

# **BP-14 Balancing Reserve Capacity Quantity Forecast Update**



# 99.5% BP-14 Balancing Reserve Forecast August 2012 Update - No Self Supply

99.5% Reserves BPA-14 Averages No Self Supply		Installed Capacity				TOTAL		LOAD*		NON-FEDERAL THERMAL ***		SOLAR		WIND		HYDRO****		FEDERAL THERMAL ****	
		WIND Persistence	Schedule Interval	WIND TOTAL	SOLAR	HYDRO	THERMAL***	TOTAL		TOTAL		TOTAL		TOTAL		TOTAL		TOTAL	
								INC	DEC	INC	DEC	INC	DEC	INC	DEC	INC	JAN	INC	FEB
<b>BP12 30 min</b>	<b>BP12 60 min</b>	4693	21	2604	5784	941	-1245	271	-309	51	-80	0.45	-0.46	619	-855	22	-29	19	-25
20 min	15 min	4871	15	2527	5192	688	-748	276	-294	53	-60	0.35	-0.36	358	-393	21	-25	7	-7
30 min	15 min	4871	15	2527	5192	808	-935	294	-326	58	-69	0.35	-0.36	455	-540	24	-30	7	-8
30 min	30 min	4871	15	2527	5192	888	-1060	301	-338	59	-72	0.34	-0.35	527	-650	25	-32	7	-8
30 min	60 min	4871	15	2527	5192	1074	-1310	312	-352	61	-74	0.34	-0.34	700	-884	26	-34	7	-8
45 min	60 min	4871	15	2527	5192	1225	-1531	311	-351	61	-74	0.34	-0.34	853	-1105	24	-31	7	-8
60 min	60 min	4871	15	2527	5192	1341	-1736	308	-350	59	-72	0.34	-0.35	973	-1313	24	-31	8	-10
Actual **	60 min	4871	15	2527	5192	1069	-1316	310	-351	62	-75	0.34	-0.35	696	-889	24	-31	7	-8

**NOTES:**

- \* Load includes all Non-AGC-Controlled Hydro and CGS
- \*\* Actual Wind missing or nonexistent (new plants) are filled with 30 minute / 60 minute .
- \*\*\* Thermal includes new Thermal and Biomass as an allocated amount by nameplate capacity
- \*\*\*\* Hydro (Non-AGC Controlled Hydro) and Federal Thermal listed for reference only.

## 99.5% BP-14 Balancing Reserve Forecast August 2012 Update - No Self Supply

99.5% Reserves BPA-14 Averages No Self Supply		Installed Capacity				NON-FEDERAL THERMAL		SOLAR		WIND		HYDRO		FEDERAL THERMAL	
		WIND	SOLAR	HYDRO	THERMAL	TOTAL		TOTAL		TOTAL		TOTAL		TOTAL	
Wind	Schedule Interval	TOTAL				INC	DEC	INC	DEC	INC	DEC	INC	DEC	INC	JAN
BP12 30 min	BP12 60 min	4693	21	2604	5784	0.9%	-1.4%	2.1%	-2.2%	13.2%	-18.2%	0.8%	-1.1%	1.5%	-2.0%
20 min	15 min	4871	15	2527	5192	1.0%	-1.2%	2.3%	-2.4%	7.3%	-8.1%	0.8%	-1.0%	0.5%	-0.6%
30 min	15 min	4871	15	2527	5192	1.1%	-1.3%	2.3%	-2.4%	9.3%	-11.1%	1.0%	-1.2%	0.5%	-0.6%
30 min	30 min	4871	15	2527	5192	1.1%	-1.4%	2.3%	-2.3%	10.8%	-13.4%	1.0%	-1.3%	0.5%	-0.6%
30 min	60 min	4871	15	2527	5192	1.2%	-1.4%	2.2%	-2.3%	14.4%	-18.2%	1.0%	-1.3%	0.6%	-0.6%
45 min	60 min	4871	15	2527	5192	1.2%	-1.4%	2.2%	-2.3%	17.5%	-22.7%	1.0%	-1.2%	0.5%	-0.6%
60 min	60 min	4871	15	2527	5192	1.1%	-1.4%	2.2%	-2.3%	20.0%	-27.0%	0.9%	-1.2%	0.6%	-0.8%
Actual **	60 min	4871	15	2527	5192	1.2%	-1.4%	2.3%	-2.3%	14.3%	-18.3%	1.0%	-1.2%	0.6%	-0.7%
<b>NOTES:</b>															
** Actual Wind missing or nonexistent (new plants) are filled with 30 minute / 60 minute .															
**** Hydro (Non-AGC Controlled Hydro) and Federal Thermal listed for reference only.															

