

Overview of Task 9 Activity for EIPC Production Cost Modeling

November 15, 2012

CRA Charles River
Associates

The results presented herein use modeling assumptions developed by EIPC, EIPC stakeholders and CRA for purposes of EIPC capacity expansion modeling. As such, these results do not necessarily reflect the opinions or views of CRA or any individual EIPC stakeholder.

Overview

- CRA is using the GE MAPS model to evaluate the 2030 production cost of Scenarios 1, 2, and 3, along with six additional sensitivities.
 - GE MAPS is a detailed economic dispatch and production cost model that simulates the operation of the electric power system taking into account transmission topology.
 - The model footprint comprises the Eastern Interconnect, and includes the generating units and the transmission load flow and flowgates for each scenario from Tasks 7 and 8.
- Using the EIPC stakeholder-approved input assumptions into GE MAPS as approved in July, and the results of Task 7 and 8, CRA completed modeling of:
 - S3 Base (Business as Usual)
 - S2 Base (National RPS – State/Regional Implementation)
 - S1 Base (Combined Federal Climate and Energy Policy)

Overview

- CRA has also completed modeling of the six sensitivities approved by the SSC:
 - **S3 High Gas:**
 - *All gas prices increased by 25%*
 - **S3 High Load:**
 - *All loads increased by 5%*
 - **S1 High Load:**
 - *All loads increased by 5%*
 - **S1 High Spin Availability**
 - *Reduce the spin requirement in MISO, SPP, PJM and IESO by 50% and modify CC operating parameters in all regions to increase operating flexibility*
 - **S1 Flowgate Relief**
 - *High Spin Availability changes above, plus increase by 50% the limits for 25 flowgates in MISO_W, MISO_MO-IL, and MAPP_US.*
 - **S1 Reduced Wind**
 - *Multiply wind capacity for every wind unit in MISO_W by 75%, in Nebraska by 61%, in SPP_N by 85%, and in MISO_MO_IL by 74%.*

High-Level Summary of Results

S1, S2 & S3 Base

- Generation by Capacity Type for the EI in 2030 is shown below for S1 Base, S2 Base, and S3 Base
 - Overall results are fairly close to the Phase 1 Results

	Generation (TWh)			% of Total Supply		
	S1 Base	S2 Base	S3 Base	S1 Base	S2 Base	S3 Base
Coal	40	1,095	1,399	1%	30%	38%
Nuclear	1,087	875	886	36%	24%	24%
CC	755	532	831	25%	15%	23%
CT	39	32	43	1%	1%	1%
Steam Oil/Gas	6	13	15	0%	0%	0%
Hydro	211	228	193	7%	6%	5%
On-Shore Wind	722	476	217	24%	13%	6%
Off-Shore Wind	6	92	6	0%	3%	0%
Other Renewable	65	253	66	2%	7%	2%
Pump Storage Net	-8	-6	-4	0%	0%	0%
DR	4	0	1	0%	0%	0%
Total Generation	2,927	3,590	3,653	98%	99%	99%
External Supply	51	31	34	2%	1%	1%
Total	2,979	3,621	3,687	100%	100%	100%

High-Level Summary of Results

S1, S2 & S3 Base

- EI 2030 Production Costs, Emissions, and Wind Curtailment are shown below for S1 Base, S2 Base, and S3 Base
 - Wind is curtailed when prices (LMPs) at the unit's location fall below \$1/MWh.

	S1 Base	S2 Base	S3 Base
Production Costs (M\$)			
Fuel	40,802	73,789	85,057
Variable O&M	6,430	15,502	18,411
Total	47,231	89,291	103,469
CO2	45,340	126	154
Total w/CO2	92,571	89,416	103,622
Emissions (short tons)			
NOx (000)	93	873	1,122
SO2 (000)	21	1,300	1,771
CO2 (millions)	358	1,391	1,792
Wind Curtailment			
Wind Curtailment (TWh)	131	30	1
Percent Curtailed	15%	5%	0%

High-Level Summary of Results

S1, S2 & S3 Base

- Wind curtailment (TWh) in S1 Base takes place predominately in three NEEM regions.

