

Field Demonstration of an Automated Generator Evaluation Tool at BPA

April 16, 2024

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PNNL is operated by Battelle for the U.S. Department of Energy









- Multi-lab team partnered with utilities to develop advanced measurement capabilities for resilient integration of inverter-based resources (IBRs)
- PNNL partnered with BPA to address one of their needs
 - All generators must meet requirements to interconnect with BPA's system
 - Ongoing performance verification is time consuming, and increasingly so as new IBR plants come online
- The resulting Generator Scorecard tool was demonstrated at BPA



March 2023

JD Follum R Hovsapia Agalgaonk:



Advanced Measurements for Resilient Integration of **Inverter-Based Resources**

PROGRESS MATRIX Year-1 Report

K Mahapatr A Riepnieks AJ Wilson S Chanda S Granda

PNNI -34089



Capabilities

- Analyzes long records of archived or incoming PMU data
- Detects frequency and voltage excursions
- Automatically performs frequency and voltage response analysis
- Tracks adherence to the assigned voltage schedule
- Summarizes performance in easy to interpret visualizations





Frequency Response Measure (FRM)

Measure of a plant's change in active power in response to a change in frequency

$$FRM = \frac{B_P - A_P}{10(B_F - A_F)}$$
 in $\frac{MW}{0.1Hz}$





Frequency Response Measure (FRM)

- Plants operating without headroom are unable to respond, even if frequency control is active
- Under-frequency excursions may not provide enough information





Frequency Response Measure (FRM)

- Over-frequency excursions allow evaluation of plants operating without headroom
- Signatures of pumped storage motors turning off were specifically sought





Voltage Response Measure (VRM)

Measure of a plant's change in reactive power in response to a change in voltage magnitude

$$VRM = \frac{\Delta V}{V_{scale}} \times \frac{\Delta Q}{Q_{scale}}$$





Voltage Response Measure (VRM)

- Detector targets capacitor switching events
- Scaling provides consistency across kV levels

$$VRM = \frac{\Delta V}{V_{scale}} \times \frac{\Delta Q}{Q_{scale}}$$





Voltage Schedule

- BPA bases their voltage schedules on three loading periods
- The schedule has a kV target with upper and lower bounds
- The tool reports the proportion of time the plant is off schedule





Follow-Up for Potential Performance Issues

- The Generator Scorecard provides an initial assessment
- Potential performance issues first reviewed by BPA internally
 - Check for straightforward explanation
 - > Outage causing higher than normal voltages
 - > Known limitations for certain operating conditions
 - Manual model-based analysis
 - Coordination between departments that may have insight
- For issues that need to be addressed, BPA's interactions with generator operator are cooperative
 - Informal conversation to check if the issue is known
 - Organizations collaborate to find a solution



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Demonstration

- Deployed at BPA's synchrophasor laboratory
 - Many thanks to Tony Faris for setting up and running the tool
- Configured to evaluate 22 power plants
- Presented results are based on one month of archived PMU data

Frequency Response Measure (FRM)

Pacific

Northwest



			- 0	×
All	v			
All	· ·			
lant	Ave FRM	Best FRM	Worst FRA	4
1	10.3	-29.62	275.12	~
2	-20.65	-140.92	25.57	
3	-22.18	-738.56	63.1	
4	-1.45	-122.09	25.73	
5	-48.21	-479.72	16.25	
5	-20.86	-99.82	16.52	
7	-88.54	-577.69	82.47	111
3	-83.66	-724.12	97.88	
9	0.94	-73.21	23.06	
)	4.61	-31.2	153.71	
1	-24.45	-294.35	185.47	
2	-8.78	-88.01	72.32	
				1

0	FRM	FRM manual	С	ΔF	ΔΡ	
23 07:5	-198.71		59.965	-0.031	62.49	~
23 22:5	-3.9		59.945	-0.004	0.16	
23 07:3	-59.28	1	59.925	-0.05	29.74	
23 07:5	-49.12		59.969	-0.036	17.5	
23 07:5	-104.46		59.956	-0.025	25.89	
23 08:0	-126.8		59.958	-0.015	18.88	
23 20:0	-53.46		60.043	0.025	-13.13	
23 11:5	-118.83		59.976	-0.017	20.08	
23 12:0	-257.4		59.972	-0.007	18.63	
23 01:1	-52.3		60.043	0.006	-3.08	
23 07:5	-161.72		59.965	-0.012	19.35	
23 20:5	-22.36		59.957	-0.039	8.62	V



