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DER Data Collection and Modeling

Vermont System Planning Committee

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SENIOR ENGINEER | TRANSMISSION SERVICE STUDIES

Presentation Outline

- DER Data Collection
- DER Modeling
- DER Interconnection Studies
- Questions

DER DATA COLLECTION

Collection Methods

- ISO-NE has different processes for collecting different levels of DER data
  - DER Surveys
  - I.3.9 Process
  - Distributed Generation Forecast
- Data collected comes from close collaboration with utilities in our region
  - Transmission Owners
  - Distribution Owners
  - Municipals
  - State Departments

DER Surveys - Old

- ISO-NE collects DER surveys through the Distributed Generation Forecast Working Group (DGFWG)
- Data is on an individual installation basis
- Previously ISO-NE only received the town it was located in

Project Status	Facility City	Rating/ KW	TYPE OF INTERCONNECT	FUEL TYPE	In-Service Date
In-Service	Town A	5	Solar	Photovoltaic	01/04/23
In-Service	Town B	10	Solar	Photovoltaic	01/27/23
In-Service	Town B	125	Solar	Photovoltaic	01/27/23
In-Service	Town C	10	Solar	Photovoltaic	01/09/23
In-Service	Town C	8.8	Solar	Photovoltaic	01/19/23
In-Service	Town D	7	Solar	Photovoltaic	01/17/23
In-Service	Town E	10	Solar	Photovoltaic	01/03/23

DER Surveys - New

- ISO-NE has started a new effort to collect higher fidelity data
- Data is still on an individual installation basis
- New DER surveys through the DGFWG contain substation level information as well

Non-Default 1547 Setting Categories:

1. ISO-NE Ridethrough Settings (PV that went in service after 8/1/2018)
2. NERC Underfrequency Settings (PV > 100 kW that went in service from 5/1/2016 to 7/31/2018)
3. IEEE 1547 2003 Setting (All PV that went in service from 1/1/2003 to 4/30/2016 and all PV ≤ 100 kW that went in service from 5/1/2016 to 7/31/2018)
4. Non-Default 1547 Settings (all non-PV or any PV that went in service prior to 2003)

Town	State	Status	In-Service Date	Technology Type	Installed Capacity (kW)	PV & Storage	Storage Only	Feeder	Feeder kV	Substation Name	Substation High kV	Substation Low kV	Substation Mid kV	Non-Default 1547
ABC Town	CT	In-Service	1/1/2003	PV	5.60			12346	13.80	Substation A	115	13.80	N/A	
ABC Town	CT	In-Service	6/15/2007	PV	4.00			12345	13.80	Substation A	115	13.80	N/A	
ABC Town	CT	In-Service	4/8/2018	PV	2.50			ABC123	13.80	Substation B	115	13.80	N/A	
ABC Town	CT	In-Service	5/16/2018	PV	10.00			ABC123	13.80	Substation B	115	13.80	N/A	
ABC Town	CT	In-Service	9/26/2019	PV	15.00			ABC124	13.80	Substation B	115	4.80	N/A	
ABC Town	CT	In-Service	2/13/2019	PV	2.00			ABC125	13.80	Substation B	115	13.80	N/A	
ABC Town	CT	In-Service	10/17/2020	PV	2.16			35789	13.80	Substation C	115	13.80	N/A	
ABC Town	CT	In-Service	3/23/2021	PV	3.75			35789	13.80	Substation C	115	13.80	N/A	
ABC Town	CT	In-Service	5/28/2022	PV	1.20			35788	4.80	Substation C	115	13.80	N/A	
ABC Town	CT	In-Service	12/17/2022	PV	1,000.00			35788	13.80	Substation C	115	13.80	N/A	

I.3.9 Process

- **Stakeholder Review & Information Exchange**
  - New interconnections (>1MW) must submit either a Small Generator Notification or Proposed Plan Application regardless of POI
  - Interconnections are channeled through the Reliability Committee which allows affected parties to have a chance to voice concerns (I.3.9 process)
  - Transmission System Impact Studies (SIS) sometimes needed based on size or location of interconnection
- **What we do with the information**
  - Tracking DER interconnections
  - Determination of study requirements
  - Data from forms and SIS used in steady state and dynamics modeling

9.0 Attachment 3 – Generator Notification Form for Units or Changes of Less Than 5 MW

ISO NEW ENGLAND GENERATOR NOTIFICATION FORM FOR UNITS OR CHANGES OF LESS THAN 5 MW

ISO New England Planning Procedure 5-1
Page 1 of 4

Submit Completed Form to ProposedPlans@iso-ne.com

Contact Customer Service at 413-540-4220 or custserv@iso-ne.com to begin market system asset registration process

Applicant _____ Date _____
Generation Owner (if different than Applicant) _____
Contact Person _____
Phone # (____)_____ Fax # (____)_____ E-mail _____

1. Station Name _____
   a. Location/Interconnection Point (Indicate point of coupling with utility system by specifying distribution feeder or transmission line name(s) or substation name. Distribution facilities should include the transmission facility substation(s) that the distribution facilities are supplied from.)
   _____
   b. Address of Plant
   Street Address _____
   Town or City _____
   County _____ State _____ Zip Code _____
   c. Unit/Aggregate Generation Asset Identification _____

Net ratings entered in below should reflect the netting of auxiliary loads from the gross unit rating(s) that are directly related to the operation of the unit/aggregate generation.

	Winter (0 or higher Deg F)*	Winter (20 Deg F)	Summer (50 or higher Deg F)**	Summer (90 Deg F)
Gross Unit Rating (MW)				
Net Unit Rating (MW)				
Unit Rating (Lagging MVAR)		N/A		
Unit Rating (Leading MVAR)		N/A		

* Enter all values in this column corresponding to the temperature of 0 degree F or greater at which gross facility output will be the highest. As an example, if the maximum gross facility output occurs at 12 degrees F, all values in this column shall correspond to the 12 degree F operating condition.

** Enter all values in this column corresponding to the temperature of 50 degrees F or greater at which net unit facility output will be the highest. As an example, if the maximum net facility output occurs at 67 degrees F, all values in this column shall correspond to the 67 degree F operating condition.

