

Future 6-8 Soft Constraints Transfer Limit Hardening

NEEM-TX Subteam

SSC Meeting

July 28, 2011

SSC Decision Items

1. Approve F6 transfer limit increase values
2. Decide for remaining F7 sensitivities whether to use:
 - Baseline Infrastructure Transfer Limits
 - Transfer limit increases derived from F7S1 OL25 sensitivity
3. Decide for remaining F8 sensitivities whether to use:
 - Baseline Infrastructure Transfer Limits
 - Transfer limit increases derived from F8S1 OL75 sensitivity
 - Transfer limit increases derived from F8S1 OL75 sensitivity

F6 Transfer Limit Increase Values

F6S1 (OL25)	RHC	Johnson	NGO	Average
NE_2_SPP_N	1523	928	1153	1201
MISO_WUMS_2_MISO_MI	687	830	973	830
NYISO_A-F_2_NYISO_G-I	1520	0	0	507
SPP_S_2_SPP_N	0	624	526	383
NEISO_2_NYISO_J-K	89	121	0	70
NYISO_G-I_2_NYISO_J-K	0	0	173	58
MAPP_CA_2_MISO_W	53	0	0	18
MISO_W_2_MAPP_CA	45	0	0	15

- Subteam recommends using the “Average” transfer limit increases shown to the left for the remaining sensitivities of F6
- SSC previously agreed to use OL25 sensitivity results for F5 and F6

NEEM/TX Subteam Notes

- F6S1 produces low transfer limit increase due to small shadow price differentials
 - Each super-region has a 30% RPS subject to \$200 ACP
 - Only PJM ROR does not achieve RPS target (27% renewables)
 - Other regions go above 30% target to make up PJM ROR insufficiency
 - Given high level of renewables in each region, most regions look similar therefore large increases in transfers are not needed
 - Similar to F3, lower intermittency penetration rate and regional RPS targets prevents the levels of wind penetration needed to create large shadow price differentials

Shadow Prices

Shadow Prices	F5B	F6B
MAPP_CA_2_MISO_W	\$ 2.40	\$2.32
MISO_W_2_MAPP_CA	\$ 3.66	\$2.06
NEISO_2_NYISO_J-K	\$ 1.75	\$1.79
NYISO_A-F_2_NYISO_G-I	\$ 2.17	\$1.79
MAPP_US_2_MAPP_CA	\$ 2.85	\$1.78
NEISO_2_NYISO_G-I	\$ 1.50	\$1.56
IESO_2_MAPP_CA	\$ 1.07	\$1.42
IESO_2_MISO_W	\$ 1.19	\$1.27
PJM_E_2_NYISO_J-K	\$ 0.44	\$1.25
IESO_2_MISO_MI	\$ 1.30	\$1.18
PJM_E_2_NYISO_G-I	\$ 0.36	\$1.10
NEISO_2_NYISO_A-F	\$ 0.81	\$1.00
SPP_S_2_ENT	\$12.83	\$0.76
NE_2_SPP_N	\$ 3.18	\$0.72
SPP_N_2_ENT	\$12.98	\$0.70

- F5B – high shadow prices between regions with best (wind) potential relative to other regions
- F6B – shadow price differentials largely tied to existing generation fleets

F7 Transfer Limit Increase Values

F7S1 (OL25)	RHC	Johnson	NGO	Average
MISO_W_2_MAPP_CA	2537	1066	2239	1947
NE_2_SPP_N	1391	854	920	1055
NYISO_A-F_2_NYISO_G-I	2226	0	0	742
IESO_2_NYISO_A-F	0	0	948	316
MISO_WUMS_2_MISO_MI	75	265	365	235
NYISO_G-I_2_NYISO_J-K	621	0	0	207
NEISO_2_NYISO_J-K	186	422	0	203
IESO_2_MISO_W	0	398	0	133
NYISO_J-K_2_PJM_E	0	140	0	47
MISO_MO-IL_2_MISO_W	0	0	87	29
NEISO_2_NYISO_G-I	80	0	0	27
MISO_MI_2_MISO_WUMS	0	60	0	20
IESO_2_MAPP_CA	9	0	0	3

