Smart Inverters

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Central Hudson Distribution Planning & Interconnections

What are Smart Inverters

- A more sophisticated version of a standard inverter that utilize power electronics for autonomous decision making

Benefits of Smart Inverters

- Potentially allow for increased interconnection capacity

- May reduce mitigation costs

- Will play an important role in grid support with ride-through capability / aiding in voltage stability

- Will play an important role in distribution management system (DMS)

Complications Due to Smart Inverters

- Dynamic system impact studies required when sites have different settings

Effective January 1, 2023

Smart Inverter Settings Required for all Inverter-Based Systems
Inverters Must Meet IEEE 1547-2018 and UL 1741 SB Standards

Bulk Power System Settings	
Setting	**Selection**
Category	Cat III
Voltage Disturbance - OV2	1.20 pu / 0.16 sec
Voltage Disturbance - OV1	1.10 pu /2.0 sec
Voltage Disturbance - UV2	0.5 pu / 1.1 sec
Voltage Disturbance - UV1	0.88 pu / 3.0 sec
Frequency Disturbance – OF2	62.0 Hz / 0.16 sec
Frequency Disturbance – OF1	61.2 Hz / 300.0 sec
Frequency Disturbance – UF2	56.5 Hz / 0.16 sec
Frequency Disturbance – UF1	58.5 Hz / 300.0 sec
Frequency Droop	IEEE 1547-2018 Default
Enter Service Criteria – Frequency Minimum	≥ 59.5 Hz
Enter Service Criteria – Frequency Maximum	IEEE 1547-2018 Default ≤ 60.1 Hz
Enter Service Criteria – Voltage Minimum	IEEE 1547-2018 Default ≥ 0.917 p.u.
Enter Service Criteria – Voltage Maximum	≤ 1.05 pu
Enter Service Performance – Delay Before Export	300.0 sec
Enter Service Performance – Ramp Time	300.0 sec
Enter Service Ramp Characteristics	Linear
Enter Service Exceptions	Require default linear ramp for systems >50 kVA
Voltage Support Functions	
Category	B
Preferred Reactive Power Function	Volt-Var
Modify Volt-Var Curve from Defaults	Yes
Enable Volt-Watt	No
Modify Volt-Watt Curve from Default	Yes

Previous Voltage & Frequency System Settings Requirements	
Setting	Selection
Category	Cat III
Voltage Disturbance - OV2	1.20 pu / 0.16 s
Voltage Disturbance - OV1	1.10 pu / 1.0 s
Voltage Disturbance - UV2	0.45 pu / 0.16 s
Voltage Disturbance - UV1	0.88 pu / 2.0 s
Frequency Disturbance – OF2	61.8 Hz / 0.16 s
Frequency Disturbance – OF1	61 Hz / 180.0 s
Frequency Disturbance – UF2	57 Hz / 0.16 s
Frequency Disturbance – UF1	59 Hz / 300.0 s

- Smart inverters (UL-1741 SB) required as of January 1st
- Settings modifications made to voltage and frequency deviations / ride-through
- Volt-var will be the primary voltage support function
- Settings will be verified using .csv file type

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Common File Format for Inverter Setting Verification

