Supplement to the 2020 Study of the Levels of Flex Reserve and Regulating Reserve Necessary for Reliable System Operation

October 2020

The TRC-approved Flex Reserve study completed in May 2020, studied the Flex Reserve requirements associated with adding up to 1500 MW of wind generation above the already existing wind generation within the PSCo BA as of ~2022; a total amount of installed wind of 6,462 MW. Based on the Company's near and long-term carbon reduction goals, the Company decided to study the Flex Reserve requirements associated with up to 3000 MW of incremental wind generation; a total amount of installed wind of 7,962 MW. This Supplement to the Flex Reserve Study applied the previously approved TRC methodologies to study the Flex Reserve requirements associated with up to 1500 MW of wind generation incremental to what was included in the Flex Reserve Study. The same 1-minute wind data from November 2015 through May 2019 was also used in the Supplemental Study.

In the Flex Study, we looked at various permutations of adding 500 MW of additional wind in each of ERZ1, ERZ2, and ERZ3. For this supplemental study, the Company boosted the volumes of incremental wind generation in each location to achieve the total volumes that we wanted to study. Table 1 lists the 1-minute wind generation profiles with time offsets that each represents an incremental 250 MW wind plant.

Table 1: Wind Generation Profiles for Incremental Wind Plants

Profile Capacity (MW)	ERZ1	ERZ2	ERZ3
500 (Flex Study)	CC2 +15 minutes CC2 +30 minutes	CDPT +15 minutes GW +30 minutes	TWBT +15 minutes TWBT +30 minutes
1000 (Supplemental Flex Study)	CC2 +15 minutes CC2 +30 minutes CC2 –15 minutes CC2 –30 minutes	CDPT +15 minutes GW +30 minutes CDPT –15 minutes GW +15 minutes	TWBT +15 minutes TWBT +30 minutes TWBT -15 minutes TWBT -30 minutes
1500 (Supplemental Flex Study)	CC2 +15 minutes CC2 +30 minutes CC2 –15 minutes CC2 –30 minutes CC2 +45 minutes CC2 +60 minutes	CDPT +15 minutes GW +30 minutes CDPT –15 minutes GW +15 minutes GW + 45 minutes GW + 60 minutes	TWBT +15 minutes TWBT +30 minutes TWBT -15 minutes TWBT -30 minutes TWBT –45 minutes TWBT +45 minutes

The Company then constructed wind generation portfolios with various permutations of incremental wind generation in each of the ERZs. The final Flex Reserve Requirement for a particular volume of wind generation (e.g. Base Case + 2000 MW = 6,962 MW) was the average of the Flex Reserve Requirements for the underlying portfolios (e.g. Profiles A through F). Table 2 lists the six profiles (A-F) with a total wind portfolio capacity of 6,962 MW and the contribution of incremental wind generation from each ERZ. Table 3 lists the six profiles (A-F) with a total wind portfolio capacity of 7,462 MW and Table 4 lists

the seven profiles (A-G) with a total wind portfolio capacity of 7,962 MW, along with the contributions of incremental wind generation from each ERZ.

Table 2

Base Case + 2000 MW = 6,962 MW			
Profile	ERZ1	ERZ2	ERZ3
A	1000	500	500
B	500	1000	500
C	500	500	1000
D	1000	1000	0
E	1000	0	1000
F	0	1000	1000

Table 3

Base Case + 2500 MW = 7,462 MW			
Profile	ERZ1	ERZ2	ERZ3
A	1000	1000	500
B	1000	500	1000
C	500	1000	1000
D	500	500	1500
E	500	1500	500
F	1500	500	500

Table 4

Base Case + 3000 MW = 7,962 MW			
Profile	ERZ1	ERZ2	ERZ3
A	1000	1000	1000
B	1500	500	1000
C	1500	1000	500
D	1000	500	1500
E	1000	1500	500
F	500	1000	1500
G	500	1500	1000

Figure 1 shows the 30-minute Flex Reserve Requirement for the three wind generation portfolios studied in the Supplemental Study (6,962 MW, 7,462 MW, and 7,962 MW). In Figure 1, wind generation is measured along the horizontal axis and the required Flex Reserve is measured along the vertical axis.