BPA/DOE Archive Walker



to	BA FRM	C	۵F	ΔΡΒΑ	
12/2/23 12:26	-119.38	59.973	-0.024	29.49	^
12/2/23 20:00	-344.75	59.955	-0.01	36.77	
12/3/23 07:59	-144.48	59.955	-0.019	28.84	
12/3/23 10:53	-223.9	59.96	-0.024	57.1	
12/4/23 23:07	-398.21	59.948	-0.014	58.94	
12/5/23 22:50	-112	59.956	-0.036	40.71	
12/6/23 17:39	-623.84	60.046	0.007	-40.63	
12/6/23 23:00	-2347.37	60.046	0.001	-32.04	
12/7/23 10:32	-86.69	59.958	-0.029	25.38	
12/7/23 15:00	-108.69	60.044	0.035	-38.32	
12/7/23 16:54	-116.47	59.958	-0.045	52.96	
12/7/23 23:15	-898.93	60.039	0.004	-32.84	~

Type: All Y

Plant	FRM	FRM manual	ΔPplant	
Plant01	3.73		-0.92	~
Plant02	-18.02		4.45	
Plant03	NaN		NaN	
lant04	0.62		-0.15	
lant05	-14.82		3.66	
Plant06	NaN		NaN	
Plant07	-26.16		6.46	
Plant08	NaN		NaN	
lant09	-7.26		1.79	
Plant10	-14.2		3.51	
Plant11	-18.95		4.68	
Plant12	-5.44		1.34	1



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Voltage Response Measure (VRM)

Northwest

Pacific



			1000	٥	×
ul form	ance Summary				
nt	Mean	Best	-11.3	Worst	
	0.02	0.15	-0.5		1
	0.47	0.83	0.06		
	0.14	0.74	-0.31	1	
	1.03	1.03	1.03		
	1.51	1.51	1.51		
	0.17	0.6	-0.18	3	
	0.18	0.24	0.13		
	0.24	0.54	-1		
	0.24	0.54 0.12	-1 -0.16	5	
	0.24 0.02 59.2	0.54 0.12 1164.9	-1 -0.16 -0.02	5	
	0.24 0.02 59.2 0.27	0.54 0.12 1164.9 0.55	-1 -0.16 -0.02 -1.94	5	

	VRM		ΔV	ΔQ	
06:23	0.52	238.72	1.02	20.82	A .
13:35	0.44	240.85	-0.87	-19.42	
16:55	0.33	241.13	-0.76	-16.7	
06:38	0.42	238.6	0.96	17.36	
13:17	0.34	241.11	-0.74	-16.41	
05:41	0.46	239.01	1.02	17.96	
15:24	0.4	241.58	-0.86	-17.5	
07:25	0.41	238.8	0.93	17.19	
14:41	0.46	241.3	-0.92	-18.49	
08:02	0.38	239.18	0.89	16.65	
15:11	0.4	241.51	-0.9	-16.9	
08:06	0.45	238.1	0.97	17.61	4

Plot all plants as reference:

Retrieve Detail	Discard Event

B	PA/DOE Archive Walker
2	Coordinates Settings Results Signal Inspection Available Results: 12/01/2023 00:00:00 - 12/26/2023 23:59:00
oject	Forced Oscillations Out of Range Events Ringdowns Wind Ramps Mode Meter FRM VRM Voltage Schedule
ker Pn	Search Start Time: 12/01/2023 00:00:00 🗘 🗸 Search End Time: 12/27/2023 23:59:59 🗘 🖌 GO
Wall	
chive	
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M Perform	nance Summary			
Plant	Mean	E	Best	Worst
t _A	VRM	А	ΔV	ΔQ

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Voltage Schedule



Cancel O Federal O Non-Federal O 230 kV O 500 kV

D

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All kV

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Proportion of time off schedule by loading level

● All

Plant	Low	Med	High	All
nt01	0.15	0.12	0.17	0.15
nt02	0.59	0.04	0.05	0.2
nt03	0.26	0.02	0.01	80.0
nt05	0.17	0	0	0.05
nt06	0.59	0.68	0.91	0.79
nt07	0	0	0	0
nt08	0	0	0	0
nt09	0.01	0.02	0.01	0.01
nt12	0.33	0.25	0.38	0.35
nt13	0.07	0	0	0.02
nt17	0	0	0	0
nt20	0	0	0	0
nt19	0	0	0	0
nt18	0.03	0.21	0.45	0.3
nt16	0	0	0	0

