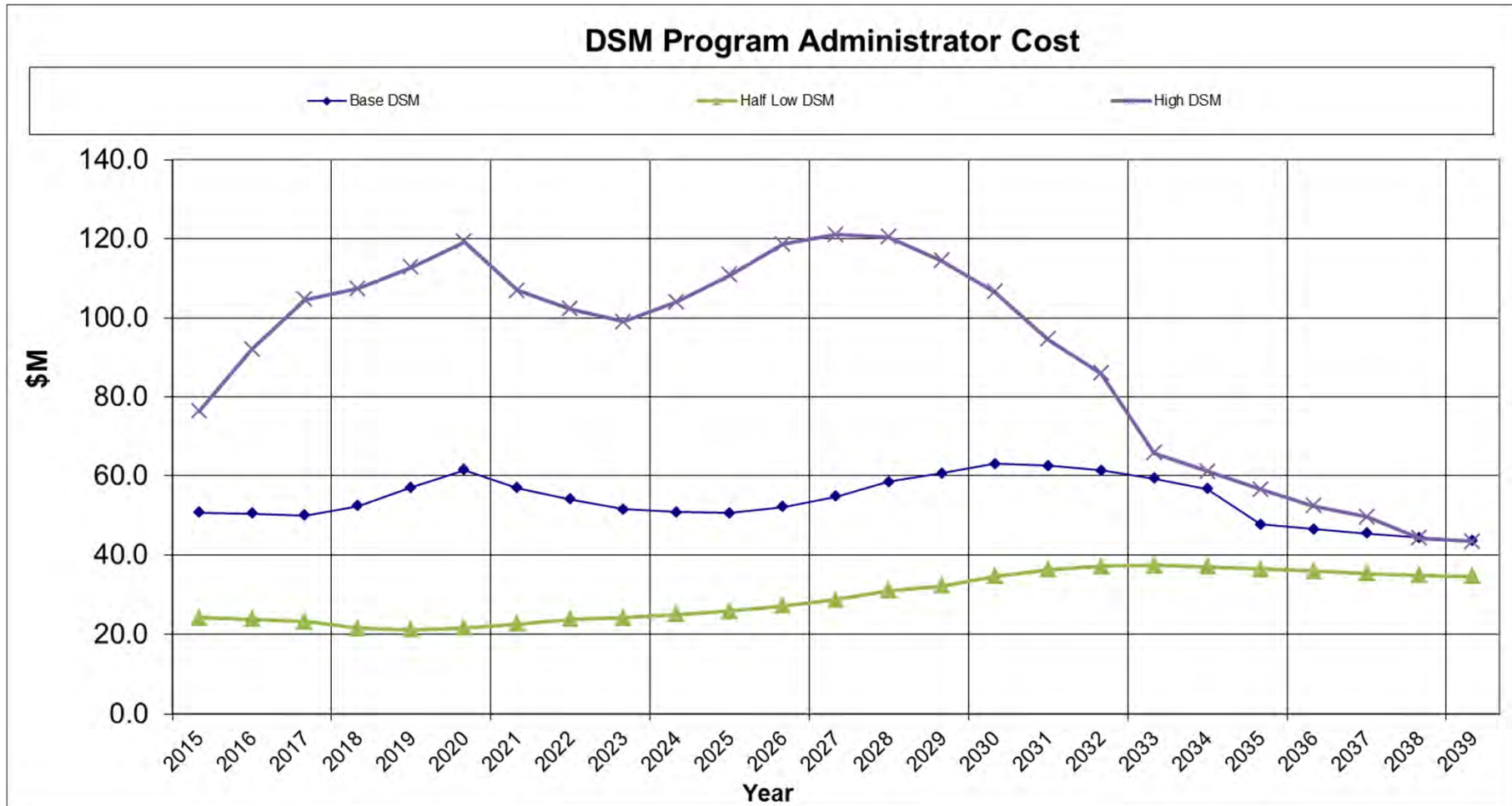
Preliminary Results

DSM Cumulative GWh



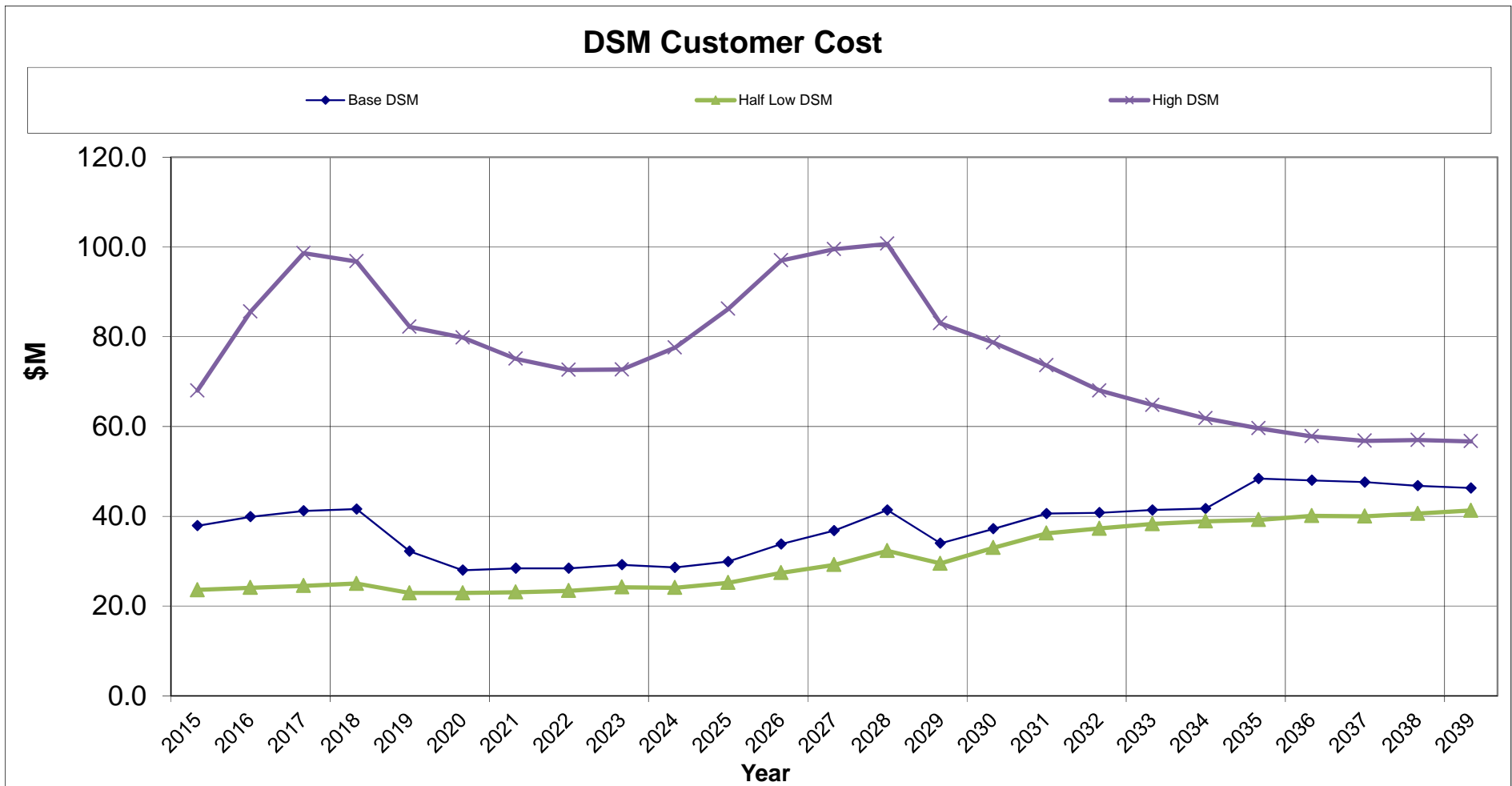
Preliminary Results

DSM Program Administrator Cost



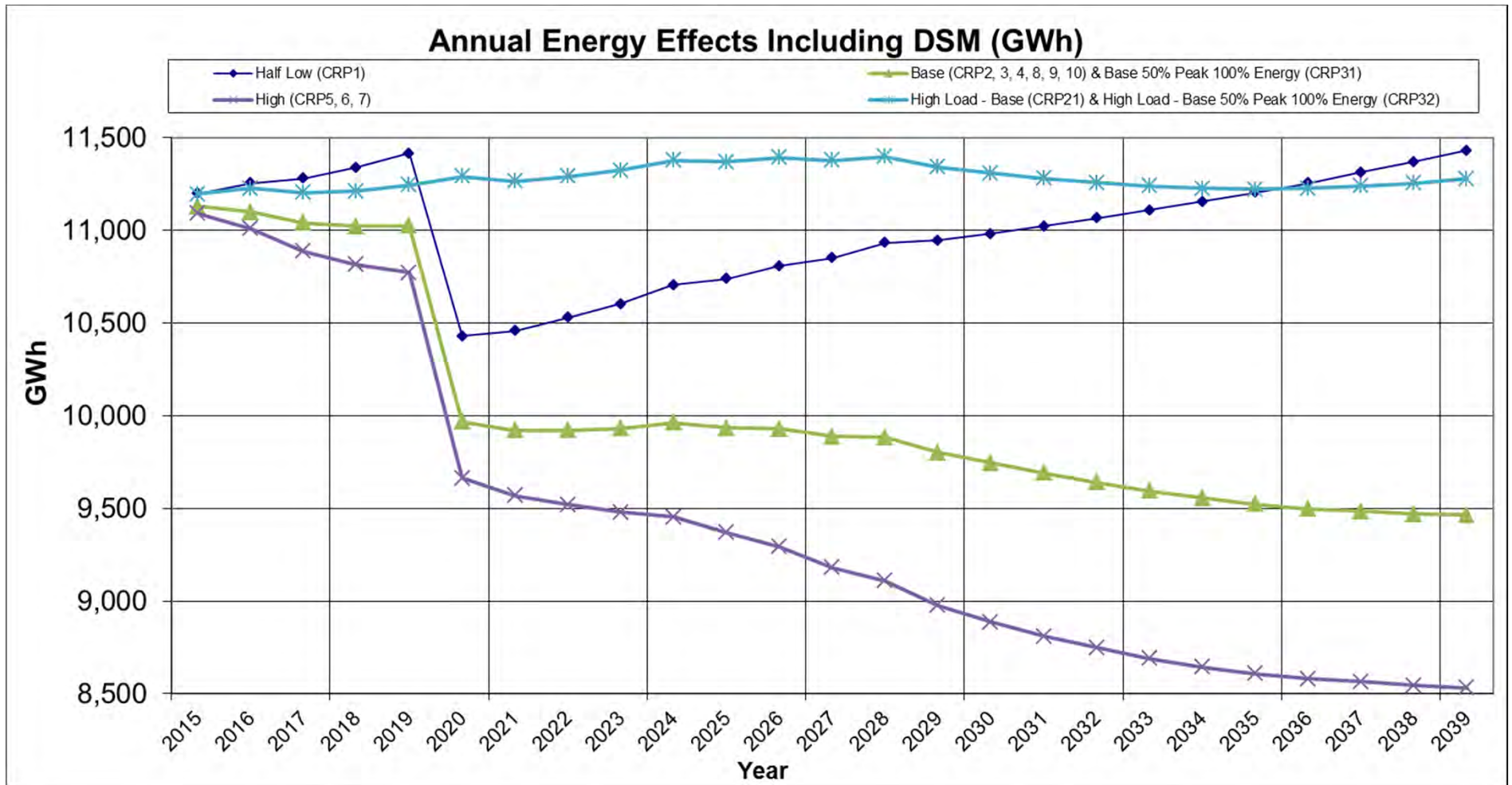
Preliminary Results

DSM Customer Cost



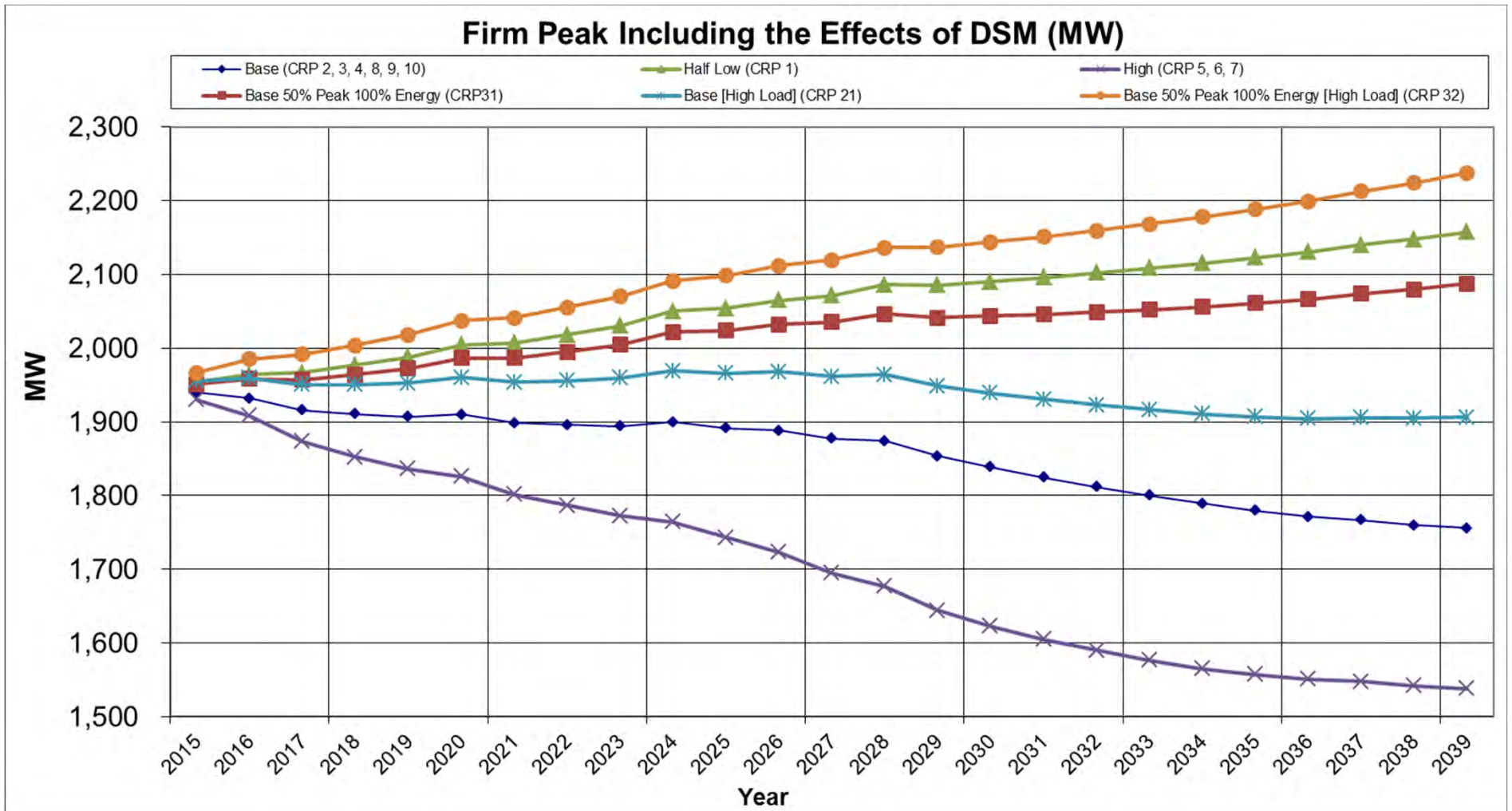
Preliminary Results

Annual Energy Including the Effects of DSM (GWh)



Preliminary Results

Firm Peak Including the Effects of DSM (MW)



Sustaining Capital Adjustment

- Sustaining capital adjustment is necessary in order for CRPs with different coal fleet retirement timelines to be comparable by NPV up to the planning period horizon.
- Sustaining capital adjustment is calculated for certain CRPs to represent the different retirement strategies (Max, Med & Min) and the different load levels (Base and High load).