Figure 1: 30-minute Flex Requirement for Supplemental Study wind portfolios

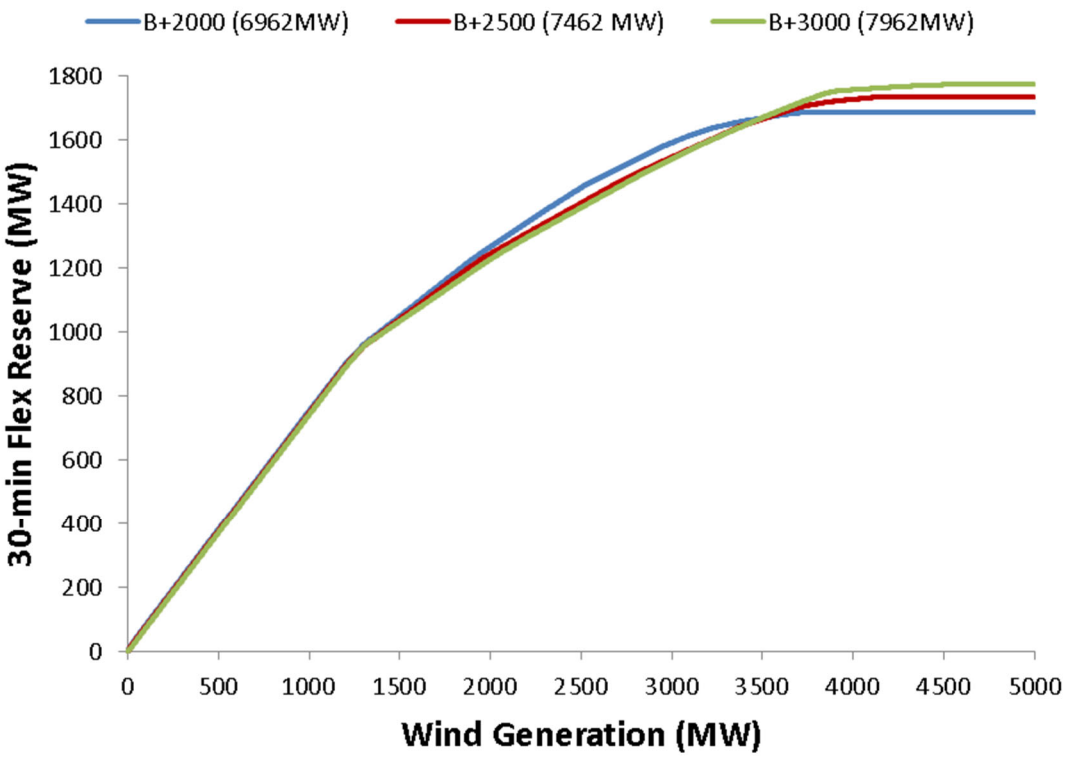


Figure 2 compares the Base Case + 1500 MW portfolio from the Flex Reserve Study and the Base Case + 2000 MW portfolio from the Supplemental Study. Note that the resulting Flex Reserve Requirement is almost identical for these two portfolios. Rather than applying separate Flex Reserve Requirements for these portfolios, the Company recommends using the Base Case + 1500 MW Flex Reserve Requirement for both portfolios.

Figure 3 compares the Flex Reserve requirements from the various portfolios in the Flex Reserve Study and the Supplemental Study. Note that the Base Case + 2000 MW curve is not displayed as it is almost identical to the Base Case = 1500 MW curve. Table 5 lists the maximum Flex Reserve Requirement for each of the wind portfolios.

Table 5: Maximum 30-minute Flex Requirement for wind portfolios

Wind Portfolio	Wind Generation Capacity	Maximum Flex Reserve
Base Case	4,962 MW	1,390.7 MW
Base Case + 500 MW	5,462 MW	1,493.6 MW
Base Case + 1000 MW	5,962 MW	1,552.8 MW
Base + 1500 MW, Base + 2000 MW	6,462 MW and 6,962 MW	1,691.1 MW
Base Case + 2500 MW	7,462 MW	1,733.4 MW
Base Case + 3000 MW	7,962 MW	1,773.3 MW