## 99.5% BP-14 Balancing Reserve Forecast August 2012 Update –Self Supply

99.5% Reserves BPA-14 Averages with Self Supply		Installed WIND Capacity	TOTAL		WIND		SELF SUPPLY		SELF SUPPLY	
			TOTAL		TOTAL		WIND GI****		WIND GI****	
Wind Persistence	Schedule Interval		INC	DEC	INC	DEC	INC	DEC	INC	DEC
BP12 30 min	BP12 60 min	4693	791	-1012	469	-622	150	-233	10.8%	-16.8%
20 min	15 min	4871	651	-701	322	-347	36	-47	2.4%	-3.1%
30 min	15 min	4871	740	-840	387	-445	69	-95	4.6%	-6.3%
30 min	30 min	4871	795	-928	434	-518	93	-132	6.2%	-8.8%
30 min	60 min	4871	923	-1099	549	-673	151	-211	10.1%	-14.1%
45 min	60 min	4871	1022	-1244	650	-819	203	-286	13.5%	-19.0%
60 min	60 min	4871	1096	-1379	729	-956	244	-357	16.2%	-23.7%
Actual **	60 min	4871	919	-1104	547	-677	149	-212	9.9%	-14.1%
<b>NOTES:</b>										
** Actual Wind missing or nonexistant (new plants) are filled with 30 minute / 60 minute .										
**** Self Supply Wind GI is the amount that Wind GI, Wind Total, Total GI and Total Total Balancing Reserves would be reduced if Iberdrola Self Supplies GI during the BPA-14 Rate Case										

# **Missing Data Points Filled for the BP-14 Balancing Reserve Forecast**



## Missing Data Points filled for the BP-14 Balancing Reserve Forecast

- Analysis broken into two parts:
  - Existing Generator data filled by the Wind Generator supplied Potential Generation.
  - Wind Generator Data filled by the Wind Scaling Methodology:
    - New Plants – Not online prior to October 1, 2011, and require 100% Synthetic Data.
    - Partial Plants – Online from October 1, 2007, to October 1, 2011, and require <100% Synthetic Data.
    - Missing Data in Existing Plants, not filled through Potential Generation.

## Data Fill Points

Month of Study	Number of Plants	Total Number of Wind Data Points (# of Plants * # of Mins)	Missing Data Points filled by Potential Generation	All Missing Data Points filled by Wind Scaling Methodology*	New Plants filled 100% by Wind Scaling Methodology*	Partial Plants filled <100% by Wind Scaling Methodology*	Missing Data for Existing Plants filled by Wind Scaling Methodology*
			% of Wind Points	% of Wind Points	% of Wind Points	% of Wind Points	% of Wind Points
10/1/2013	37	77842080	1%	46%	14%	32%	1%
11/1/2013	37	77842080	1%	46%	14%	32%	1%
12/1/2013	37	77842080	1%	46%	14%	32%	1%
1/1/2014	37	77842080	1%	46%	14%	32%	1%
2/1/2014	37	77842080	1%	46%	14%	32%	1%
3/1/2014	37	77842080	1%	46%	14%	32%	1%
4/1/2014	37	77842080	1%	46%	14%	32%	1%
5/1/2014	37	77842080	1%	46%	14%	32%	1%
6/1/2014	41	86257440	1%	51%	22%	29%	1%
7/1/2014	41	86257440	1%	51%	22%	29%	1%
8/1/2014	41	86257440	1%	51%	22%	29%	1%
9/1/2014	42	88361280	1%	53%	24%	28%	1%
10/1/2014	42	88361280	1%	53%	24%	28%	1%
11/1/2014	42	88361280	1%	53%	24%	28%	1%
12/1/2014	46	96776640	0%	57%	30%	26%	1%
1/1/2015	46	96776640	0%	57%	30%	26%	1%
2/1/2015	46	96776640	0%	57%	30%	26%	1%
3/1/2015	46	96776640	0%	57%	30%	26%	1%
4/1/2015	46	96776640	0%	57%	30%	26%	1%
5/1/2015	46	96776640	0%	57%	30%	26%	1%
6/1/2015	46	96776640	0%	57%	30%	26%	1%
7/1/2015	46	96776640	0%	57%	30%	26%	1%
8/1/2015	48	100984320	0%	58%	33%	24%	1%
9/1/2015	49	103088160	0%	59%	35%	24%	1%
<b>AVERAGE</b>	<b>42</b>	<b>88536600</b>	<b>1%</b>	<b>52%</b>	<b>23%</b>	<b>28%</b>	<b>1%</b>