- Assume that CRPs with the same retirement strategy and same load level have the same sustaining capital adjustment.

Representative CRP	Load	Retirement Strategy	CRPs with the same Sustaining Capital Adjustment
CRP2-01	Base	Max	CRP 3, 5, 31
CRP2-01-FGD	Base	Max	CRP 1
CRP4-01	Base	Med	
CRP4-1-FGD	Base	Med	
CRP 10	Base	Med	this Med retirement strategy is different that CRP 4
CRP 9	Base	Min	CRP 6, 7, 8, 9WC
CRP21	High	Max	CRP 32

Annual Sustaining Capital Costs

Approach:

- Historical analysis is used to establish an investment rate for each asset class.
- Asset Health (based on latest assessments) is used to establish when large (special) investments are to be made. Major outages for example.
- Each scenario specifies the capacity factors and retirements (cycling assumption are also applied) which:
 - refines the prediction of maintenance intervals.
 - determines the degree to which regular (non-major) investments should be prorated.

Annual Sustaining Capital Costs

- Using the Economic Analysis Model (EAM), the revenue requirement profile was determined for each annual sustaining capital investment for 2015 to 2039
- This was done for each thermal unit (existing and new units added in the plan).
- For units that are retiring, any revenue requirements for undepreciated sustaining capital are assumed to be recovered over the 5 years after retirement.
- NPV of this stream of values was taken back to 2015.
- The resulting values is now the adder to the planning period costs (2015-2039) for all CRPs with that retirement strategy.
- This analysis does not adjust the costs in the end effects portion of the study period (post 2039).
- These calculations were completed outside of Strategist.

Plexos Operational Test of Select CRPs

The following CRPs were tested in hourly system dispatch model, on sample years 2020, 2025 and 2030, in order to identify any potential operational issues:

- CRP 1 – DSM 50% low – Wind Base – Maximum Coal retirement strategy
- CRP 2 – DSM BASE – Wind Base – Maximum Coal retirement strategy
- CRP 3 – DSM BASE – Wind Medium – Maximum Coal retirement strategy
- CRP 5 – DSM HIGH – Wind Base – Maximum Coal retirement strategy
- CRP 6 – DSM HIGH – Wind High – Minimum Coal retirement strategy
- CRP 8 – DSM BASE – Wind High – Minimum Coal retirement strategy

These CRPs are selected in order to examine broad range of system configuration possibilities.