- Subteam recommends using the “Average” transfer limit increases shown to the left for F7
- F7 transfer limit increases similar to BAU
 - Slight differences in placement of generation due to less natural gas
- SSC to decide on whether to use these transfer limit increases for the remaining F7 sensitivities or to use baseline infrastructure transfer limits

Future 7 Capacity

		Installed Capacity in 2030														
		F1S3	F2B	F2S11	F3B	F3S12	F4B	F5B	F5S2	F6B	F6S1	F7B	F7S1	F8B	F8S1	F8S2
Total		BAU	Fed	Hard	Reg	Hard	Aggr	Nat	25%	Reg	25%	Nuk	25%	CO2+	75%	25%
2010		Base	CO2	Limit	CO2	Limit	EE/DR	RPS	Soft	RPS	Soft	Res	Soft	RPS	Soft	Soft
Coal	272	199	29	31	40	39	172	177	174	178	176	199	197	17	17	18
Nuclear	100	105	133	131	134	134	105	105	105	105	105	129	129	137	135	133
CC	133	202	246	226	256	252	138	167	167	157	159	174	172	210	199	186
CT	120	132	106	112	104	105	69	136	143	134	134	134	137	61	64	71
Steam Oil/Gas	75	36	22	29	18	18	3	38	39	38	38	34	35	9	4	4
Hydro	45	45	50	51	52	52	45	52	51	52	52	47	47	49	49	52
On-Shore Wind	19	68	282	317	199	197	54	236	216	160	159	68	68	245	263	287
Off-Shore Wind	0	2	2	2	2	2	2	2	2	39	39	2	2	2	2	2
Other Renewable	4	14	13	13	13	13	12	13	13	37	37	14	14	12	12	13
New HQ/Maritimes	0	0	0	3	0	5	0	0	6	0	1	0	0	0	0	3
Other	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
Total w/o DR	783	819	901	932	833	833	617	942	933	916	917	816	816	759	762	786
DR	33	71	71	71	71	71	152	71	71	71	71	71	71	152	152	152
Total w/DR	816	890	971	1003	904	903	769	1013	1004	987	987	889	889	912	915	938

Source: CRA

F8 Transfer Limit Increase Values

F8S1 (OL75)	RHC	Johnson	NGO	Average
MISO_W_2_PJM_ROR	26563	13400	17236	19066
SPP_N_2_ENT	7070	3734	5833	5546
SPP_S_2_ENT	2583	2686	5022	3430
NE_2_MISO_W	1579	1562	2900	2014
SPP_N_2_MISO_MO-IL	2243	3620	0	1954
IESO_2_MISO_MI	1889	1222	743	1285
NYISO_A-F_2_NYISO_G-I	1774	1274	0	1016
NEISO_2_NYISO_J-K	26	745	1053	608
IESO_2_NYISO_A-F	1114	384	0	499
MISO_IN_2_MISO_MI	0	1187	285	490
SPP_N_2_MISO_W	0	749	0	250
MISO_W_2_MISO_MO-IL	744	0	0	248
MISO_WUMS_2_MISO_MI	0	374	211	195
MISO_MI_2_MISO_WUMS	0	421	0	140
MISO_W_2_MISO_WUMS	354	0	0	118
IESO_2_MISO_W	86	79	0	55
NE_2_SPP_N	0	0	163	54
IESO_2_MAPP_CA	22	0	0	7
NYISO_J-K_2_PJM_E	0	5	0	2