**NOTES**

\* All Missing Data Points filled by Wind Scaling Methodology is a summation of the New Plants, Partial Plants and Missing Sections of Existing Plants filled by Wind Scaling Methodology

# **BP-14 DSO 216 Estimates Under Various Scheduling Accuracy Assumptions and Scheduling Periods**





## BP-14 DSO 216 Estimates

- Post-analysis run on the data set for each month modeled for the BP-14 Rate Period.
- Assumes current DSO 216 Rules and Implementation.
- Assumes full reserves available and no wind generator movement for reasons other than wind volatility.

## BP-14 DSO 216 Estimates

	30 Min Persistence with 30 Min Schedules				30 Min Persistence with 60 Min Schedules				Actual Wind Schedules			
	Generator Limitation		Tag Curtailment		Generator Limitation		Tag Curtailment		Generator Limitation		Tag Curtailment	
	# of Events	Average MW	# of Events	Average MW	# of Events	Average MW	# of Events	Average MW	# of Events	Average MW	# of Events	Average MW
Oct-13	6.5	303	11.0	-270	7.5	290	8.5	-260	7.5	292	8.0	-268
Nov-13	7.0	320	9.5	-172	8.0	307	10.5	-245	7.0	238	11.0	-255
Dec-13	7.0	320	12.5	-217	9.5	360	12.0	-189	12.0	332	10.0	-183
Jan-14	12.0	277	14.5	-250	10.0	314	12.0	-186	10.0	357	12.0	-177
Feb-14	7.5	371	8.5	-172	7.5	329	10.5	-224	7.0	328	10.0	-217
Mar-14	13.0	376	24.0	-222	13.0	327	20.0	-236	11.0	349	18.0	-219
Apr-14	10.0	309	12.0	-112	9.0	280	10.5	-127	9.5	265	11.5	-124
May-14	9.0	285	12.5	-118	7.0	361	12.0	-139	8.5	314	8.5	-156
Jun-14	10.5	260	10.5	-307	9.0	247	9.0	-313	9.0	263	9.5	-291
Jul-14	4.0	206	8.5	-215	5.5	244	6.0	-167	5.5	224	6.0	-163
Aug-14	8.0	310	7.5	-176	10.5	324	6.0	-219	9.0	321	5.5	-199
Sep-14	5.5	368	9.0	-216	6.0	334	9.5	-229	4.5	298	10.0	-219
Oct-14	7.5	311	11.0	-273	7.5	290	10.0	-263	7.5	286	8.0	-282
Nov-14	7.0	323	10.0	-184	8.5	307	10.5	-243	8.0	271	10.0	-247
Dec-14	7.0	331	12.0	-222	9.0	384	11.5	-193	11.5	340	10.5	-204
Jan-15	11.0	317	15.5	-250	10.5	325	11.5	-183	10.5	353	11.5	-189
Feb-15	7.5	372	8.5	-197	7.5	306	10.0	-243	7.0	330	9.5	-228
Mar-15	11.0	396	23.5	-218	13.0	341	19.5	-237	11.0	365	18.5	-237
Apr-15	9.0	320	13.5	-120	9.0	274	11.5	-137	9.5	268	10.5	-129
May-15	8.0	288	11.0	-125	6.5	360	11.5	-144	7.5	337	8.5	-151
Jun-15	10.0	271	10.5	-314	10.0	250	9.0	-316	9.5	261	9.0	-307
Jul-15	4.0	211	7.5	-195	5.5	234	5.5	-174	5.5	234	6.5	-159
Aug-15	8.0	321	9.0	-203	10.5	332	6.0	-193	8.5	338	4.5	-214
Sep-15	5.5	375	8.0	-235	6.5	340	9.0	-231	5.5	310	9.5	-199
BP-14 AVG	8.1	314	11.7	-208	8.6	311	10.5	-212	8.4	303	9.9	-209