	Potential Wind Energy	Generated Onshore Wind Energy	Generated Offshore Wind Energy	Curtail- ment	Wind Generated as % of Demand	Curtail- ment Percent
ENT	1	1	0	0	0%	30%
FRCC	0	0	0	0	0%	
MAPP_US	32	28	0	4	97%	12%
MISO_IN	28	28	0	1	32%	2%
MISO_MI	24	24	0	0	27%	0%
MISO_MO-IL	32	23	0	8	25%	26%
MISO_W	261	196	0	65	150%	25%
MISO_WUMS	9	9	0	0	16%	1%
NE	55	33	0	22	109%	40%
NEISO	18	16	2	0	15%	2%
NonRTO_Midwest	0	0	0	0	0%	
NYISO_A-F	19	18	0	1	33%	5%
NYISO_G-I	1	1	0	0	4%	0%
NYISO_J-K	0	0	0	0	0%	
PJM_E	6	2	4	0	2%	1%
PJM_ROM	6	6	0	0	4%	0%
PJM_ROR	44	43	0	1	9%	1%
SOCO	0	0	0	0	0%	
SPP_N	146	125	0	21	163%	15%
SPP_S	148	143	0	5	92%	3%
TVA	0	0	0	0	0%	0%
VACAR	9	9	0	0	4%	0%
IESO	17	15	0	2	12%	13%
MAPP_CA	1	1	0	0	3%	0%
EI	859	722	6	131	24%	15%

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High-Level Summary of Results

S1, S2 & S3 Base

- Wind curtailment (TWh) in S2 Base takes place predominately in VACAR.

	Potential Wind Energy	Generated Onshore Wind Energy	Generated Offshore Wind Energy	Curtail- ment	Wind Generated as % of Demand	Curtail- ment Percent
ENT	0	0	0	0	0%	0%
FRCC	0	0	0	0	0%	
MAPP_US	25	25	0	0	69%	2%
MISO_IN	1	1	0	0	1%	0%
MISO_MI	9	9	0	0	8%	0%
MISO_MO-IL	3	3	0	0	2%	0%
MISO_W	86	81	0	5	48%	5%
MISO_WUMS	4	4	0	0	6%	0%
NE	9	9	0	0	22%	1%
NEISO	15	14	2	0	12%	0%
NonRTO_Midwest	0	0	0	0	0%	
NYISO_A-F	11	11	0	0	18%	0%
NYISO_G-I	0	0	0	0	1%	0%
NYISO_J-K	0	0	0	0	0%	
PJM_E	36	2	34	0	28%	0%
PJM_ROM	21	21	0	0	13%	0%
PJM_ROR	143	142	0	0	26%	0%
SOCO	1	1	0	0	0%	
SPP_N	40	39	0	1	40%	3%
SPP_S	93	90	0	4	46%	4%
TVA	0	0	0	0	0%	0%
VACAR	81	6	56	19	21%	24%
IESO	17	17	0	1	12%	3%
MAPP_CA	1	1	0	0	2%	2%
EI	598	476	92	30	16%	5%

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High-Level Summary of Results

S3 Sensitivities

- Generation by Capacity Type for the EI in 2030 is shown below for the S3 sensitivities
 - [High Gas](#) reduces generation by CCs and replaces it with mostly coal
 - [High Load](#) increases the generation of CCs, and to a lesser extent CTs and coal