Application Identification No. _____

d. What is the maximum net power injection at the point of interconnection? _____

e. Is there load reduced by operating this generation? (Check Yes or No) ☐ Yes ☐ No
If "Yes:"
By how much is the load reduced? _____
Where is the load located?_____

2. Type of Application (Check one)
☐ Construction ☐ Capacity Change

3. Requested Commercial Operation Date _____

4. Is the unit equipped with under-frequency protection? (Check yes or no) ☐ Yes ☐ No

If "Yes:"

a. Has the host utility reviewed the settings? ☐ Yes ☐ No

b. Will the unit be tripped for under-frequency conditions in the area above the curve in Figure 1 of Standard PRC-006-NPCC? ☐ Yes ☐ No

i. If "Yes," has additional automatic load shedding been provided equivalent to the amount of generation to be tripped? ☐ Yes ☐ No

c. Will the unit be tripped in conjunction with dropping low voltage feeder during load shedding? ☐ Yes ☐ No

i. If "Yes," has the host utility ensured that sufficient automatic load shedding capability will be available to system operators? ☐ Yes ☐ No

Note: A "No" response to b.i or c.i is grounds for rejection.

5. Provide the following information on fuel used by the unit.
a. List the unit's primary energy source code (from "Energy Sources" listed on the following page)
_____
b. List the unit's secondary energy source code (from "Energy Sources" listed on the following page)
_____

6. Will the unit have black start capability? (Check Yes or No) ☐ Yes ☐ No
If "Yes," can it be operated on its own auxiliaries prior to synchronization with the system? ☐ Yes ☐ No

7. Provide the following information on the interconnection point.
a. Specify the interconnection bus name and the voltage level the unit is connected to.
_____
b. Specify the modeled PSS/E bus name and number that is electrically closest to where the unit is interconnected.
_____

(Check the appropriate box and provide appropriate diagram(s))

☐ The unit is connected to the power system at transmission voltage (69 kV or higher). Provide an electrical one-line diagram showing all essential devices including GSU impedance, station arrangements, station service and connections to the bulk power system, including the voltage levels below 69 kV.

☐ The unit is connected to the distribution system. Provide one-line diagram(s) showing the unit connection and where the distribution network connects to the bulk power system.

8. Has an interconnection request been submitted for the new unit or change of less than 5 MW? Yes ☐ No ☐
a. If "Yes," when was the interconnection request submitted and to whom?
_____
b. If "No," when will the interconnection request be submitted and to whom?
_____

7.0 Attachment 1 – Generation Proposed Plan Application

GENERATION PROPOSED PLAN APPLICATION

ISO New England Planning Procedure 5-1

Page 1 of 2

Applicant _____ Date _____

Contact Person _____ Phone _____

1. Station Name and Location _____

   Unit Identification _____

	Winter (0 or higher Deg F)*	Winter (20 Deg F)	Summer (50 or higher Deg F)**	Summer (90 Deg F)
Gross Unit Rating (MW)				
Net Unit Rating (MW)				
Unit Rating (Lagging MVAR)		N/A		
Unit Rating (Leading MVAR)		N/A		

* Enter all values in this column corresponding to the temperature of 0 degrees F or greater at which gross facility output will be the highest. As an example, if the maximum gross facility output occurs at 12 degrees F, all values in this column shall correspond to the 12 degree F operating condition.

** Enter all values in this column corresponding to the temperature of 50 degrees F or greater at which net facility output will be the highest. As an example, if the maximum net facility output occurs at 67 degrees F, all values in this column shall correspond to the 67 degree F operating condition.

2. Type of Application

   ☐ Construction ☐ Capacity Change

3. Requested Commercial Operation Date _____

4. Will the facility be equipped with a functioning governor? ☐ Yes ☐ No (A "No" response may be grounds for rejection pursuant to OP 14.)

5. Is the unit equipped with under-frequency protection? ☐ Yes ☐ No

   If "Yes:"

   a. Has the host utility reviewed the settings? ☐ Yes ☐ No

   b. Will the unit be tripped for under-frequency conditions in the area above the curve in Figure 1 of Standard PRC-006-NPCC? ☐ Yes ☐ No

      i. If "Yes," has additional automatic load shedding been provided equivalent to the amount of generation to be tripped? ☐ Yes ☐ No

Application Identification No. _____

GENERATION PROPOSED PLAN APPLICATION

ISO New England Planning Procedure 5-1

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   c. Will the unit be tripped in conjunction with dropping low voltage feeders during load shedding?

      ☐ Yes ☐ No

      i. If "Yes," has the host utility ensured that sufficient automatic load shedding capability will be available to system operators? ☐ Yes ☐ No

Note: A "No" response to b.i or c.i is grounds for rejection.

6. Provide the following information on fuel used by the unit

   a. List the unit's primary fuel _____ and secondary fuel _____.

7. Will the unit have black start capability? ☐ Yes ☐ No

   a. If "Yes," can it be operated on its own auxiliaries prior to synchronization with the system? ☐ Yes ☐ No

8. Attach an electrical one-line diagram showing all essential devices including GSU impedance, station arrangements, station service and connections to the transmission system (69 kV and higher), including the voltage levels.

9. Is a Transmission Proposed Plan Application required? ☐ Yes ☐ No

   a. If "Yes," identify the Transmission Applications associated with this Application, the Governance Participant responsible for filing and the date the Application was/will be submitted.