## BP-14 DSO 216 Estimates

	45 Min Persistence with 60 Min Schedules				60 Min Persistence with 60 Min Schedules			
	Generator Limitation		Tag Curtailment		Generator Limitation		Tag Curtailment	
	# of Events	Average MW	# of Events	Average MW	# of Events	Average MW	# of Events	Average MW
<b>Oct-13</b>	6.5	261	8.0	-240	5.5	281	9.0	-259
<b>Nov-13</b>	7.0	249	9.0	-235	5.0	329	10.0	-222
<b>Dec-13</b>	8.5	398	10.0	-229	5.5	459	9.5	-170
<b>Jan-14</b>	9.0	333	11.0	-182	8.0	303	12.5	-211
<b>Feb-14</b>	8.0	329	8.5	-166	6.0	267	8.0	-160
<b>Mar-14</b>	12.5	359	18.5	-249	9.5	338	22.0	-226
<b>Apr-14</b>	8.0	274	10.5	-126	5.0	305	12.0	-163
<b>May-14</b>	7.5	361	9.5	-146	8.0	309	10.5	-153
<b>Jun-14</b>	7.5	249	8.0	-298	9.5	269	11.0	-210
<b>Jul-14</b>	5.0	228	3.0	-199	4.5	237	4.0	-148
<b>Aug-14</b>	9.0	279	5.0	-134	7.5	306	5.0	-186
<b>Sep-14</b>	5.5	316	9.0	-158	3.5	273	9.0	-177
<b>Oct-14</b>	6.5	259	7.5	-242	5.0	294	8.5	-257
<b>Nov-14</b>	7.0	241	9.5	-242	4.5	350	10.0	-211
<b>Dec-14</b>	9.0	393	9.0	-228	5.5	454	10.0	-192
<b>Jan-15</b>	8.5	343	10.5	-190	7.0	299	11.0	-220
<b>Feb-15</b>	8.5	332	9.0	-155	6.0	257	7.5	-168
<b>Mar-15</b>	12.0	365	18.5	-243	9.5	335	22.0	-233
<b>Apr-15</b>	7.5	277	12.0	-134	6.0	294	11.0	-170
<b>May-15</b>	6.5	384	8.5	-155	8.0	308	9.0	-151
<b>Jun-15</b>	8.0	252	9.0	-286	10.0	263	11.0	-240
<b>Jul-15</b>	5.0	231	3.5	-170	4.5	219	4.0	-147
<b>Aug-15</b>	9.0	301	5.0	-129	7.5	318	4.5	-182
<b>Sep-15</b>	5.5	311	8.5	-171	3.5	269	9.5	-154
<b>BP-14 AVG</b>	7.8	305	9.2	-196	6.4	306	10.0	-192

## BP-14 DSO 216 Estimates

	20 Min Persistence with 15 Min Schedules				30 Min Persistence with 15 Min Schedules			
	Generator Limitation		Tag Curtailment		Generator Limitation		Tag Curtailment	
	# of Events	Average MW	# of Events	Average MW	# of Events	Average MW	# of Events	Average MW
<b>Oct-13</b>	7.5	275	8.5	-178	8.0	286	8.0	-267
<b>Nov-13</b>	11.0	216	10.5	-129	7.0	257	8.5	-164
<b>Dec-13</b>	6.5	235	17.0	-144	7.5	242	14.0	-219
<b>Jan-14</b>	16.0	227	18.5	-155	12.0	242	15.0	-211
<b>Feb-14</b>	7.0	293	12.0	-113	6.0	362	8.0	-135
<b>Mar-14</b>	17.5	287	20.0	-185	14.5	355	20.5	-199
<b>Apr-14</b>	11.0	248	16.0	-95	8.0	332	11.0	-94
<b>May-14</b>	7.5	264	10.0	-89	8.0	252	8.0	-113
<b>Jun-14</b>	12.0	253	6.5	-344	10.5	264	7.0	-363
<b>Jul-14</b>	5.0	223	6.0	-170	4.0	262	7.0	-223
<b>Aug-14</b>	8.5	241	10.0	-160	8.5	246	8.0	-201
<b>Sep-14</b>	4.5	387	9.0	-164	4.0	379	5.5	-230
<b>Oct-14</b>	8.0	284	8.5	-191	8.5	291	7.5	-275
<b>Nov-14</b>	11.0	251	10.5	-134	7.0	297	8.5	-184
<b>Dec-14</b>	6.0	251	18.0	-158	6.0	283	13.5	-201
<b>Jan-15</b>	15.5	238	15.5	-177	12.0	236	14.0	-244
<b>Feb-15</b>	8.0	306	12.0	-109	6.0	373	9.0	-134
<b>Mar-15</b>	17.0	302	20.5	-190	14.5	360	19.5	-227
<b>Apr-15</b>	10.0	271	15.5	-95	7.5	330	12.0	-114
<b>May-15</b>	6.5	286	9.0	-108	7.5	314	6.5	-130
<b>Jun-15</b>	13.0	243	7.0	-325	10.5	265	7.0	-382
<b>Jul-15</b>	5.0	221	6.5	-156	4.5	263	6.5	-238
<b>Aug-15</b>	9.0	265	9.5	-167	8.5	251	8.0	-201
<b>Sep-15</b>	4.5	384	10.0	-191	4.0	366	6.0	-233
<b>BP-14 AVG</b>	9.5	269	11.9	-164	8.1	296	9.9	-208