CRP 2 is most similar to the present day system configuration and as such it was used to benchmark and validate Plexos model against Strategist output and provide a base for comparison.

CRP 1 was selected to explore the effects of higher system demand and the benefit of the scrubber which was picked as optimal by Strategist.

CRPs 3 and 5 were selected as relatively close relatives to CRP 2, in order to examine operational fleet behavior with high DSM and additional wind generation coupled with maximum coal utilization in both plans.

CRPs 6 and 8 are the two more far reaching CRPs both containing the highest studied wind penetration, with high and base DSM coupled with early coal fleet retirement (min coal).

Plexos Output Analysis

Plexos model output results were summarized across variables which were not handled by Strategist resource optimization modules:

1. Wind energy Curtailed

Wind energy is curtailed only due to system security violations and as such is a good indicator of system stability.

2. Uneconomic exports to NB

Export energy to New Brunswick was modeled to always be priced at \$10 per MWh. This low export price simulation technique allows system flexibility to aid model convergence, while assuring that export decisions were based not on economics but only on excess energy basis.

3. Imports form NB

Import of economic energy from New Brunswick is an important indicator of system behavior as it can be used to indicate inadequate generating capacity or type of generating capacity in the province.

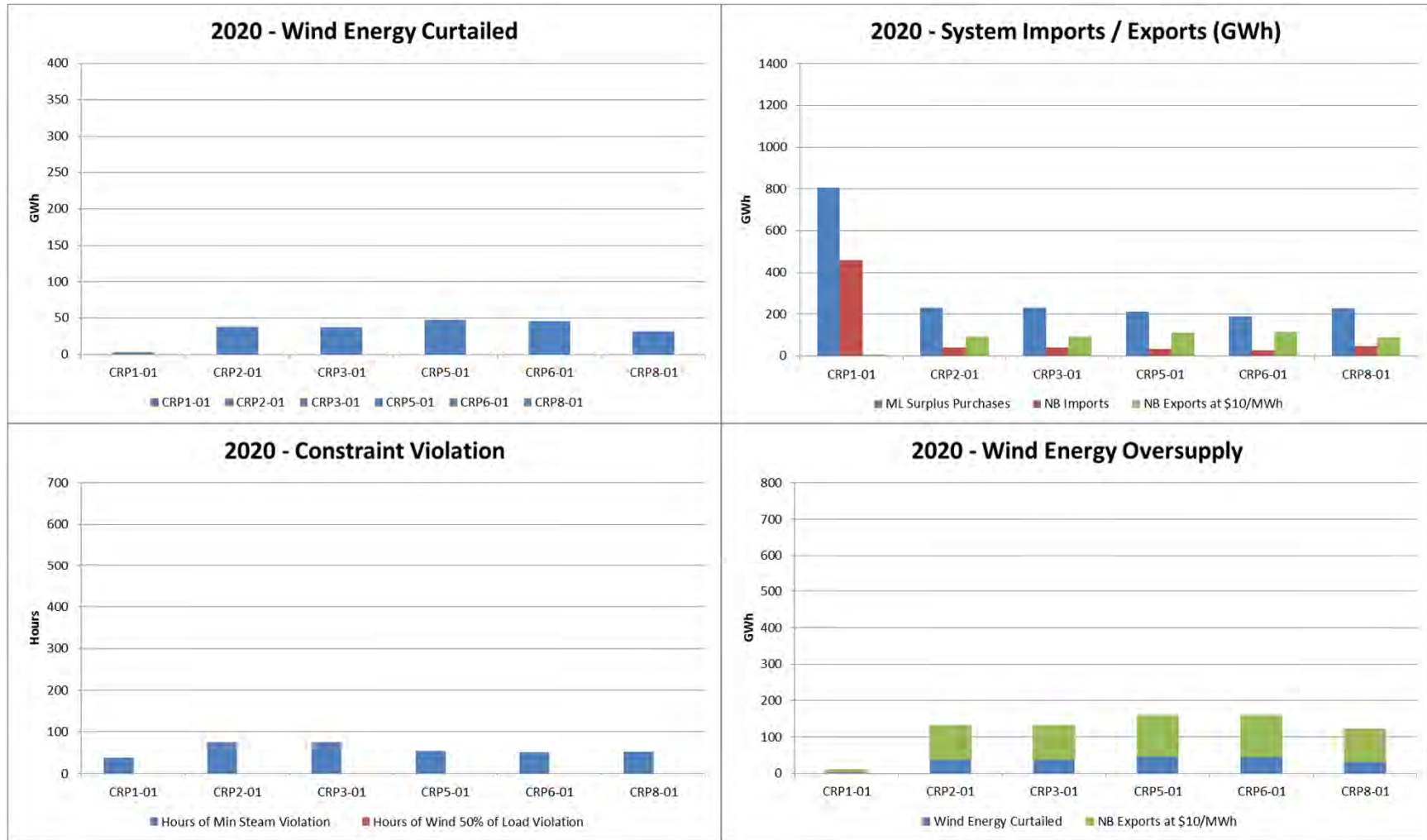
4. Surplus energy purchases form Maritime Link