Figure 2: Flex Reserve for Base Case + 1500 MW and Base Case + 2000 MW

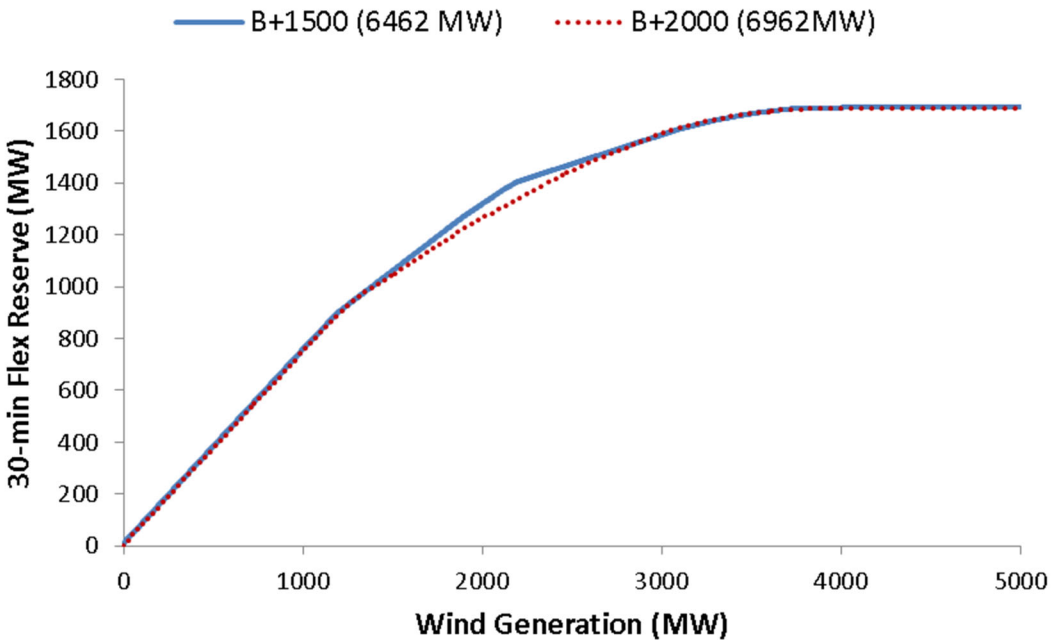
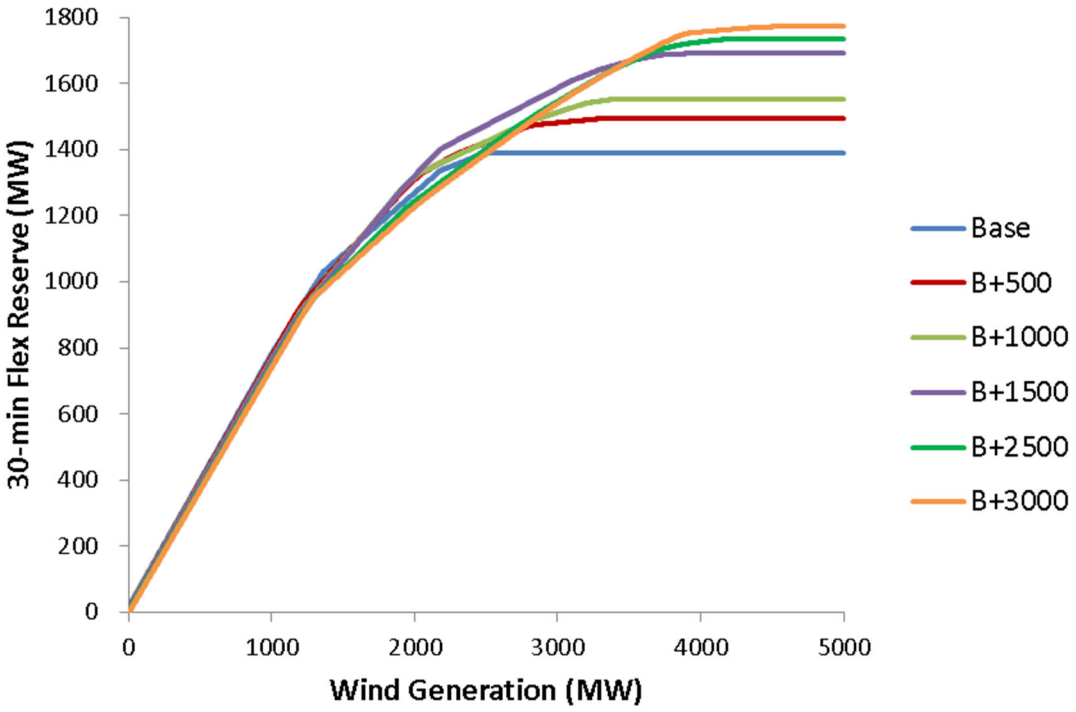


Figure 3: Flex Reserve curves from Flex Study and Supplemental Study



Regulation portion of 10-minute Flex Reserve

There are several components that make up the total Flex Reserve requirement. The total Flex Reserve is based on the maximum 30-minute loss of wind generation for a given starting volume of wind generation. Of this total Flex Reserve volume, 60% must be comprised of resources available within 10 minutes. In the Flex Reserve Study, Regulating Reserve only accounts for the Fast-Moving and Following components attributable to Load and Solar generation. Any regulation attributable to wind is assumed to be covered by Flex Reserve. To account for the Regulating Reserve attributable to wind generation, the Company calculated the 95th percentile of 10-minute wind generation down ramps for each 100MW generation bin for each wind generation portfolio. The maximum 10-minute Regulating Reserve value was consistently ~15% of the Maximum Flex Reserve requirement or ~25% of the 10-minute component of Flex Reserve.

Figure 4 shows the various components of the 30-minute Flex Reserve Requirement for the Base Case Portfolio. The first 15% of the Flex Reserve Requirement must be comprised 10-minute online resources. The next 45% of the Flex Reserve Requirement can be served with 10-minute resources either online or offline. The last 40% of the Flex Reserve Requirement can be served with any resource available within 30 minutes.