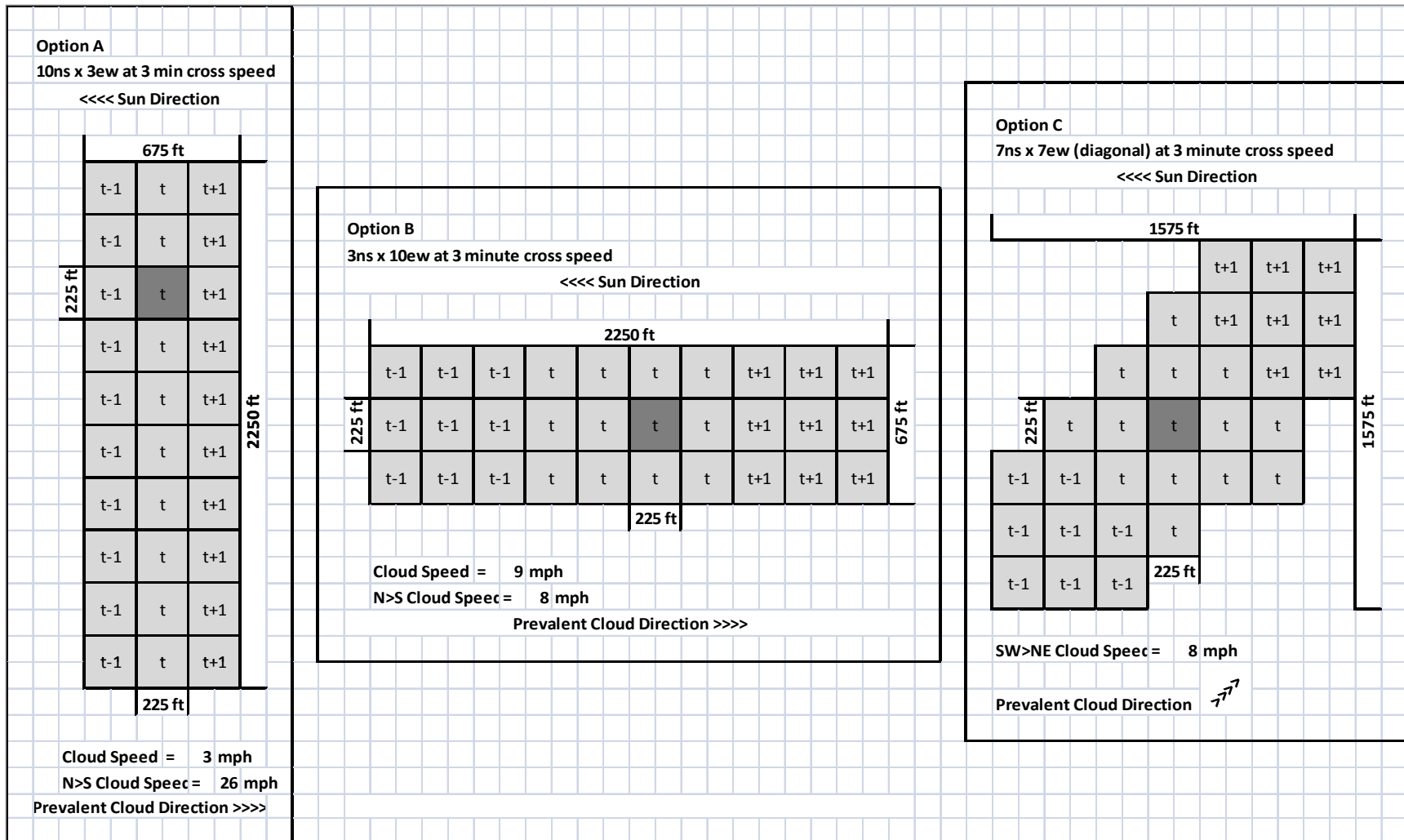
# **BP-14 Solar Generation Studies**



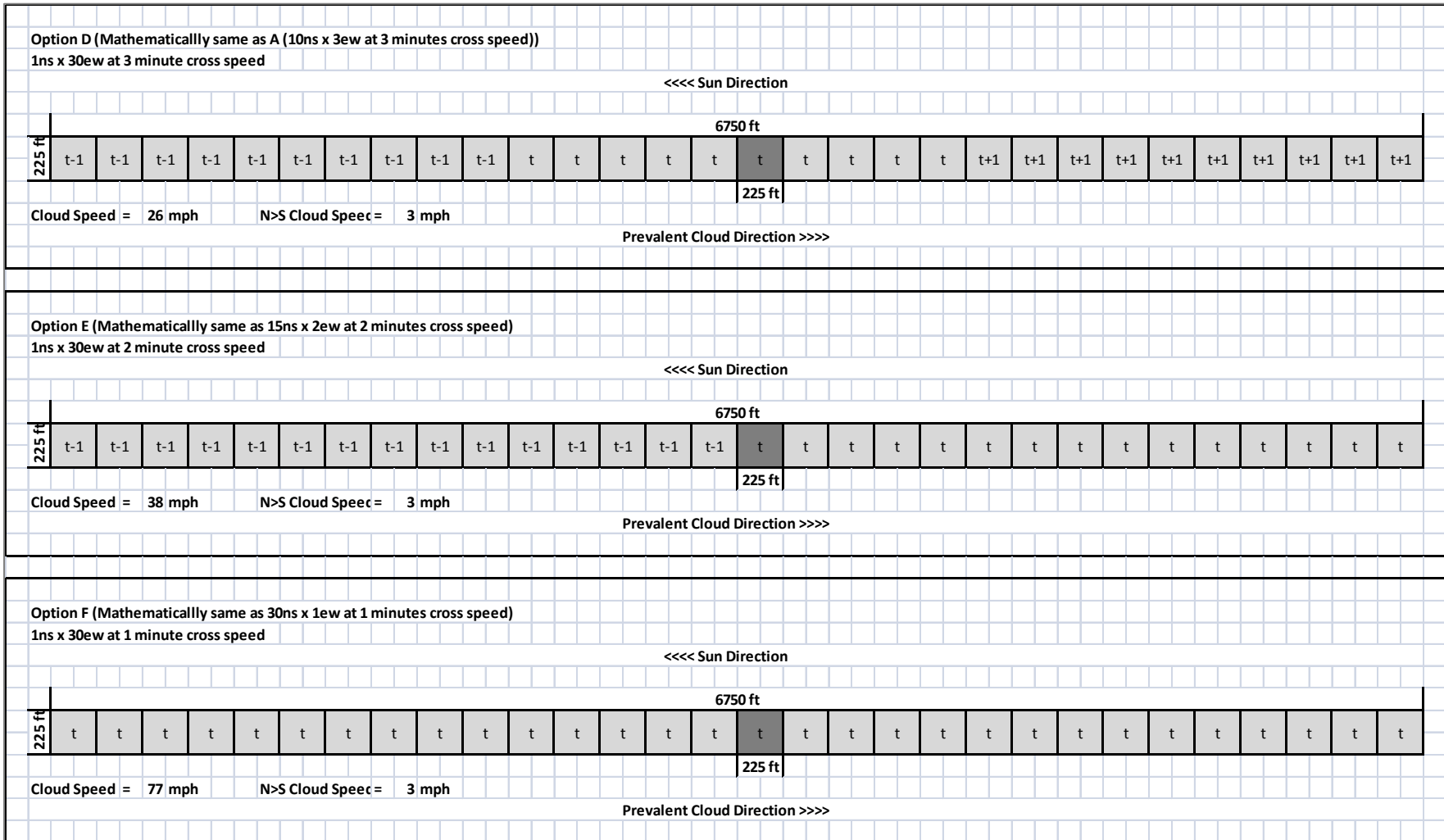
## BP-14 Balancing Reserve Solar Generation

- Is there diversity within a 15 MW Solar Plant?
- Layouts explored in following slides are based on:
  - Growth of Puget Sound Energy's Wildhorse Solar from 0.5 MW to 15 MW.
  - Assumed fixed tilt photovoltaic and an industry average 11.5 Watts per ft<sup>2</sup>
- Cloud speeds can range from 0 mph (fog) to 100 mph (high cirrus clouds filtering the sun).
- Only Option F (no time shift) gives a reasonable range of cloud speed for a 15 MW plant.

# BP-14 Balancing Reserve Potential Solar Generation Layouts



# BP-14 Balancing Reserve Potential Solar Generation Layouts





## Solar Growth Study

- 15 full BP-14 Rate Case studies with increasing amounts of Solar Generation.
- All showed minimal reserves growth as a percent of nameplate with the 3000 MW worst case (assumes no diversity) at about 10% of nameplate.