Being able to purchase additional energy from Maritime Link is crucial to taking the full advantage of the Maritime Link investment. This measure is selected to indicate whether the resource composition of certain CRPs is presenting a barrier to being able to fully utilize this resource.

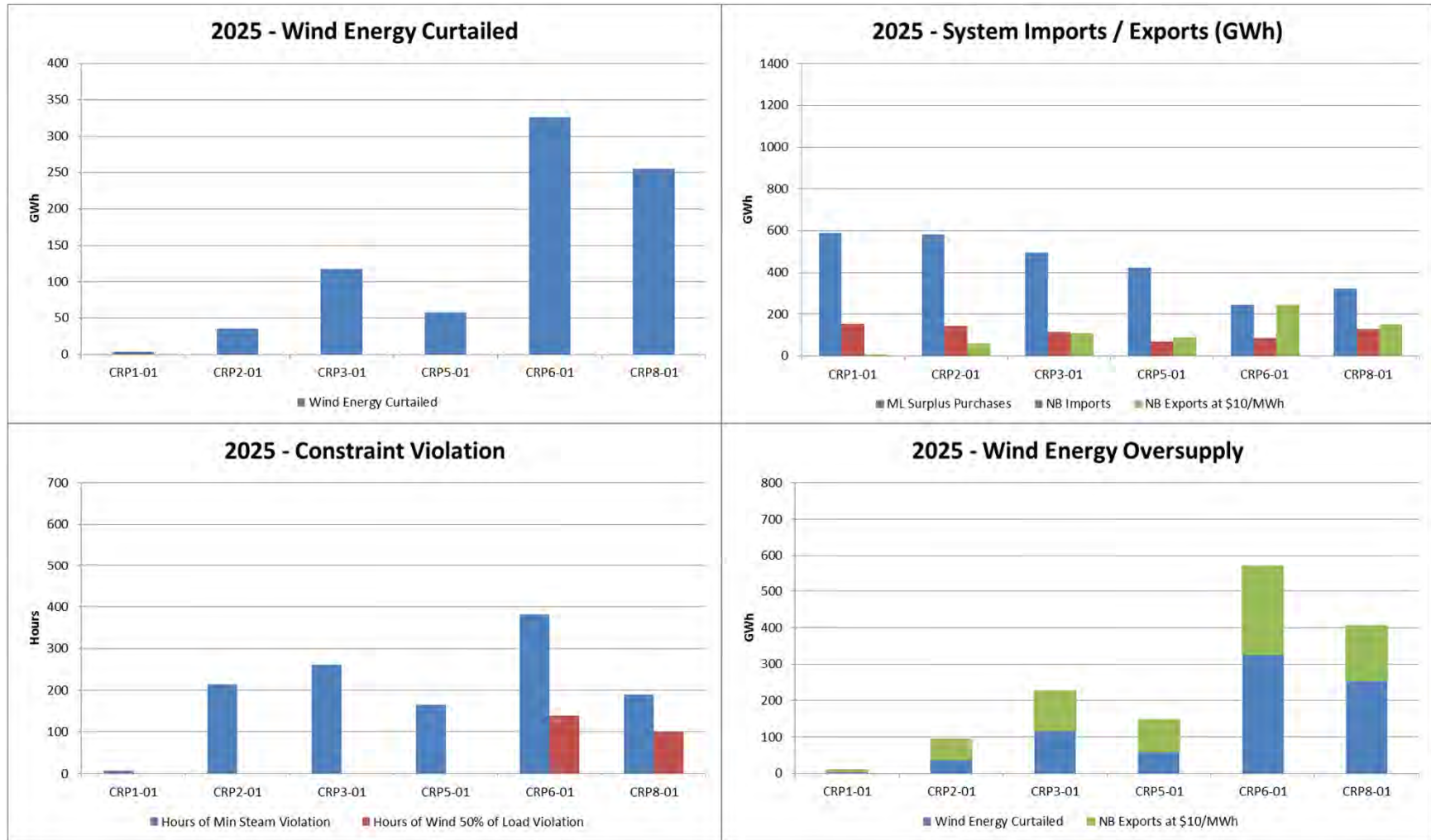
5. Model Constraints Violation

Plexos allows for modeling of “soft” constraints, which can be violated under a notional penalty, in order to aid model convergence and indicate operational difficulties. Minimum steam commitment and wind generation as a percentage of total system demand are two system security constraints sensitive to demand and variable generation hourly excursions.