   _____

10. System Reliability Studies

Short Circuit	☐ Completed	☐ Planned	☐ Not Needed
Load Flow	☐ Completed	☐ Planned	☐ Not Needed
Stability	☐ Completed	☐ Planned	☐ Not Needed
Other_____	☐ Completed	☐ Planned	☐ Not Needed

Application Identification No. _____

Form Data

- Forms have some built in logic to help standardize data entries
- Data is able to be downloaded from the forms in an easily exportable way
- Data is then added to tracking sheets in bulk

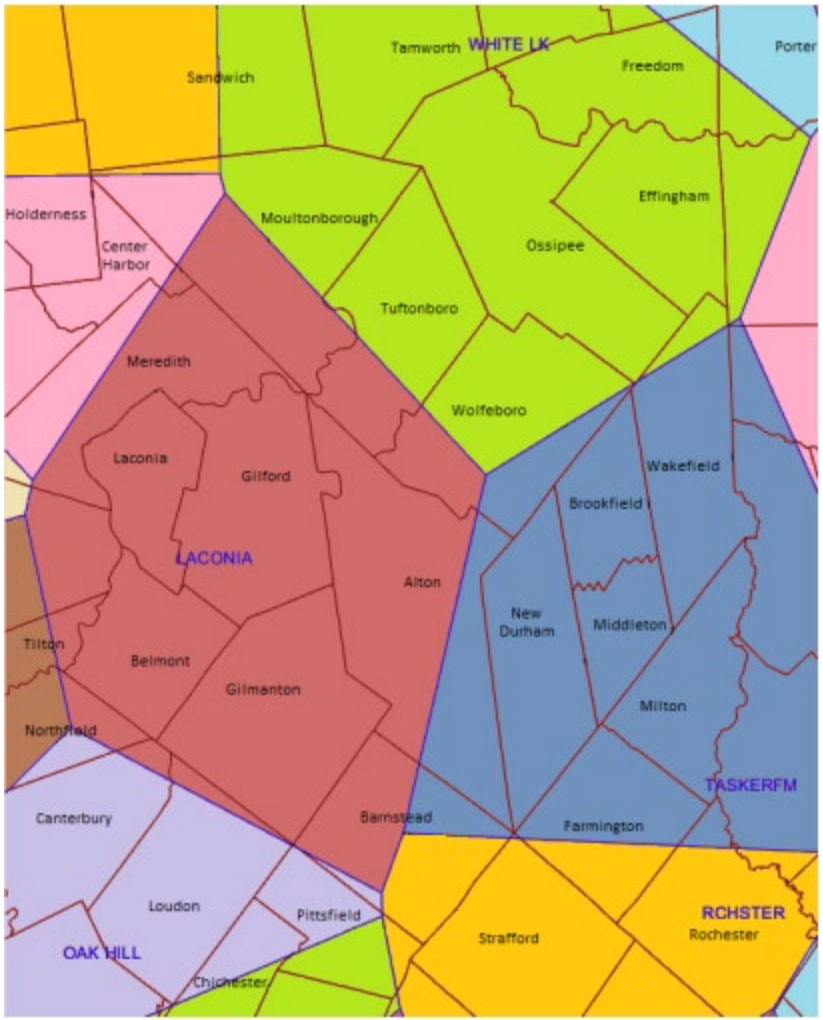
PPA number	Date of application (Date on Cover Letter)	Date of PPA approval letter	Project Name	Town	State	Address	Project Applicant	Maximum Net Power Injection (MW)	Requested Effective Date	Calendar Year of Requested Effective Date	Planning Year of Requested Effective Date. EX: Planning Year 2017 runs from June 1, 2016 to May 31, 2017	Interconnection bus name and voltage level	Substation name	Final bus number to be associated with the project (RED highlight indicates PTF bus)
ABC-22-G01	4/10/2022	5/14/2022	ABC Solar	Town ABC	MA	116 ABC Road	ABC Developer	1.900	7/1/2023	2023	2024	13.8 kV ABC distribution feeder 320 W3	ABC	999999
ABC-22-G02	4/10/2022	5/14/2022	DEF Solar, LLC	Town ABC	MA	146 DEF Rd	DEF Developer	2.500	9/1/2023	2023	2024	13.8 kV DEF 17K A3 Bus	DEF	999999
ABC-22-G03	4/10/2022	5/14/2022	DEF Solar, LLC	Town ABC	MA	146 DEF Rd	DEF Developer	2.500	9/1/2023	2023	2024	13.8 kV DEF 17K A3 Bus	DEF	999999

DER MODELING

Converting Data into Models

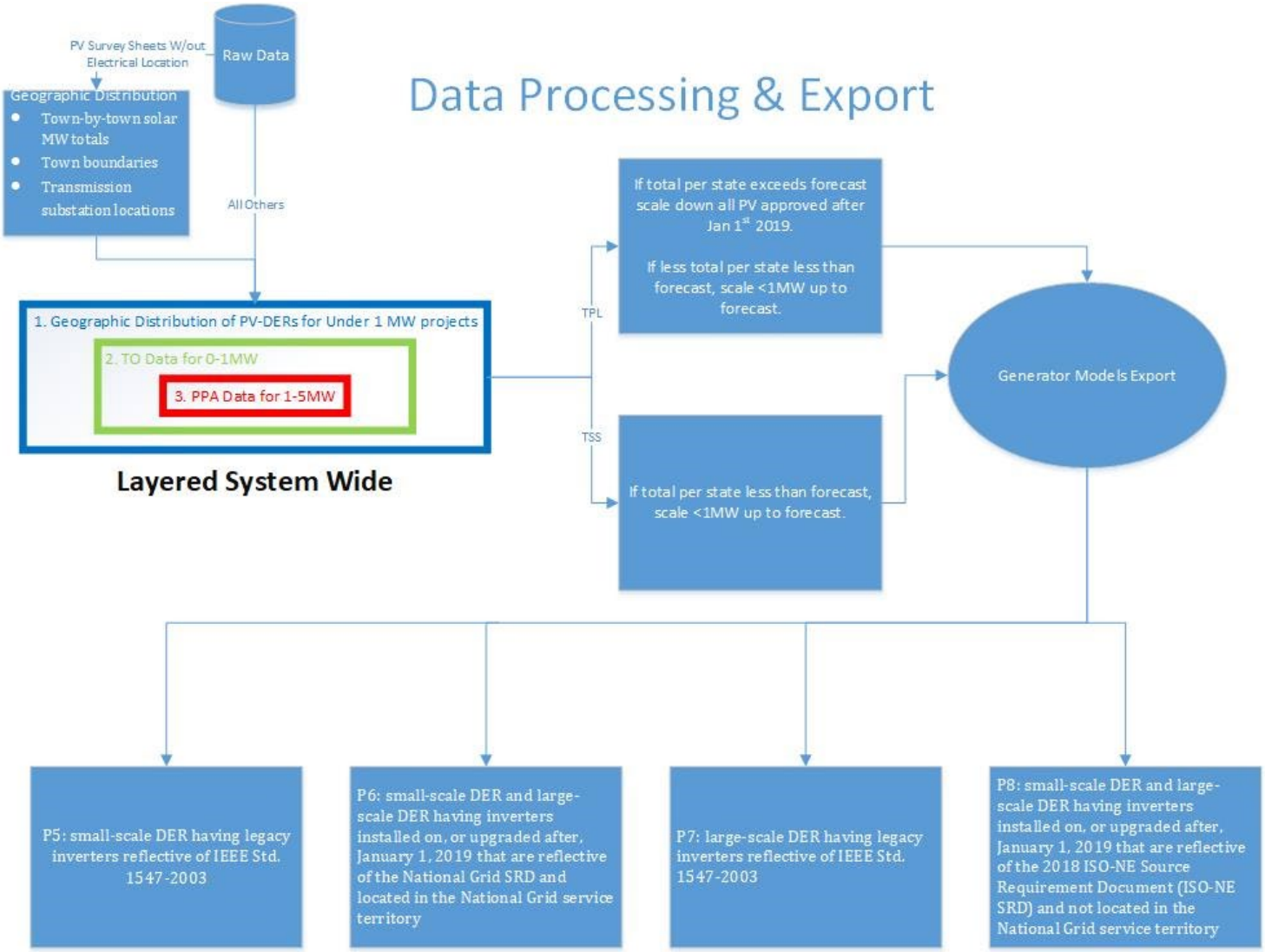
- Powerflow models are built for all DERs <5MW
- Models are added as generator models that are aggregates of the data sources
  - Town-by-town level DER survey data is used in what is called the "Geographic Approach"
  - Expanded DER Surveys
  - I.3.9 Tracking sheets