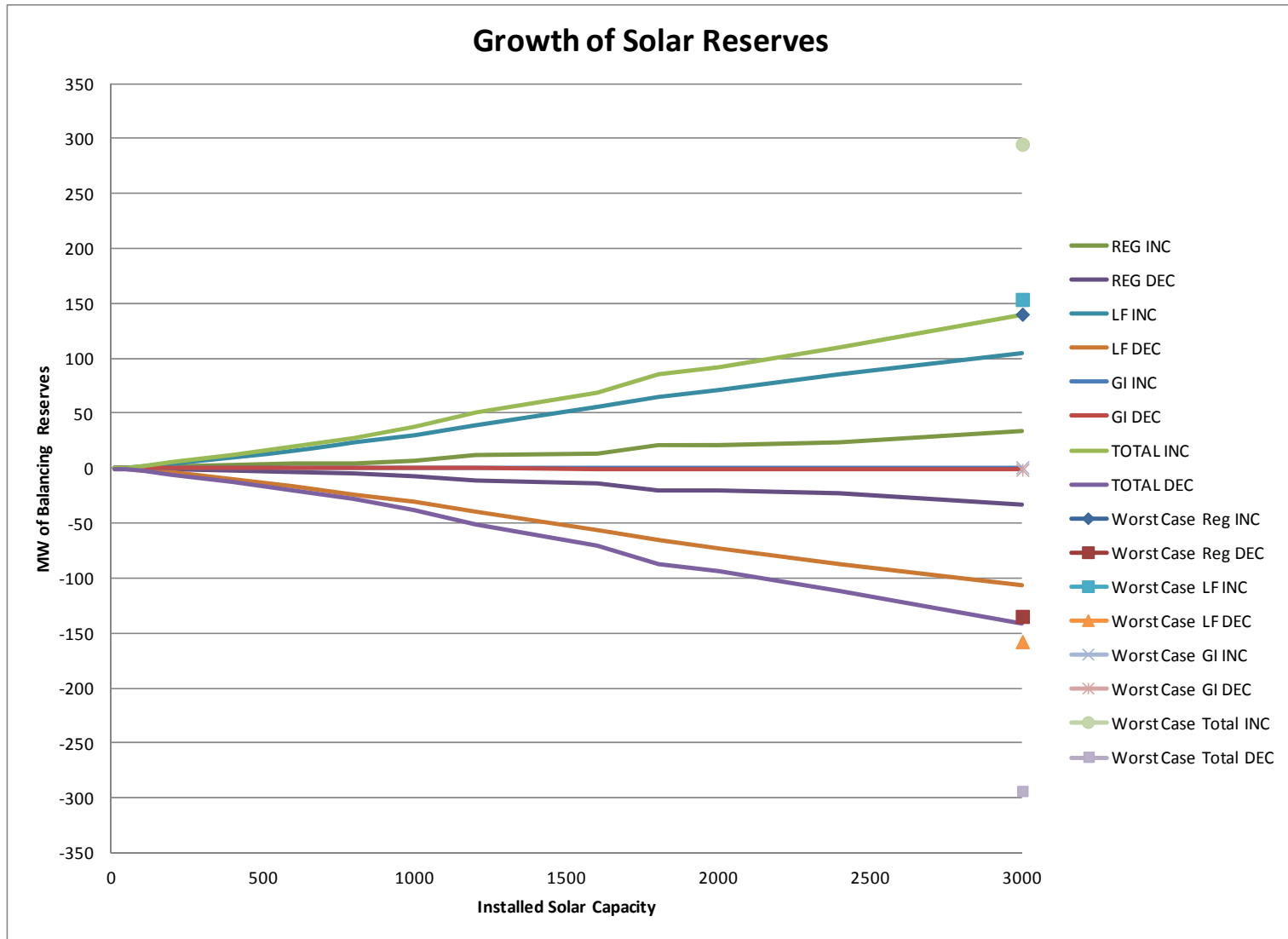
15MW is SMUD scaled to 15MW (One 15MW plant)
50MW is SMUD and PSE scaled to 25MW (Two 25MW plants)
100MW is SMUD and PSE scaled to 50MW (Two 50MW plants)
200MW is SMUD and PSE scaled to 100MW (Two 100MW plants)
400MW is 200MW case with another 200MW shifted ahead 5 minutes (Four 100MW plants)
600MW is 400MW case with another 200MW shifted back 5 minutes (Six 100MW plants)
800MW is 600MW case with another 200MW shifted ahead 10 minutes (Eight 100MW plants)
1000MW is 800MW case with another 200MW shifted back 10 minutes (Ten 100MW plants)
1200MW case is 600MW case doubled. (Six 200MW plants)
1600MW case is 800MW case doubled. (Eight 200MW plants)
1800MW case is 600MW case tripled. (Six 300MW plants)
2000MW case is 1000MW case doubled. (Ten 200MW plants)
2400MW case is 800MW case tripled. (Eight 300MW plants)
3000MW case is 1000MW case tripled. (Ten 300MW plants)
3000MW Worst Case is SMUD scaled to 3000MW. (One 3000MW plant)