AN	BPA/DOE Archive Walker
0	Coordinates Settings Results Signal Inspection Available Results: 08/01/2023 00:01:00 - 08/14/2023 23:59:00
ject	Forced Oscillations Out of Range Events Ringdowns Wind Ramps Mode Meter FRM VRM Voltage Schedule
ker Pro	Search Start Time: 08/01/2023 00:01:00 + Search End Time: 08/14/2023 23:59:00 + Report by: Minute Overview Retrieve Detail 0% Cancel
Wal	Data Trends
chive	
An	

Detection Details

Plant	Low	Med	High	All

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- Continue to integrate feedback from BPA
- Transition the final tool to BPA for continued use
- Work with partner to make the capabilities more broadly available under separate funding



Thank you





Frequency Response Measure (FRM)

Pacific

Northwest



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All	~			
MI	<u></u>			
lant	Ave FRM	Best FRM	Worst FRA	4
1	10.3	-29.62	275.12	^
2	-20.65	-140.92	25.57	
3	-22.18	-738.56	63.1	
4	-1.45	-122.09	25.73	
5	-48.21	-479.72	16.25	
5	-20.86	-99.82	16.52	
7	-88.54	-577.69	82.47	100
3	-83.66	-724.12	97.88	
9	0.94	-73.21	23.06	
5	4.61	-31.2	153.71	
1	-24.45	-294.35	185.47	
2	-8.78	-88.01	72.32	

0	FRM	FRM manual	С	ΔF	ΔΡ	
23 07:5	-198.71		59.965	-0.031	62.49	~
23 22:5	-3.9		59.945	-0.004	0.16	
23 07:3	-59.28	1 1	59.925	-0.05	29.74	
23 07:5	-49.12		59.969	-0.036	17.5	
23 07:5	-104.46		59.956	-0.025	25.89	
23 08:0	-126.8		59.958	-0.015	18.88	
23 20:0	-53.46		60.043	0.025	-13.13	
23 11:5	-118.83		59.976	-0.017	20.08	
23 12:0	-257.4		59.972	-0.007	18.63	
23 01:1	-52.3		60.043	0.006	-3.08	
23 07:5	-161.72		59.965	-0.012	19.35	
23 20:5	-22.36		59.957	-0.039	8.62	V





BPA/DOE Archive Walker



Sort by plant F contrib for an e selecte the tab above

			Sor	t e vei	nts by	С
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			und	erfred	quenc	v or
	Sortow	onto		froqu	Jonov	,
	Sollev	ents	ove	mequ	lency	
	by BA I	FRM	eve	nts		
		Ţ	ļ			
	t ₀	BA FR	M C	ΔF	ΔΡ _{ΒΑ}	
	12/18/23	02:5 -523.8	59.958	-0.016	85.53	
	12/26/23	01:1 -454.5	7 60.043	0.006	-26.77	
	12/11/23	20:2 -449.8	7 59.956	-0.012	52.55	
	12/9/23 2	1:58 -408.3	5 60.054	0.013	-52.57	
	12/21/23	22:5 -404.6	9 59.945	-0.004	16.75	
	12/4/23 2	3:07 -398.2	1 59.948	-0.014	58.94	
	12/9/23 0	4:45 -392.0	5 59.927	-0.035	136.73	
	12/24/23	08:0 -389.5	2 59.958	-0.015	58.02	
	12/20/23	07:5 -369.0	9 59.965	-0.031	110.14	
	12/2/23 2	11.5 200.0	5 59.955	-0.01	30.77	
	12/23/25	11.3 -200.9	5 <u>59.970</u>	-0.017	40.05	
	Plant	FRM	FRM m	anual	ΔPplant	
	Plant11	47.07		16	.41	
00	Plan	-32.34		11	.28	
	Plant02	-26.82		9	25	
	Plant12	-18.95		5.	61	
`	Plant13	-17.7		6.	17	
/	Plant21	-13.31		4.	64	
PM	Plant03	-11.67		4.	07	
	Plant04	-5.5		1.9	92	
ution	Plant16	-3.93		1.	37	
event	Plant14	-1.78		0.	62	
n in	Plant22	-1.36		0.4	47	
le		F	Retrieve Deta	ail		
		Discar	d ERM for th	ic Plant		
]		Discar	d FRM for a	I Plants		
	Adju	ust to by	seco	nds (Go	
	Set	Manual FRM	1 to	(G0	