Geographic Approach



- New process uses town-by-town level data in what is called the “Geographic Approach”
  - Used for areas where the ISO does not have specific electrical locations for each DER
  - Assumes DERs will be connected to the which ever substation the town is closest to

Creating the models

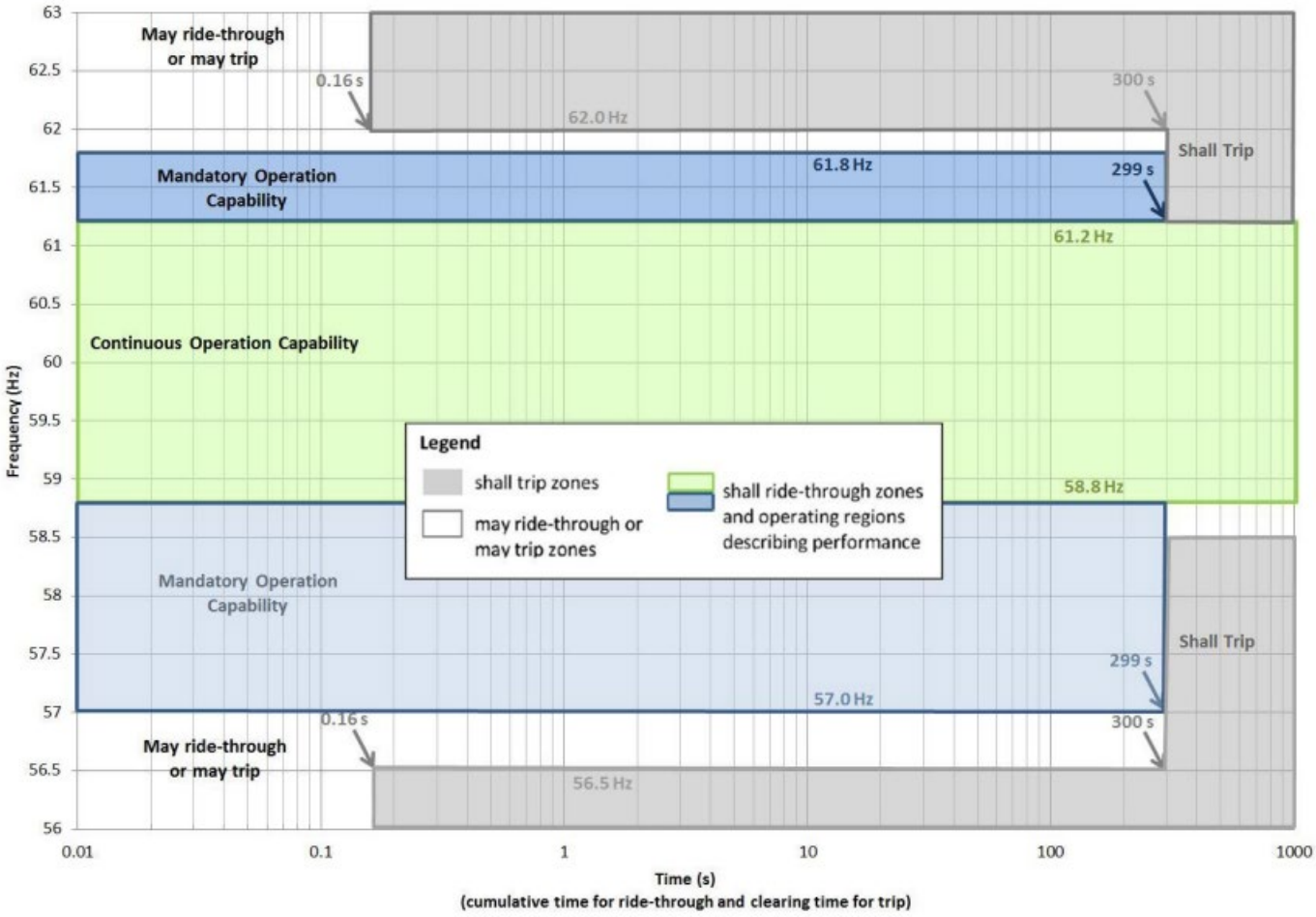


Stability Modeling

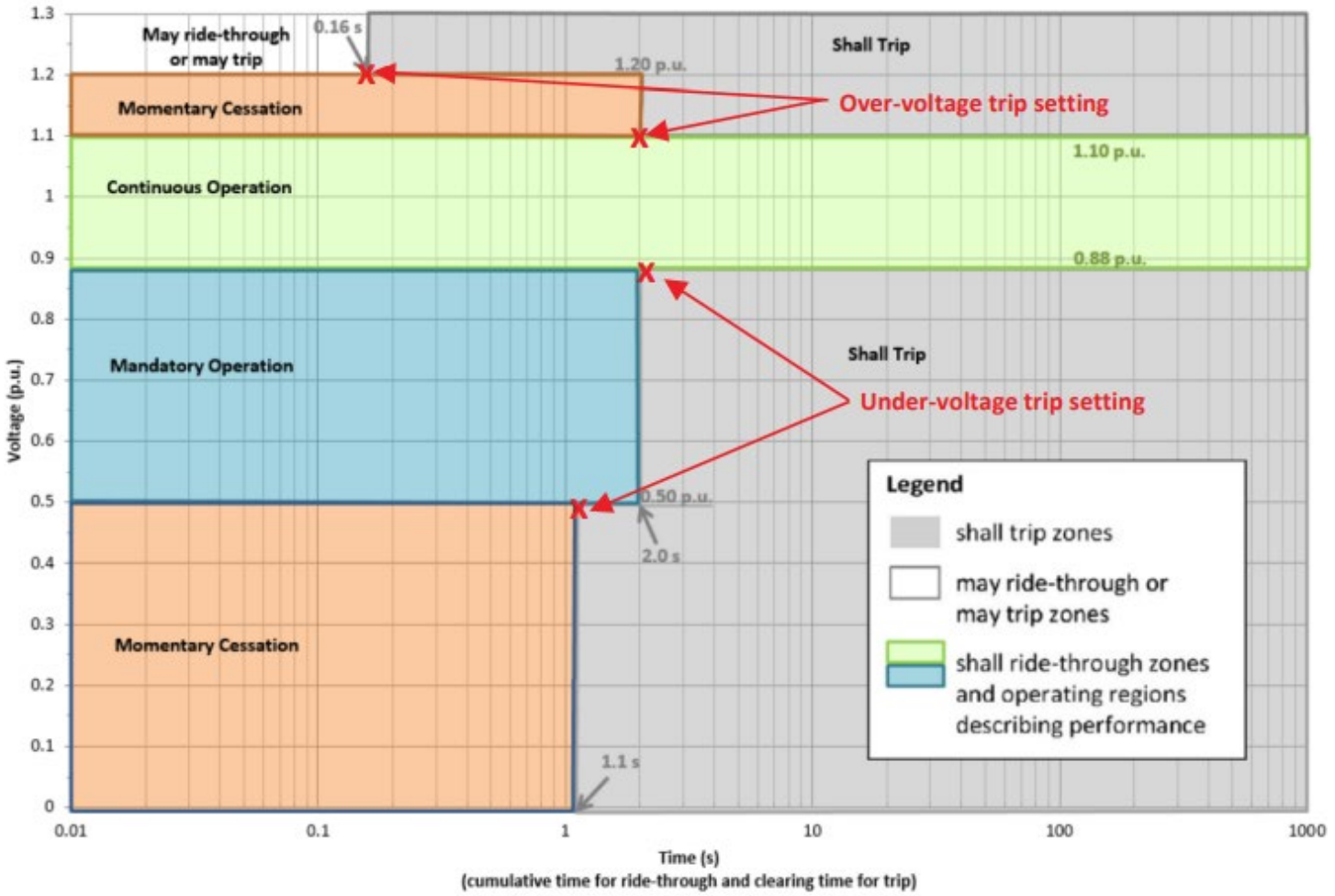
- DER_A Models are built for each aggregated generator model
- Parameterization depends on the in-service date which informs which vintage of IEEE-1547 the project was installed under

Parameter	IEEE Std. 1547-2003 P5	IEEE Std. 1547-2003 P7	National Grid SRD P6	2018 ISO-NE SRD P8
trv	0.02	0.02	0.02	0.02
trf	0.02	0.02	0.02	0.02
dbd1	-99	-99	-99	-99
dbd2	99	99	99	99
kqv	0	0	0	0