F8S2 (OL25)	RHC	Johnson	NGO	Average
MISO_W_2_PJM_ROR	50149	27139	32675	36654
SPP_N_2_ENT	21064	10728	9990	13928
MISO_MO-IL_2_MISO_IN	2547	4567	8250	5121
SPP_N_2_MISO_MO-IL	3507	4625	6523	4885
MISO_WUMS_2_MISO_MI	4069	3814	5928	4604
IESO_2_MISO_MI	6157	2982	4296	4478
SPP_S_2_ENT	4849	3078	4938	4288
NE_2_MISO_W	3159	2875	4951	3662
MISO_W_2_MISO_MO-IL	2869	3812	3364	3348
ENT_2_SOCO	545	2111	4741	2466
PJM_ROR_2_VACAR	737	1377	2984	1699
NYISO_A-F_2_NYISO_G-I	2208	1692	809	1570
SPP_N_2_MISO_W	0	2024	1382	1135
NE_2_SPP_N	870	428	1801	1033
NEISO_2_NYISO_J-K	427	849	1527	934
MAPP_CA_2_MISO_W	0	0	782	261
MISO_W_2_MISO_WUMS	373	397	0	257
IESO_2_NYISO_A-F	727	0	0	242
SPP_S_2_SPP_N	0	232	0	77
MISO_MI_2_MISO_WUMS	0	226	0	76
MISO_MI_2_MISO_IN	0	0	46	15
MISO_IN_2_MISO_MI	0	0	42	14
IESO_2_MAPP_CA	16	0	0	5
NYISO_J-K_2_PJM_E	0	10	0	3

SSC to decide whether to use Baseline Infrastructure, OL75 or OL25 transfer limit increases for remaining F8 sensitivities

Future 8 Capacity

2030 EI Capacity by Region: Futures 7 and 8 vs. BAU (GW)

	Cum New Builds in 2030						Cum New CCs in 2030						Cum New On-Sh Wind 2030					
	F1S3	F7B	F7S1	F8B	F8S1	F8S2	F1S3	F7B	F7S1	F8B	F8S1	F8S2	F1S3	F7B	F7S1	F8B	F8S1	F8S2
	BAU Base	Nuk Res	25% Soft	CO2+ RPS	75% Soft	25% Soft	BAU Base	Nuk Res	25% Soft	CO2+ RPS	75% Soft	25% Soft	BAU Base	Nuk Res	25% Soft	CO2+ RPS	75% Soft	25% Soft
ENT	4	3	3	7	5	3	3	2	2	6	4	2	0	0	0	0	0	0
FRCC	16	14	14	31	31	31	13	7	6	11	10	10	0	0	0	0	0	0
IESO	5	6	6	5	5	5	1	1	1	1	1	1	2	2	2	2	2	2
MAPP_CA	2	3	3	3	3	5	2	0	0	1	1	1	0	0	0	0	0	0
MAPP_US	2	2	2	6	10	12	0	0	0	0	0	0	1	1	1	6	10	11
MISO_IN	5	2	1	55	47	12	4	1	0	15	17	11	0	0	0	39	29	0
MISO_MI	3	4	4	6	3	2	0	0	0	3	1	0	3	3	3	3	3	2
MISO_MO-IL	2	3	3	28	8	8	0	0	0	0	0	0	0	0	0	26	6	6
MISO_W	9	9	9	27	61	96	0	0	0	0	0	0	9	9	9	27	61	96
MISO_WUMS	10	10	12	15	8	12	4	2	3	4	5	10	1	1	1	9	1	1
NE	1	1	3	13	15	18	0	0	0	0	0	0	0	0	2	12	15	18
NEISO	9	9	9	9	9	9	2	2	2	2	2	2	5	5	5	5	5	5
NonRTO_Mid	1	1	1	5	5	5	1	1	1	4	5	4	0	0	0	0	0	0
NYISO_A-F	4	5	4	6	7	4	1	1	1	1	1	1	4	4	3	5	6	3
NYISO_G-I	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
NYISO_J-K	3	3	4	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
PJM_E	7	8	9	7	7	7	5	5	5	5	5	5	1	1	1	1	1	1
PJM_ROM	12	14	15	6	6	7	2	2	2	2	2	2	7	6	7	1	1	1
PJM_ROR	20	20	19	55	37	25	8	4	3	26	21	13	9	9	9	26	13	9
SOCO	10	11	11	22	21	19	8	9	9	10	10	10	0	0	0	0	0	0
SPP_N	3	2	1	27	42	67	2	1	0	0	0	0	0	0	0	26	41	66
SPP_S	8	8	7	35	47	45	2	2	3	0	0	0	3	5	3	33	46	43
TVA	8	9	9	8	8	8	4	3	2	6	6	4	0	0	0	0	0	0
VACAR	20	19	19	25	23	22	11	5	4	12	11	9	4	4	4	4	4	4
	165	169	170	404	411	421	75	47	45	109	101	86	49	49	49	226	244	268