FRM – Event Review

Plant Review Event Review



BA FRM	C	ΔF	ΔP _B
-523.8	59.958	-0.016	85.53
-454.57	60.043	0.006	-26.7
-449.87	59.956	-0.012	52.55
-408.35	60.054	0.013	-52.5
-404.69	59.945	-0.004	16.75
-398.21	59.948	-0.014	58.94
-392.05	59.927	-0.035	136.7
-389.52	59.958	-0.015	58.02
-369.09	59.965	-0.031	116.1
-344.75	59.955	-0.01	36.77
-288.98	59.976	-0.017	48.83
-261.79	60.043	0.025	-64.2
	BA FRM -523.8 -454.57 -449.87 -408.35 -404.69 -398.21 -398.21 -399.52 -389.52 -369.09 -344.75 -288.98 -261.79	BA FRM C -523.8 59.958 -454.57 60.043 -449.87 59.956 -408.35 60.054 -404.69 59.948 -398.21 59.948 -392.05 59.958 -369.09 59.955 -344.75 59.955 -288.98 59.976 -261.79 60.043	BA FRM C ΔF -523.8 59.958 -0.016 -454.57 60.043 0.006 -449.87 59.956 -0.012 -408.35 60.054 0.013 -404.69 59.945 -0.004 -398.21 59.948 -0.014 -398.25 59.958 -0.015 -389.52 59.958 -0.015 -369.09 59.955 -0.01 -344.75 59.955 -0.01 -288.98 59.976 -0.017 -261.79 60.043 0.025

Type: All

Plant13 -17.7

Plant FRM Plant20 NaN NaN NaN NaN Plant15 NaN NaN Plant19 -83.23 29.03 Plant07 -55.27 19.28 Plant08 -47.71 16.64 Plant05 Plant11 -47.07 16.41 Plant17 -32.34 11.28 -30.9 10.78 Plant06 -26.82 9.35 Plant02 -18.95 6.61 Plant12

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6.17

Note: Overall, the entire BA has satisfactory performance to frequency excursion events with delta f vs delta P being in the right quadrants, and FRM values being mostly negative.





Plant Review Event Review



Sort plan average	ts by FRM	
~ 		
Ave FRM	Best FRM	Worst FRM
-20.65	-140.92	25.57
-16.37	-193.17	11.99
-13.34	-206.78	22.01
-10.31	-37.66	21.54
-8.78	-88.01	72.32
-4.85	-50.02	14.42
-4.29	-41.15	8.74
-1.45	-122.09	25.73
0.25	-33.88	16.84
0.94	-73.21	23.06
0.96	-32.3	36.01
4.61	-31.2	153.71
	Average Ave FRM -20.65 -16.37 -13.34 -10.31 -8.78 -4.85 -4.29 -1.45 0.25 0.94 0.96 4.61	Ave FRM Best FRM -20.65 -140.92 -16.37 -193.17 -13.34 -206.78 -10.31 -37.66 -8.78 -88.01 -4.85 -50.02 -4.29 -41.15 -1.45 -122.09 0.25 -33.88 0.94 -73.21 0.96 -32.3 4.61 -31.2

Select a plant

		t ₀	FRM	FRM manual	С	ΔF	ΔP
		12/2/23 12:26	-2.56		59.972	-0.025	0.63
'		12/2/23 20:00	-13.07		59.953	-0.011	1.4
4		12/3/23 07:59	-9.67		59.953	-0.02	1.92
1		12/3/23 10:53	-3.39		59.958	-0.026	0.86
		12/4/23 23:07	5.1		59.946	-0.015	-0.76
		12/5/23 22:50	-2.28		59.956	-0.036	0.83
	⇒	12/6/23 17:39	21.3		60.046	0.007	1.39
		12/6/23 23:00	36.01		60.047	0.001	0.49
		12/7/23 10:32	-2.53		59.958	-0.029	0.74
		12/7/23 15:00	-2.04		60.044	0.035	-0.72
		12/7/23 16:54	0.86		59.958	-0.045	-0.39
m		12/7/23 23:15	-19.26		60.039	0.004	-0.7



Note: The Generator does not exhibit the desired response to an overfrequency event



17:41

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Voltage Response Measure (VRM)