vref0	0	0	0	0
tp	0.02	0.02	0.02	0.02
tiq	0.02	0.02	0.02	0.02
ddn	0	0	0	0
dup	0	0	0	0
fdbd1	-99	-99	-99	-99
fdbd2	99	99	99	99
femax	0	0	0	0
femin	0	0	0	0
pmax	1	1	1	1
pmin	0	0	0	0
dpmax	99	99	99	99
dpmin	-99	-99	-99	-99
tpord	0.02	0.02	0.02	0.02
Imax	1.2	1.2	1.2	1.2
vl0	0.50	0.83	0.50	0.50
vl1	0.85	0.88	0.55	0.55
vh0	1.15	1.15	1.15	1.15
vh1	1.1	1.1	1.1	1.1
tvl0	0.1	0.1	1.1	1.1
tvl1	0.1	0.1	1.1	1.1
tvh0	1	1	2	2
tvh1	1	1	2	2
Vrfrac	0	0	1	1
fltrp	59.3	57	57	57
fhtrp	60.5	60.5	61.8	61.8
tfl	0.16	0.16	0.16	0.16
tfh	0.16	0.16	0.16	0.16
tg	0.02	0.02	0.02	0.02
rrpwr	0.1	0.1	2	2
tv	0.02	0.02	0.02	0.02
Kpg	0	0	0	0
Kig	0	0	0	0
xe	0.25	0.25	0.25	0.25
vpr	0.7	0.7	0.7	0.7
iqh1	0	0	0	0
iql1	0	0	0	0
pflag	1	1	1	1
frqflag	0	0	0	0
pqflag	1	1	1	1
typeflag	1	1	1	1
Vtripflag	1	1	1	1
Ftripflag	1	1	1	1