Source: CRA

NEEM/TX Subteam Notes

- F8 transfer limit increases similar to F2
 - Slightly smaller due to lower F8 load levels
 - F8 RPS is not binding as carbon price drives renewables additions
 - Model practically builds as much wind in southwest and mid-west as intermittency penetration limits and transmission and load constraints will allow

F2 vs F8

	F2S1	F2S2	F8S1	F8S2
MISO_W_2_PJM_ROR	12,420	31,421	19,066	36,654
SPP_N_2_ENT	13,843	16,272	5,546	13,928
MISO_WUMS_2_MISO_MI	688	15,406	195	4,604
MISO_MI_2_MISO_IN	0	8,251	0	15
SPP_N_2_MISO_MO-IL	2,019	7,084	1,954	4,885
MISO_W_2_MISO_WUMS	38	5,698	118	257
NE_2_MISO_W	2,489	5,612	2,014	3,662
SPP_S_2_ENT	1,992	5,132	3,430	4,288
MISO_W_2_MISO_MO-IL	122	4,954	248	3,348
ENT_2_SOCO	1,900	4,497	0	2,466
MISO_MO-IL_2_MISO_IN	0	4,104	0	5,121
NE_2_SPP_N	160	3,355	54	1,033
IESO_2_MISO_MI	751	2,904	1,285	4,478
NYISO_A-F_2_NYISO_G-I	1,435	2,271	1,016	1,570
PJM_ROR_2_PJM_ROM	0	1,787	0	0
SPP_N_2_SPP_S	236	1,069	0	0
NEISO_2_NYISO_J-K	315	825	608	934
PJM_ROR_2_VACAR	0	460	0	1,699
IESO_2_NYISO_A-F	0	358	499	242
NYISO_G-I_2_NYISO_J-K	0	70	0	0
SPP_N_2_NE	0	64	0	0
NYISO_J-K_2_PJM_E	74	44	2	3
IESO_2_MISO_W	67	35	55	0
SPP_N_2_MISO_W	337	32	250	1,135
MAPP_CA_2_MISO_W	0	1	0	261
SPP_S_2_SPP_N	0	0	0	77
MISO_MI_2_MISO_WUMS	0	0	140	76
MISO_IN_2_MISO_MI	768	0	490	14
IESO_2_MAPP_CA	0	0	7	5
MISO_IN_2_PJM_ROR	261	0	0	0
Total TX Limit Increase	39,916	121,706	36,978	90,758

- Transmission build and intermittency penetration rates very similar in F2 and F8

	F2S1, OL75	F2S2, OL25	F8S1 OL75	F8S2 OL25
South	29.7%	34.9%	28.2%	34.7%
PJM-MISO	34.5%	34.6%	32.1%	34.6%
Northeast	20.9%	16.8%	15.6%	12.6%
IESO	6.7%	6.7%	7.0%	7.0%
EI	30.2%	32.2%	28.0%	31.7%

