

Wind Integration Event Frequency Study

Analysis, for various reserve amount scenarios, of the frequency of wind or load exceeding the study allocation

Utilization of Reserves by Load and Wind beyond Allocation

The variability of Load and Wind both contribute to utilization of reserves. At times, the Load and Wind work together minimizing reserve usage, and at other times they work against each other increasing the usage of reserves from that used by either one alone. The reserve requirement study determined the amount of reserves needed to support the combination of both Load and Wind together. This total reserve amount was then allocated (apportioned) for rate-making purposes to the Load (inc R_{il} and dec R_{dl}) and Wind (inc R_{iw} and dec R_{dw}). This study considers how often, and how much, the error in the Load or the Wind exceeds the respective allocated portions of the total reserves under various scenarios. The data used is the same 21-month study data used to determine the reserve requirement and allocation. For purposes of this analysis, it is assumed no limits to wind generation or curtailments to wind schedules are implemented. The average hours per month identified reflects the hours where either load or wind or both were over their allocated reserve amount.

Utilization of Reserves beyond allocation, Scenario A through D

- Reserves are held at a level required by a **30-minute persistence** wind estimate accuracy
- Actual wind estimates are based on
 - A – 30-minute persistence
 - B – 45-minute persistence
 - C – 60-minute persistence
 - D – 2-hour average persistence

Installed Wind	R_{it} (MW)	R_{il} (MW)	R_{iw} (MW)	R_{dt} (MW)	R_{dl} (MW)	R_{dw} (MW)
2,105	1,019.3	787.5	231.8	-1,287.9	-991.2	-296.7
3,155	1,210.9	772.2	438.7	-1,472.6	-925.3	-547.2
4,330	1,396.8	751.5	645.2	-1,754.5	-964.2	-790.3
5,570	1,581.2	735.7	845.5	-1,971.7	-910.3	-1,061.4

Installed Wind	Wind Accuracy	Average Hours/mo	Load Inc MWh/Mo	Load Dec MWh/Mo	Wind Inc MWh/Mo	Wind Dec MWh/mo
<i>Scenario A</i>						
2,105	30-min	104	41.2	145.2	2,290.6	2,449.6
3,155	30-min	67	68.0	232.8	1,896.9	2,186.4
4,330	30-min	46	115.4	212.9	1,315.7	1,702.7
5,570	30-min	38	148.6	289.8	1,108.2	1,472.6
<i>Scenario B</i>						
2,105	45-min	136	41.2	145.2	4,013.5	4,249.2
3,155	45-min	91	68.0	232.8	3,657.1	4,155.4
4,330	45-min	66	115.4	212.9	2,825.9	3,500.2
5,570	45-min	55	148.6	289.8	2,632.3	3,260.5
<i>Scenario C</i>						
2,105	60-min	163	41.2	145.2	6,087.5	6,377.8
3,155	60-min	115	68.0	232.8	5,859.0	6,673.0
4,330	60-min	86	115.4	212.9	4,905.5	6,013.7
5,570	60-min	74	148.6	289.8	4,868.6	5,882.0
<i>Scenario D</i>						
2,105	2-hour	207	41.2	145.2	10,272.4	10,762.5
3,155	2-hour	154	68.0	232.8	10,704.9	12,226.6
4,330	2-hour	124	115.4	212.9	9,944.1	12,198.3
5,570	2-hour	110	148.6	289.8	10,605.6	12,747.3

Utilization of Reserves beyond allocation, Scenario E through H

- Reserves are held at a level required by a **45-minute persistence** wind estimate accuracy
- Actual wind estimates are based on
 - E – 30-minute persistence
 - F – 45-minute persistence
 - G – 60-minute persistence
 - H – 2-hour average persistence

Installed Wind	R_{it} (MW)	R_{il} (MW)	R_{iw} (MW)	R_{dt} (MW)	R_{dl} (MW)	R_{dw} (MW)
2,105	1,086.0	786.0	300.1	-1,308.3	-942.3	-366.0
3,155	1,334.3	802.2	532.1	-1,691.5	-948.5	-743.1
4,330	1,585.8	768.6	817.2	-1,953.6	-940.4	-1,013.2
5,570	1,841.3	698.0	1,143.3	-2,273.4	-904.3	-1,369.1