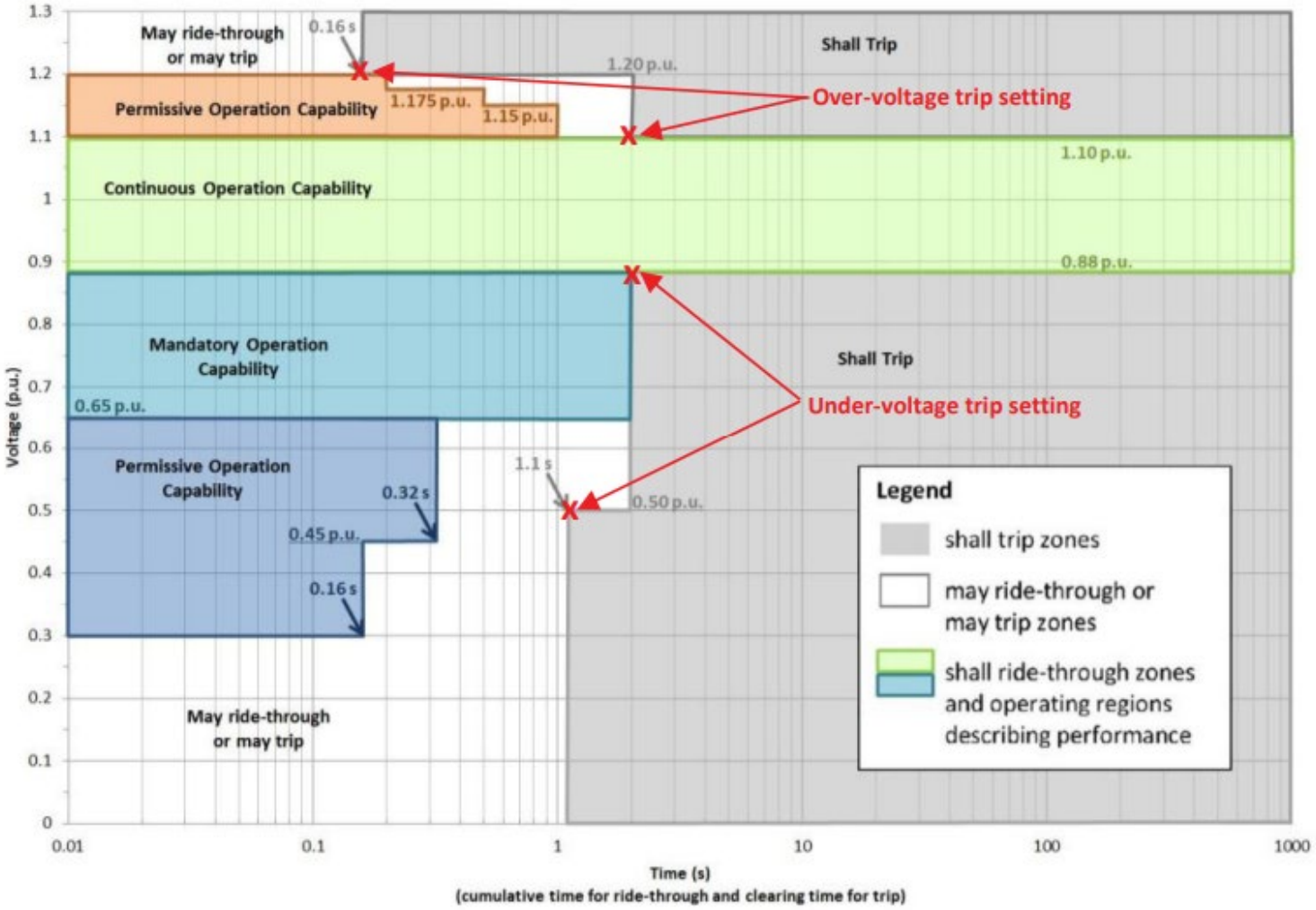
DER Ride Through Settings



DER Ride Through Settings



DER Ride Through Settings

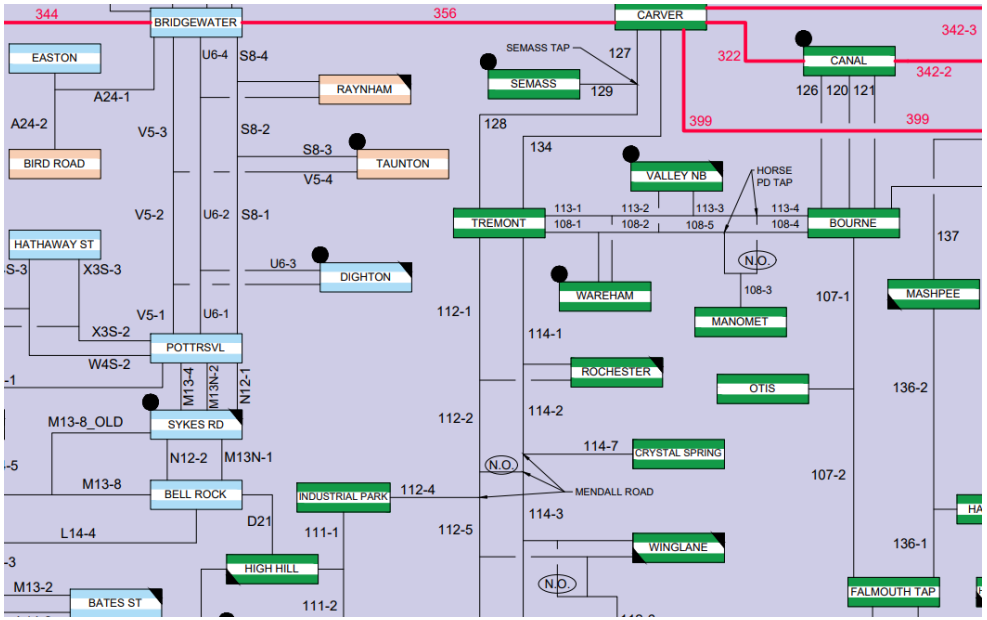


AFFECTED SYSTEM OPERATOR STUDIES

ASO Studies

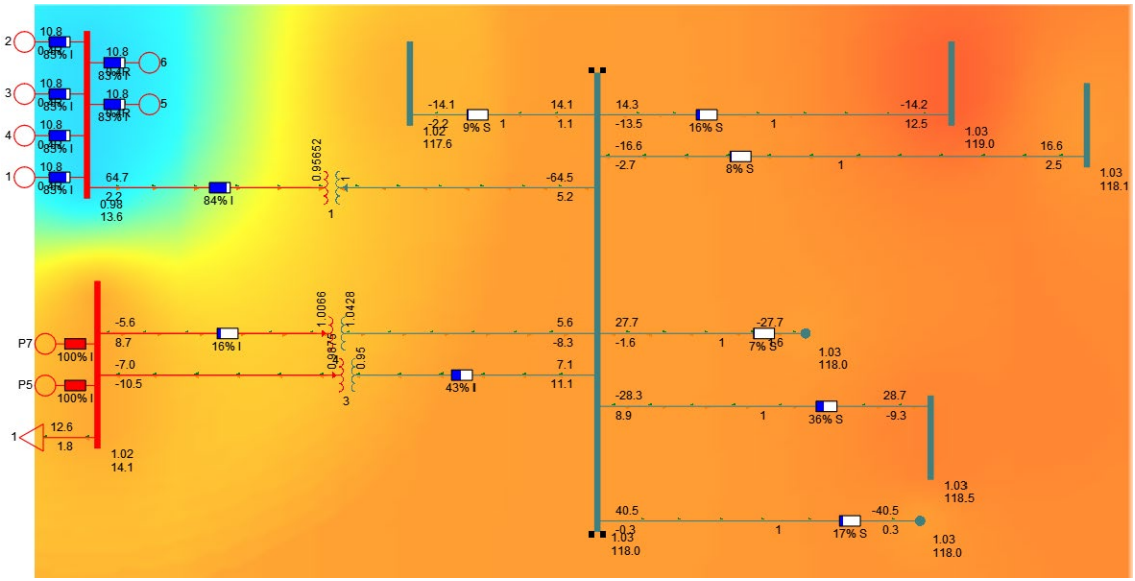
- Projects that fall under the I.3.9 process are aggregated and studies may be needed
  - All individual projects 5MW or greater
  - Aggregates of 20MW or more at a single station, or between electrically proximal stations

- Different types of studies may be needed
  - Steady State
  - Short Circuit
  - Stability
  - EMT



ASO Studies Cont.

- DERs are studied to determine if there is an impact on the transmission system
  - Thermal
  - Voltage
  - Breaker duties
  - DER ride through
  - Instability
  - Adverse impacts to market participants



ASO Studies Scenarios

Steady State

DER Studies	High Solar	Low Solar	No Solar	Batteries Charging	Batteries Discharging	Notes
Peak Load 90/10	No	26%	Only if Topology Changes are present	No	100%	