#	Parameter	Value
1	PARAMETER	VALUE
2	MT_FILE_INFO_TYPE	SS
3	MT_UTILITY_NAME	Central Hudson
4	MT_COUNTRY	United States of America
5	MT_STATE	New York
6	MT_DATE_OF_APPLICABILITY	1/1/2023
7	MT_DER_SITE_NAME-APP	
8	MT_DER_OWNER_NAME-APP	
9	MT_POWER_CONVERSION_DEV	INVERTER
10	MT_NP_NORMAL_OP_CAT-APP	CAT_B
11	MT_NP_ABNORMAL_OP_CAT-APP	CAT_III
12	MT_NP_P_MAX-MIN-APP	50
13	MT_NP_P_MAX-MAX-APP	
14	MT_NP_AC_V_NOM-APP	
15	MT_CIRCUIT_TOPOLOGY	
16	MT_SERVICE_TYPE	
17	MT_PRIMARY_POWER_SOURCE	
18	MT_APPLICATION_PURPOSE	
19	MT_PRIMARY_MOVER	
20	MT_VARIABLE_GENERATION_TYPE	
21	COMMENT	For PV DER, PV_CURVE_P2 should be the lesser value of 0.2 of Prated or Pmin
22	AP_LIMIT_ENABLE-SS	
23	AP_LIMIT-SS	
24	ES_PERMIT_SERVICE-SS	ENABLED
25	ES_V_LOW-SS	0.917
26	ES_V_HIGH-SS	1.05
27	ES_F_LOW-SS	59.5
28	ES_F_HIGH-SS	60.1
29	ES_DELAY-SS	300
30	ES_RANDOMIZED_DELAY-SS	0
31	ES_RAMP_RATE-SS	300
32	CONST_PF_MODE_ENABLE-SS	DISABLED
33	CONST_PF_EXCITATION-SS	
34	CONST_PF-SS	
35	CONST_Q_MODE_ENABLE-SS	DISABLED
36	CONST_Q-SS	
37	QV_MODE_ENABLE-SS	ENABLED
38	QV_VREF-SS	1
39	QV_VREF_AUTO_MODE-SS	DISABLED
40	QV_VREF_TIME-SS	
41	QV_CURVE_V2-SS	0.97
42	QV_CURVE_Q2-SS	0
43	QV_CURVE_V3-SS	1.03
44	QV_CURVE_Q3-SS	0
45	QV_CURVE_V1-SS	0.93
46	QV_CURVE_Q1-SS	0.44
47	QV_CURVE_V4-SS	1.07
48	QV_CURVE_Q4-SS	-0.44
49	QV_OLRT-SS	5
50	QP_MODE_ENABLE-SS	DISABLED
51	QP_CURVE_P3_GEN-SS	
52	QP_CURVE_P2_GEN-SS	
53	QP_CURVE_P1_GEN-SS	
54	QP_CURVE_P1_LOAD-SS	
55	QP_CURVE_P2_LOAD-SS	
56	QP_CURVE_P3_LOAD-SS	
57	QP_CURVE_Q3_GEN-SS	
58	QP_CURVE_Q2_GEN-SS	
59	QP_CURVE_Q1_GEN-SS	
60	QP_CURVE_Q1_LOAD-SS	
61	QP_CURVE_Q2_LOAD-SS	
62	QP_CURVE_Q3_LOAD-SS	
63	PV_MODE_ENABLE-SS	DISABLED
64	PV_CURVE_V1-SS	1.07
65	PV_CURVE_P1-SS	1
66	PV_CURVE_V2-SS	1.1
67	PV_CURVE_P2-SS	
68	PV_OLRT-SS	10
69	OV2_TRIP_V-SS	1.2
70	OV2_TRIP_T-SS	0.16
71	OV1_TRIP_V-SS	1.1
72	OV1_TRIP_T-SS	2
73	UV1_TRIP_V-SS	0.88
74	UV1_TRIP_T-SS	3
75	UV2_TRIP_V-SS	0.5
76	UV2_TRIP_T-SS	1.1
77	OF2_TRIP_F-SS	62
78	OF2_TRIP_T-SS	0.16
79	OF1_TRIP_F-SS	61.2
80	OF1_TRIP_T-SS	300
81	UF1_TRIP_F-SS	58.5
82	UF1_TRIP_T-SS	300
83	UF2_TRIP_F-SS	56.5
84	UF2_TRIP_T-SS	0.16
85	PF_DBOF-SS	0.036
86	PF_DBUF-SS	0.036
87	PF_KOF-SS	0.05
88	PF_KUF-SS	0.05
89	PF_OLRT-SS	5
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Volt-VAr Settings	
Parameter	Set Point
Vref[1]	Vn[2]
V1	0.93 pu
Q1	44%, injection
V2	0.97 pu
Q2	0 pu
V3	1.03 pu
Q3	0 pu
V4	1.07 pu
Q4	44%, absorption
Open Loop Response Time	5 sec
Enable Autonomous Vref	No
Default Enabled?	Yes

[1]Vref is the reference voltage
[2]Vn is the nominal voltage

- Volt-var function shall be default enabled

- Will begin to inject reactive power at 0.97 pu voltage

- Will stop injecting reactive power at 0.93 pu voltage (maximum 44% injection)

- Will begin to absorb reactive power at 1.03 pu voltage

- Will stop absorbing reactive power at 1.07 pu voltage (maximum 44% absorption)

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| Volt-Watt Settings	
Parameter	**Set Point**
V1	1.07 pu
P1	Prated[1]
V2	1.10 pu
P2	The lesser of 0.2 Prated or Pmin[2]
P'2 (absorption, storage only)	0
Open Loop Response	10 sec