Installed Wind	Wind Accuracy	Average Hours/mo	Load Inc MWh/Mo	Load Dec MWh/Mo	Wind Inc MWh/Mo	Wind Dec MWh/mo
<i>Scenario E</i>						
2,105	30-min	60	42.2	186.6	1,045.4	1,409.3
3,155	30-min	34	43.7	205.6	949.6	775.7
4,330	30-min	22	90.7	241.3	453.3	671.1
5,570	30-min	19	230.8	299.1	216.8	511.7
<i>Scenario F</i>						
2,105	45-min	84	42.2	186.6	2,044.9	2,621.2
3,155	45-min	50	43.7	205.6	2,016.1	1,655.0
4,330	45-min	34	90.7	241.3	1,128.0	1,523.2
5,570	45-min	27	230.8	299.1	658.9	1,279.2
<i>Scenario G</i>						
2,105	60-min	107	42.2	186.6	3,319.9	4,197.8
3,155	60-min	68	43.7	205.6	3,432.9	2,945.4
4,330	60-min	48	90.7	241.3	2,168.0	2,831.5
5,570	60-min	38	230.8	299.1	1,455.5	2,489.3
<i>Scenario H</i>						
2,105	2-hour	143	42.2	186.6	6,129.3	7,567.7
3,155	2-hour	97	43.7	205.6	6,747.4	6,279.1
4,330	2-hour	72	90.7	241.3	4,926.9	6,565.1
5,570	2-hour	59	230.8	299.1	3,853.2	6,336.6

Utilization of Reserves beyond allocation, Scenario I through L

- Reserves are held at a level required by a **2-hour average persistence** wind estimate accuracy
- Actual wind estimates are based on
 - I – 30-minute persistence
 - J – 45-minute persistence
 - K – 60-minute persistence
 - L – 2-hour average persistence

Installed Wind	R_{it} (MW)	R_{il} (MW)	R_{iw} (MW)	R_{dt} (MW)	R_{dl} (MW)	R_{dw} (MW)
2,105	1,256.9	764.3	492.6	-1,569.6	-927.9	-641.7
3,155	1,618.0	762.7	855.2	-2,164.7	-879.0	-1,285.7
4,330	1,938.7	710.3	1,228.4	-2,528.9	-841.2	-1,687.7
5,570	2,386.1	636.9	1,749.2	-3,047.6	-756.3	-2,291.3

Installed Wind	Wind Accuracy	Average Hours/mo	Load Inc MWh/Mo	Load Dec MWh/Mo	Wind Inc MWh/Mo	Wind Dec MWh/mo
<i>Scenario I</i>						
2,105	30-min	13	58.6	201.7	107.5	167.2
3,155	30-min	10	78.1	299.1	78.5	33.2
4,330	30-min	11	193.9	412.0	27.9	27.2
5,570	30-min	19	441.0	674.0	5.5	7.5
<i>Scenario J</i>						
2,105	45-min	20	58.6	201.7	274.4	402.0
3,155	45-min	13	78.1	299.1	235.3	133.6
4,330	45-min	13	193.9	412.0	116.4	113.8
5,570	45-min	20	441.0	674.0	25.8	43.8
<i>Scenario K</i>						
2,105	60-min	28	58.6	201.7	578.9	737.3
3,155	60-min	17	78.1	299.1	520.5	272.2
4,330	60-min	16	193.9	412.0	291.1	268.2
5,570	60-min	20	441.0	674.0	112.7	168.7
<i>Scenario L</i>						
2,105	2-hour	43	58.6	201.7	1,303.2	1,752.8
3,155	2-hour	26	78.1	299.1	1,228.7	807.8
4,330	2-hour	23	193.9	412.0	805.0	844.6
5,570	2-hour	25	441.0	674.0	368.9	620.1