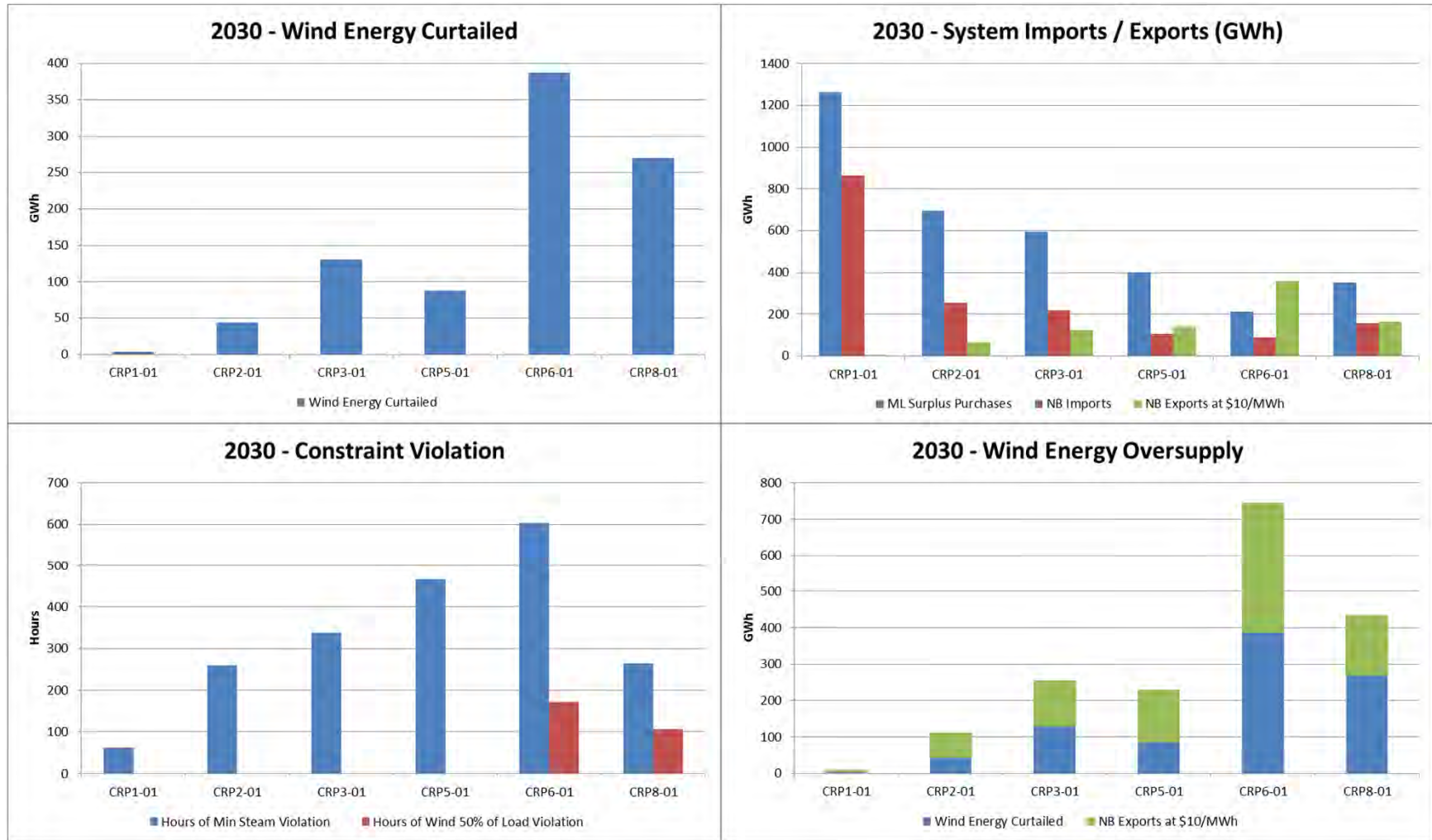
Plexos system performance indices for 2020



Plexos system performance indices for 2025



Plexos system performance indices for 2030



Plexos Output Analysis – discussion:

CRP-1

Plexos system simulation shows that higher energy requirement is beneficial to integration of base quantity of wind generation with minimum curtailment and uneconomic exports of excess energy. It also allows the system to take advantage of economic Maritime Link and New Brunswick energy purchases.