# Solar Growth Study

BP-14 Average	Installed Capacity			SOLAR Reserves (MW)							
	WIND		SOLAR	REG		LF		GI		TOTAL	
	TOTAL	Self Supply		INC	DEC	INC	DEC	INC	DEC	INC	DEC
15.00	5208	1520	15	0	0	0	0	0	0	0	0
50.00	5208	1520	50	0	0	1	-1	0	0	1	-1
100.00	5208	1520	100	0	0	2	-2	0	0	2	-2
200.00	5208	1520	200	1	-1	4	-4	0	0	5	-5
400.00	5208	1520	400	3	-3	10	-10	0	0	12	-13
600.00	5208	1520	600	4	-4	16	-16	0	0	20	-20
800.00	5208	1520	800	5	-5	23	-23	0	0	28	-28
1000.00	5208	1520	1000	7	-7	30	-31	0	0	38	-38
1200.00	5208	1520	1200	11	-11	39	-40	0	0	51	-52
1600.00	5208	1520	1600	14	-13	55	-57	0	0	69	-70
1800.00	5208	1520	1800	21	-20	64	-66	0	0	85	-87
2000.00	5208	1520	2000	20	-20	71	-72	0	0	91	-93
2400.00	5208	1520	2400	24	-23	85	-87	1	-1	109	-111
3000.00	5208	1520	3000	34	-34	104	-107	1	-1	139	-141
3000 Worst Case	5208	1520	3000	140	-135	154	-158	1	-1	295	-294

BP-14 Average	Installed Capacity			SOLAR Reserves (% of Nameplate)							
	WIND		SOLAR	REG		LF		GI		TOTAL	
	TOTAL	Self Supply		INC	DEC	INC	DEC	INC	DEC	INC	DEC
15.00	5208	1520	15	0.4%	-0.4%	1.9%	-1.9%	0.0%	0.0%	2.3%	-2.3%
50.00	5208	1520	50	0.3%	-0.3%	1.6%	-1.6%	0.0%	0.0%	1.9%	-2.0%
100.00	5208	1520	100	0.4%	-0.4%	1.7%	-1.8%	0.0%	0.0%	2.2%	-2.2%
200.00	5208	1520	200	0.7%	-0.6%	2.0%	-2.1%	0.0%	0.0%	2.7%	-2.7%
400.00	5208	1520	400	0.6%	-0.6%	2.4%	-2.5%	0.0%	0.0%	3.1%	-3.2%
600.00	5208	1520	600	0.6%	-0.6%	2.7%	-2.7%	0.0%	0.0%	3.3%	-3.4%
800.00	5208	1520	800	0.6%	-0.6%	2.9%	-2.9%	0.0%	0.0%	3.5%	-3.5%
1000.00	5208	1520	1000	0.7%	-0.7%	3.0%	-3.1%	0.0%	0.0%	3.8%	-3.8%
1200.00	5208	1520	1200	0.9%	-0.9%	3.3%	-3.3%	0.0%	0.0%	4.2%	-4.3%
1600.00	5208	1520	1600	0.8%	-0.8%	3.4%	-3.5%	0.0%	0.0%	4.3%	-4.4%
1800.00	5208	1520	1800	1.2%	-1.1%	3.6%	-3.7%	0.0%	0.0%	4.7%	-4.8%
2000.00	5208	1520	2000	1.0%	-1.0%	3.5%	-3.6%	0.0%	0.0%	4.6%	-4.7%
2400.00	5208	1520	2400	1.0%	-1.0%	3.6%	-3.6%	0.0%	0.0%	4.6%	-4.6%
3000.00	5208	1520	3000	1.1%	-1.1%	3.5%	-3.6%	0.0%	0.0%	4.6%	-4.7%
3000 Worst Case	5208	1520	3000	4.7%	-4.5%	5.1%	-5.3%	0.0%	0.0%	9.8%	-9.8%

# Solar Growth Study



# Solar Growth Study