	F1S1	F1S2	F2S1	F2S2	F3S1	F5S1	F5S2	F6S1	F7S1	F8S1	F8S2
MISO_W_2_PJM_ROR	0	0	12,420	31,421	0	1,285	9,362	0	0	19,066	36,654
SPP_N_2_ENT	0	0	13,843	16,272	0	3,981	7,440	0	0	5,546	13,928
MISO_WUMS_2_MISO_MI	977	10,054	688	15,406	1,323	7	49	830	235	195	4,604
MISO_MI_2_MISO_IN	0	1,456	0	8,251	0	0	0	0	0	0	15
SPP_N_2_MISO_MO-IL	0	0	2,019	7,084	0	490	263	0	0	1,954	4,885
MISO_W_2_MISO_WUMS	0	0	38	5,698	0	437	2,127	0	0	118	257
NE_2_MISO_W	0	0	2,489	5,612	0	1,592	17,497	0	0	2,014	3,662
SPP_S_2_ENT	0	0	1,992	5,132	0	1,825	4,282	0	0	3,430	4,288
MISO_W_2_MISO_MO-IL	0	0	122	4,954	115	2,113	4,073	0	0	248	3,348
ENT_2_SOCO	0	0	1,900	4,497	0	0	431	0	0	0	2,466
MISO_MO-IL_2_MISO_IN	0	0	0	4,104	0	3,474	4,129	0	0	0	5,121
NE_2_SPP_N	555	2,911	160	3,355	0	583	10,998	1,201	1,055	54	1,033
IESO_2_MISO_MI	0	0	751	2,904	0	0	0	0	0	1,285	4,478
NYISO_A-F_2_NYISO_G-I	507	1,059	1,435	2,271	1,593	658	638	507	742	1,016	1,570
PJM_ROR_2_PJM_ROM	0	0	0	1,787	0	0	0	0	0	0	0
SPP_N_2_SPP_S	0	0	236	1,069	0	0	1,571	0	0	0	0
NEISO_2_NYISO_J-K	82	57	315	825	347	65	90	70	203	608	934
PJM_ROR_2_VACAR	0	0	0	460	0	0	865	0	0	0	1,699
IESO_2_NYISO_A-F	19	191	0	358	0	0	0	0	316	499	242
NYISO_G-I_2_NYISO_J-K	0	0	0	70	0	0	0	58	207	0	0
SPP_N_2_NE	0	0	0	64	2	0	0	0	0	0	0
NYISO_J-K_2_PJM_E	35	54	74	44	0	67	70	0	47	2	3
IESO_2_MISO_W	156	107	67	35	0	42	74	0	133	55	0
SPP_N_2_MISO_W	0	0	337	32	0	0	0	0	0	250	1,135
MAPP_CA_2_MISO_W	0	0	0	1	226	0	0	18	0	0	261
SPP_S_2_SPP_N	0	320	0	0	0	0	0	383	0	0	77
MISO_MI_2_MISO_WUMS	0	0	0	0	0	102	8	0	20	140	76
MISO_IN_2_MISO_MI	0	0	768	0	21	0	81	0	0	490	14
IESO_2_MAPP_CA	62	48	0	0	0	0	0	0	3	7	5
MISO_W_2_MAPP_CA	227	2,341	0	0	0	0	88	15	1,947	0	0
MAPP_US_2_MAPP_CA	0	0	0	0	0	0	65	0	0	0	0
MISO_IN_2_PJM_ROR	0	0	261	0	0	0	0	0	0	0	0
MISO_WUMS_2_MISO_W	892	3,101	0	0	103	0	0	0	0	0	0
NEISO_2_NYISO_G-I	62	157	0	0	0	0	0	0	27	0	0
NEISO_2_NYISO_A-F	0	19	0	0	0	0	0	0	0	0	0
PJM_ROM_2_NYISO_A-F	0	0	0	0	0	32	0	0	0	0	0
MISO_MO-IL_2_MISO_W	167	0	0	0	0	0	0	0	29	0	0
MISO_IN_2_MISO_MO-IL	0	0	0	0	533	0	0	0	0	0	0
Total TX Limit Increase	3,741	21,876	39,916	121,706	4,263	16,754	64,203	3,082	4,963	36,978	90,758

Transfer Limit
Increases called for
by all soft constraint
sensitivities

- F1 based on different EPA and other assumptions
- F3S1 run using OL75; F6S1 and F7S1 run using OL25
- 3 lines are expanded in every run (M. WUMS to M. MI; NY AF to NY GI; NEISO to NY JK)