Northwest

Pacific



			1000	٥	×
ul form	ance Summary				
nt	Mean	Best	-11.3	Worst	
	0.02	0.15	-0.5		1
	0.47	0.83	0.06		
	0.14	0.74	-0.31	1	
	1.03	1.03	1.03		
	1.51	1.51	1.51		
	0.17	0.6	-0.18	3	
	0.18	0.24	0.13		
	0.24	0.54	-1		
	0.24	0.54 0.12	-1 -0.16	5	
	0.24 0.02 59.2	0.54 0.12 1164.9	-1 -0.16 -0.02	5	
	0.24 0.02 59.2 0.27	0.54 0.12 1164.9 0.55	-1 -0.16 -0.02 -1.94	5	

	VRM		ΔV	ΔQ	
06:23	0.52	238.72	1.02	20.82	^
13:35	0.44	240.85	-0.87	-19.42	
16:55	0.33	241.13	-0.76	-16.7	
06:38	0.42	238.6	0.96	17.36	
13:17	0.34	241.11	-0.74	-16.41	
05:41	0.46	239.01	1.02	17.96	
15:24	0.4	241.58	-0.86	-17.5	
07:25	0.41	238.8	0.93	17.19	
14:41	0.46	241.3	-0.92	-18.49	
08:02	0.38	239.18	0.89	16.65	
15:11	0.4	241.51	-0.9	-16.9	
08:06	0.45	238.1	0.97	17.61	4

Plot all plants as reference:

	F
Retrieve Detail	Discard Event



S	Sort pla nean V	nts by RM	/					
Type: All VRM Performa	∽ nce Summa							
Plant	Mear		Rest	Worst				
Plant10	0.07	0.15	5	0.03	-			
Plant02	0.12	0.21		0.09				
Plant05	0.13	0.29)	0.02				
Plant12	0.14	0.74		-0.31				
Plant04	0.16	0.66	5	-0.58				
Plant15	0.17	0.6		-0.18				
Plant16	0.18	0.24	ļ.	0.13				
Plant18	0.24	0.54	ļ.	-1				
Plant21	0.33	0.55	5	-0.1				
Plant03	0.34	1.83	3	-0.04				
Plant08	0.35	0.98	3	0.01				
Plant01	0.39	0.97	7	-0.16				
t₄	VRM	A	ΔV	ΔQ				
12/1/23 06:23	0.52	238.72	1.02	20.82				
12/1/23 13:35	0.44	240.85	-0.87	-19.42				
12/2/23 16:55	0.33	241.13	-0.76	-16.7				
12/4/23 06:38	0.42	238.6	0.96	17.36				
12/4/23 13:17	0.34	241.11	-0.74	-10.41				
12/5/23 05:41	0.40	239.01	0.06	17.90				
12/5/23 15:24	0.41	241.58	-0.80	-17.5				
12/0/23 07.23	0.41	230.0	0.95	10.40				
12/0/23 14.41	0.40	241.5	0.92	16.49				
12/7/23 06:02	0.30	235.10	0.05	16.05				
12/8/23 08:06	0.45	238.1	0.97	17.61				
.2/0/25 00.00	0.15	230.1	0.57	17.01	,			
Plot all plants	Plot all plants as reference:							
\checkmark	Retrieve De	tail	Discard Ev	ent				

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Note: The Generator exhibits the desired response to a drop in voltage



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Type: All

VRM Performance Summary

Mean	Best	Worst
0.07	0.15	0.03
0.12	0.21	0.09
0.13	0.29	0.02
0.14	0.74	-0.31
0.16	0.66	-0.58
0.17	0.6	-0.18
0.18	0.24	0.13
0.24	0.54	-1
0.33	0.55	-0.1
0.34	1.83	-0.04
0.35	0.98	0.01
0.39	0.97	-0.16
	Mean 0.07 0.12 0.13 0.14 0.16 0.17 0.18 0.24 0.33 0.34 0.35 0.39	Mean Best 0.07 0.15 0.12 0.21 0.13 0.29 0.14 0.74 0.15 0.66 0.17 0.6 0.18 0.24 0.24 0.54 0.33 0.55 0.34 1.83 0.35 0.98 0.39 0.97

t _A	VRM	А	ΔV	ΔQ
12/1/23 06:23	0.52	238.72	1.02	20.82
12/1/23 13:35	0.44	240.85	-0.87	-19.42
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12/4/23 06:38	0.42	238.6	0.96	17.36
12/4/23 13:17	0.34	241.11	-0.74	-16.41
12/5/23 05:41	0.46	239.01	1.02	17.96
12/5/23 15:24	0.4	241.58	-0.86	-17.5
12/6/23 07:25	0.41	238.8	0.93	17.19
12/6/23 14:41	0.46	241.3	-0.92	-18.49
12/7/23 08:02	0.38	239.18	0.89	16.65
12/7/23 15:11	0.4	241.51	-0.9	-16.9
12/8/23 08:06	0.45	238.1	0.97	17.61