[1]Prated is the nameplate active power rating of the DER in per unit (pu)
[2]Pmin is the minimum active power output of the DER in per unit (pu)

- Volt-Watt function shall be default disabled

- Will begin to curtail active power at 1.07 pu voltage

- Will curtail active power down to minimum rating at 1.10 pu voltage

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Voltage Support Settings
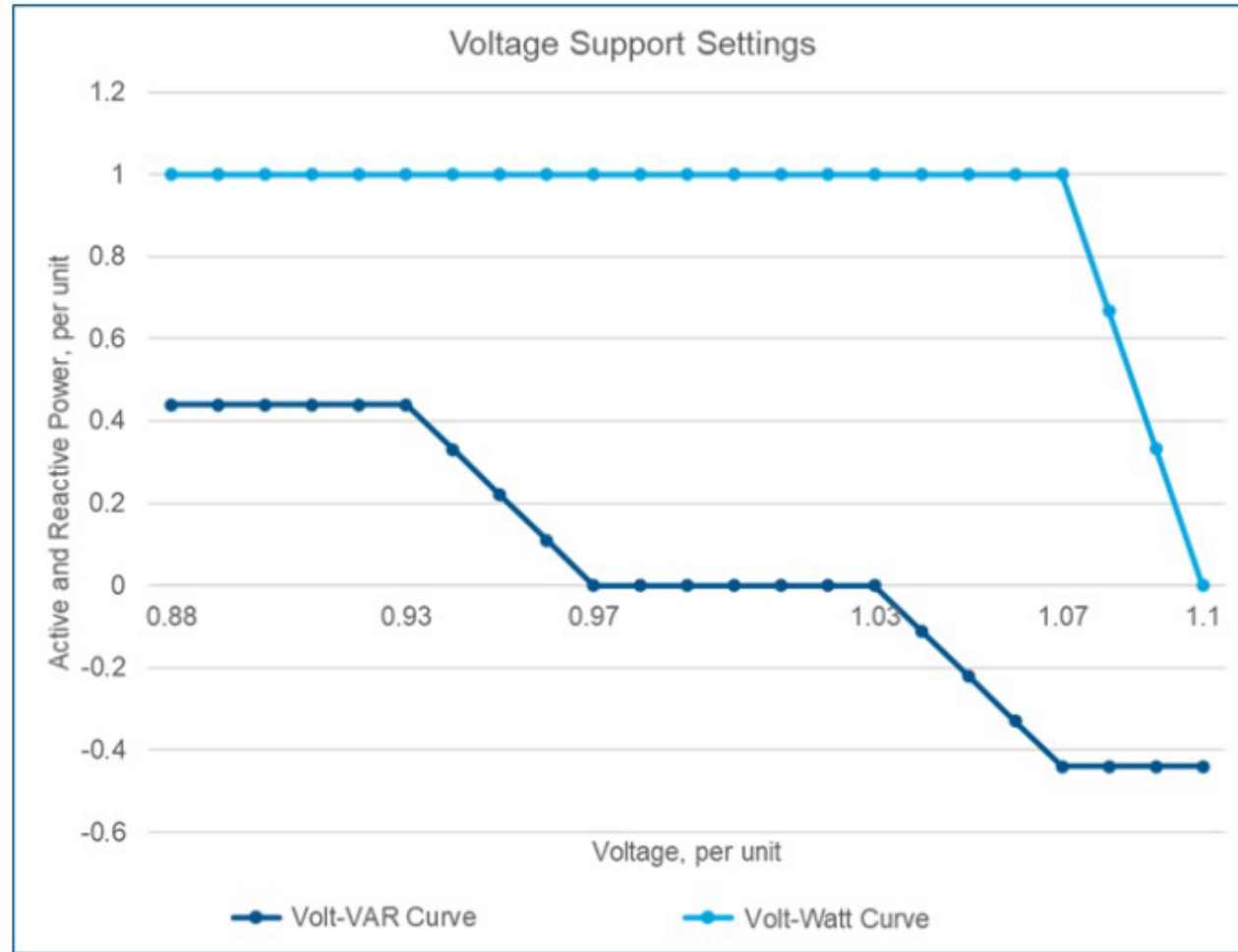
Questions / Comments

The smart inverter settings discussed in this presentation can be found on our Interconnection Online Application Portal (IOAP) at **https://cenhuddg.powerclerk.com**