	85%	No		100%	No	
Shoulder Load 18,000MW	No	No	No	No	No	
Light Load 12,500MW	No	No	No	No	No	
N-Minload 8,000MW	No	No	Only if Topology Changes are present	No	No	
D-Minload 12,000MW	100%	No	No	No	No	

Stability

DER Studies	High Solar	Low Solar	No Solar	Batteries Charging	Batteries Discharging	Notes
Peak Load 90/10	No	26%	Only if Topology Changes are present	No	100%	
Light Load 12,500MW (NET)	100%	No	No	100%	No	
D-Minload 12,000MW (GROSS)	100%	No	No	No	No	

Motivation for EMT Studies

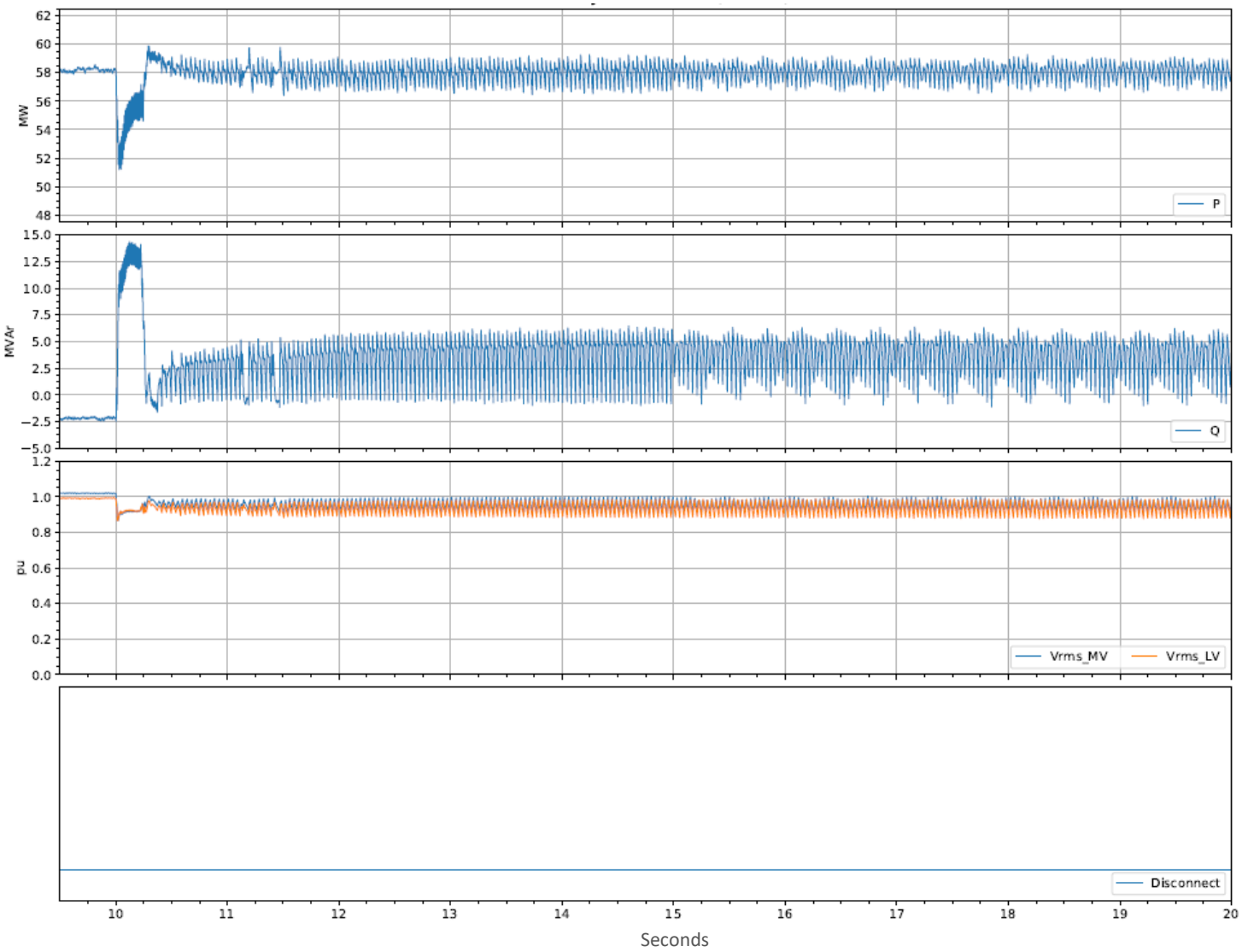
- Concerns with high penetrations
  - Other market participants
  - Ride through for bulk grid events
  - Interactions with other nearby IBRs
  - Weak Grid Instabilities
- OEM models are considered more accurate than generic models and contain actual inverter protections
  - Over/under voltage (RMS and instantaneous)
  - PLL loss of sync
  - ROCOF
  - Vector Shift
- Can be used to benchmark PSS/e results
  - Benchmark at the high side of the T&D interface