Plot all plants as reference:

Retrieve Detail Discard Event

Discard event if unsuitable for evaluation. E.g. plant was off during the event





Voltage Schedule



Cancel O Federal O Non-Federal O 230 kV O 500 kV

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All kV

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Proportion of time off schedule by loading level

● All

Plant	Low	Med	High	All
nt01	0.15	0.12	0.17	0.15
nt02	0.59	0.04	0.05	0.2
nt03	0.26	0.02	0.01	80.0
nt05	0.17	0	0	0.05
nt06	0.59	0.68	0.91	0.79
nt07	0	0	0	0
nt08	0	0	0	0
nt09	0.01	0.02	0.01	0.01
nt12	0.33	0.25	0.38	0.35
nt13	0.07	0	0	0.02
nt17	0	0	0	0
nt20	0	0	0	0
nt19	0	0	0	0
nt18	0.03	0.21	0.45	0.3
nt16	0	0	0	0



Sort plants by proportion offschedule from desired voītage[®] schedule under all loading levels

 Federal Non-Federal All 	 ○ 230 kV ○ 500 kV ● All kV
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Proportion of time off schedule by loading level

Plant	Low	Med	High	All
Plant05	0.02	0	0	0
Plant07	0	0	0	0
Plant08	0	0	0	0
Plant09	0	0	0	0
Plant20	0	0	0	0
Plant19	0	0	0	0
Plant16	0	0	0	0
Plant03	0.19	0.04	0	0.06
Plant17	0.22	0.14	0.02	0.09
Plant02	0.37	0.01	0	0.1
Plant18	0.03	0.03	0.16	0.1
Plant13	0.7	0	0	0.19
Plant12	0.33	0.33	0.51	0.43
Plant01	0.42	0.4	0.47	0.44
Plant06	0.3	0.25	0.91	0.64

Note: The Generator follows the voltage schedule during the observation period



Voltage Schedule

BPA/DOE Archive Walker



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0	Federal
\bigcirc	Non-Federal
۲	All

🔾 230 kV 🔘 500 kV All kV

Proportion of time off schedule by loading level

Plant	Low	Med	High	ļ
Plant05	0.02	0	0	0
Plant07	0	0	0	0
Plant08	0	0	0	0
Plant09	0	0	0	0
Plant20	0	0	0	0
Plant19	0	0	0	0
Plant16	0	0	0	0
Plant03	0.19	0.04	0	0.06
Plant17	0.22	0.14	0.02	0.09
Plant02	0.37	0.01	0	0.1
Plant18	0.03	0.03	0.16	0.1
Plant13	0.7	0	0	0.19
Plant12	0.33 🕇	0.33	0.51	0.43
Plant01	0.42	0.4	0.47	0.44
Plant06	0.3	0.25	0.91	0.64

Note: This Generator deviates from the voltage schedule during certain times, and the proportion off schedule for different loading levels is displayed. This plant has voltage schedule violations only during low loading in the observed period.

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Voltage Schedule

BPA/DOE Archive Walker



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O Federal	
O Non-Federal	
All	

O 230 kV ⊙ 500 kV All kV

Proportion of time off schedule by loading level

Plant	Low	Med	High	A
Plant05	0.02	0	0	0
Plant07	0	0	0	0
Plant08	0	0	0	0
Plant09	0	0	0	0
Plant20	0	0	0	0
Plant19	0	0	0	0
Plant16	0	0	0	0
Plant03	0.19	0.04	0	0.06
Plant17	0.22	0.14	0.02	0.09
Plant02	0.37	0.01	0	0.1
Plant18	0.03	0.03	0.16	0.1
Plant13	0.7	0	0	0.19
Plant12	0.33	0.33	0.51	0.43
Plant01	0.42	0.4	0.47	0.44
Plant06 1	0.3	0.25	0.91	0.64

Note: The Generator deviates from the voltage schedule after a certain time. This provides the initial information for a user to follow up with other teams and collaborators to look for the potential cause, and solutions if required.