	Generation (TWh)			% of Total Supply		
	S3 Base	S3 HiGas	S3 HiLoad	S3 Base	S3 HiGas	S3 HiLoad
Coal	1,399	1,465	1,437	38%	40%	37%
Nuclear	886	886	886	24%	24%	23%
CC	831	768	945	23%	21%	24%
CT	43	39	65	1%	1%	2%
Steam Oil/Gas	15	15	23	0%	0%	1%
Hydro	193	193	193	5%	5%	5%
On-Shore Wind	217	217	217	6%	6%	6%
Off-Shore Wind	6	6	6	0%	0%	0%
Other Renewable	66	71	67	2%	2%	2%
Pump Storage Net	-4	-6	-4	0%	0%	0%
DR	1	1	2	0%	0%	0%
Total Generation	3,653	3,655	3,837	99%	99%	99%
External Supply	34	34	34	1%	1%	1%
Total	3,687	3,689	3,871	100%	100%	100%

High-Level Summary of Results

S3 Sensitivities

- 2030 EI Production Costs, Emissions, and Wind Curtailment are shown below for the S3 sensitivities.
 - High Gas increases production costs by 10% (higher gas costs) and CO₂ emissions by 2% (higher coal use).
 - High Load increases production costs by 9% (demand increase of 5% met by higher cost resources) and CO₂ emissions by 6%.

	S3 Base	S3 HiGas	S3 HiLoad
Production Costs (M\$)			
Fuel	85,057	94,326	93,317
Variable O&M	18,411	19,072	19,407
Total	103,469	113,397	112,724
CO2	154	150	178
Total w/CO2	103,622	113,547	112,902
% Increase	-	10%	9%
Emissions (short tons)			
NOx (000)	1,122	1,171	1,184
SO2 (000)	1,771	1,988	1,880
CO2 (millions)	1,792	1,833	1,899
% Increase	-	2%	6%
Wind Curtailment			
Wind Curtailment (TWh)	1	1	1
Percent Curtailed	0%	0%	0%

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High-Level Summary of Results

S1 Sensitivities

- Generation by Capacity Type for the EI in 2030 is shown below for the S1 sensitivities.
 - [High Load](#) increases the generation of CCs, and to a lesser extent CTs and wind.
 - [High Spin Availability](#) reduces CC generation (used for spin) and reduces wind curtailment.
 - Adding [Flowgate Relief](#) further reduces wind curtailment.
 - [Reduced Wind](#) replaces the reduced wind generation with mostly CC generation.

	S1 Generation (TWh)					% of Total Supply				
	Base	High Load	High Spin Avail	+Flow-gate Relief	Re-duced Wind	Base	High Load	High Spin Avail	+Flow-gate Relief	Re-duced Wind
Coal	40	46	41	42	43	1%	1%	1%	1%	1%
Nuclear	1,087	1,090	1,091	1,091	1,089	36%	35%	37%	37%	37%
CC	755	854	725	719	786	25%	27%	24%	24%	26%
CT	39	56	43	42	44	1%	2%	1%	1%	1%
Steam Oil/Gas	6	8	7	7	7	0%	0%	0%	0%	0%
Hydro	211	214	212	212	211	7%	7%	7%	7%	7%
On-Shore Wind	722	735	733	743	672	24%	23%	25%	25%	23%
Off-Shore Wind	6	6	6	6	6	0%	0%	0%	0%	0%
Other Renewable	65	69	71	71	67	2%	2%	2%	2%	2%
Pump Storage Net	-8	-8	-6	-6	-10	0%	0%	0%	0%	0%
DR	4	5	4	3	3	0%	0%	0%	0%	0%
Total Generation	2,927	3,075	2,929	2,933	2,917	98%	98%	98%	98%	98%
External Supply	51	52	52	52	51	2%	2%	2%	2%	2%
Total	2,979	3,127	2,980	2,984	2,969	100%	100%	100%	100%	100%

High-Level Summary of Results

S1 Sensitivities

- 2030 EI Production Costs, Emissions, and Wind Curtailment are shown below for the S1 sensitivities.
 - High Load increases prod costs by 14% and CO₂ emissions by 15% (*higher CC generation*).
 - High Spin Availability decreases prod costs by 4% and CO₂ by 5% (*CC replaced with wind*).
 - Adding Flowgate Relief further decreases prod costs and CO₂ emissions by a small amount.
 - Reduced Wind increases prod costs and CO₂ emissions by 5% (*less wind*).