CRP-2

Due to lower system energy requirement, CRP-2 shows higher wind curtailment and uneconomic exports than CRP-1, while it shows lower uptake of Maritime Link surplus energy in later years. Increase in system constraint violations indicate the need for mitigation of operational difficulties by system reinforcements, in later years.

CRP-3

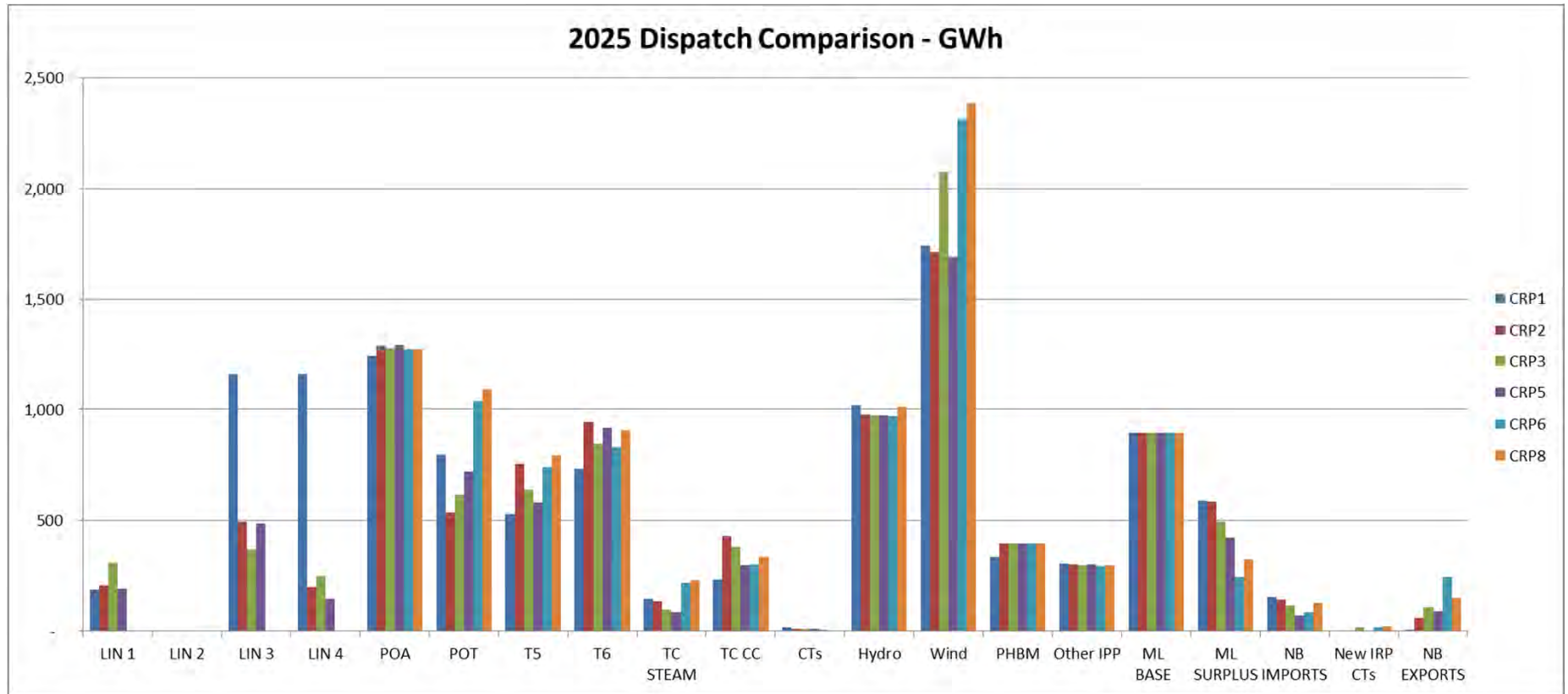
Similar to CRP-2 but with additional block of 150 MW of wind, this CRP shows that nearly half of the new wind energy would be either curtailed or sold across the border as uneconomic exports. The effect of additional variable generation is also seen in increased system constraint violations in later years and lower Maritime Link and New Brunswick economic purchases.

CRP-5

This high DSM CRP is similar to CRP-2, except for high DSM penetration assumption. The reduced system energy requirement results in additional wind energy curtailment and uneconomic sales, as well as lower capability to take in Maritime Link economic energy.

CRP-6 and CRP-8 containing High DSM, early coal fleet retirement, and high and medium additional wind generation additions show that significant system reconfiguration and expansions would be required in order to maintain system stability. Large quantities of curtailed or uneconomically exported energy indicate that energy storage may be required in order to make these CRPs viable.

Plexos generation fleet output 2025



Comprehensive overview of generating fleet output across the 6 CRPs tested in Plexos showing resource utilization, while considering operational constraints.