EMT Study considerations

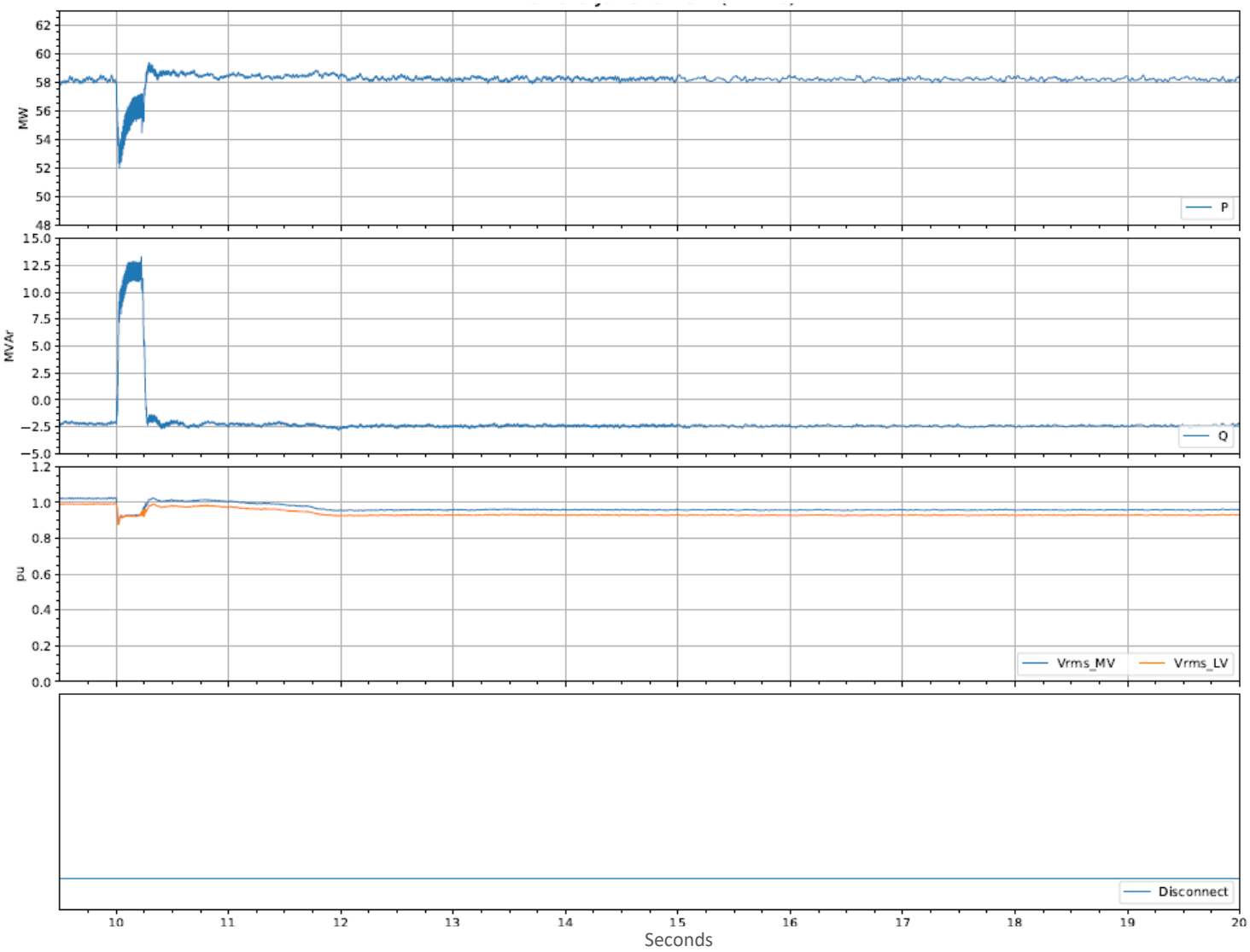
- OEM specific models are used
- Actual distribution feeder data is used to create model equivalents
- Lots of different manufacturers, so aggregate per station based on most prevalent inverters

Station Name	Transformer	Total Station DER (MW)	Inverter 1 Model		Inverter 1 Fraction	Inverter 2 Model		Inverter 2 Fraction	Inverter 3 Model		Inverter 3 Fraction
Substation 1	1	3.990	Sungrow	SC5000UD-MV-US	100%						
Substation 2	1	2.70	SMA	PV - Highpower Peak3 125-US	100%						
Substation 3	2	4.00	Sungrow	SG 3600UD	100%						
	1	4.80	EPC Power	CAB1000/PV3.2	100%						
Substation 4	1	3.000	Sungrow	SG250HX	100%						
Substation 5	1	6.525	Power Electronics	HEMK FS2125K	100%						
	2	9.989	Sungrow	SG2500U	50%	PV - Delta ESS - Sungrow	PV - Delta M125HV ESS - SC1000KU	50%			
Substation 6	1	4.996	SMA	Two (2) SMA SC 2660 UP-US	100%						
Substation 7	1	6.982	SOLECTRIA	XGI 1500 - 166/166	28.5%	SMA	SC2660-UP-US	71.4%			
Substation 8	1	14.979	Power Electronics	FS3190K HEMK POWER LIMITED TO 2495KW	33.4%	Sungrow	SG2500U	33.3%	Sungrow	"PV - SG60KU-M	33.3%

EMT Study Result



EMT Study Result cont.



Questions

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