	S1 Base	High Load	High Spin Avail	+Flow-gate Relief	Reduced Wind
Production Costs (M\$)					
Fuel	40,802	45,805	39,552	39,385	42,630
Variable O&M	6,430	6,932	6,457	6,443	6,536
Total	47,231	52,737	46,010	45,828	49,165
CO2	45,340	52,360	43,153	42,825	47,586
Total w/CO2	92,571	105,097	89,163	88,654	96,751
% Increase	-	14%	-4%	-4%	5%
Emissions (short tons)					
NOx (000)	93	113	92	92	99
SO2 (000)	21	25	21	21	23
CO2 (millions)	358	413	340	338	375
% Increase in CO2	-	15%	-5%	-6%	5%
Wind Curtailment					
Wind Curtailment (TWh)	131	119	120	110	64
Percent Curtailed	15%	14%	14%	13%	9%
% Change in Curtailment		-10%	-9%	-16%	-51%

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High-Level Summary of Results

S1 Sensitivities

- 2030 Wind Curtailment by region is shown below for the S1 Sensitivities.
 - Curtailment is reduced by about 10 TWh (15% to 14%) in High Load and High Spin Availability.
 - Curtailment is reduced another 10 TWh in Flowgate Relief (14% to 13%). *Percentage reductions in certain regions (e.g., MAPP_US and MISO_MO-IL) are more significant.*
 - With 14% less wind potential, Reduced Wind decreases curtailment by about 65 TWh.

	Potential Wind(TWh)		Curtailment (Twh)					Curtailment Percentage				
	Base & Others	Reduced Wind	Base	High Load	High Spin Avail	+Flow-gate Relief	Re-duced Wind	Base	High Load	High Spin Avail	+Flow-gate Relief	Re-duced Wind
ENT	1	1	0	0	0	0	0	30%	27%	33%	17%	23%
FRCC	0	0	0	0	0	0	0					
MAPP_US	32	32	4	3	3	2	3	12%	10%	11%	6%	10%
MISO_IN	28	28	1	0	0	1	1	2%	2%	2%	2%	2%
MISO_MI	24	24	0	0	0	0	0	0%	0%	0%	0%	0%
MISO_MO-IL	32	24	8	8	8	5	5	26%	24%	25%	15%	21%
MISO_W	261	196	65	61	62	57	26	25%	23%	24%	22%	13%
MISO_WUMS	9	9	0	0	0	0	0	1%	0%	0%	0%	0%
NE	55	34	22	21	21	19	9	40%	38%	37%	33%	26%
NEISO	18	18	0	0	0	0	0	2%	1%	1%	1%	2%
NonRTO_Midwest	0	0	0	0	0	0	0					
NYISO_A-F	19	19	1	1	1	1	1	5%	4%	4%	4%	5%
NYISO_G-I	1	1	0	0	0	0	0	0%	0%	0%	0%	0%
NYISO_J-K	0	0	0	0	0	0	0					
PJM_E	6	6	0	0	0	0	0	1%	0%	0%	0%	1%
PJM_ROM	6	6	0	0	0	0	0	0%	0%	0%	0%	0%
PJM_ROR	44	44	1	0	0	0	0	1%	1%	1%	1%	1%
SOCO	0	0	0	0	0	0	0					
SPP_N	146	124	21	18	17	14	12	15%	12%	12%	10%	10%
SPP_S	148	148	5	5	5	10	4	3%	3%	4%	7%	2%
TVA	0	0	0	0	0	0	0	0%	0%	0%	0%	0%
VACAR	9	9	0	0	0	0	0	0%	0%	0%	0%	0%
IESO	17	17	2	1	1	1	2	13%	8%	6%	6%	12%
MAPP_CA	1	1	0	0	0	0	0	0%	0%	0%	0%	0%
EI	859	742	131	119	120	110	64	15%	14%	14%	13%	9%

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