# Eversource 2023 ASO Study Customer Technical Discussion

## *Western Massachusetts & Greater Boston Areas*

**February 15, 2023**

# Agenda

- Extension of ASO Study Opt In/Opt Out Period
- Technical Data Challenges and Lessons Learned
- Eversource Data and Modeling Requirements for ASO Studies
- Technical Data submission via PowerClerk
- Q&A

# Extension of ASO Study Opt In/Opt Out Period

- Based on ASO Study participant feedback and in order to allow time to address technical questions and subsequent model submission, Eversource extended the opt in/opt out timeframe by 2 weeks and moved the schedule back by 2 weeks.
- Eversource continues to take a collaborative approach with customers in order to administrate the studies as efficiently as possible.
- The intent of this extension is to allow customers sufficient time to develop and submit fully-functioning PSCAD models as well as allow Eversource to perform their due diligence in preparation for the 2023 ASO.

# Extension of ASO Study Opt In/Opt Out Period

EVERSOURCE

## Level 0 PPA Schedule

| Due Date | Milestone |
|---|---|
| February 24th | Customers opt in/out |
| March 10th | Customers make payment and submit technical data/models |
| March 17th | Eversource provides model feedback |
| March 31st | **Cure Period**<br><br>Timeframe for customers to get project's modeling rectified and any missed requirements as part of good faith effort to meet deadlines |
| April 7th | Eversource provides model acceptance/rejection notice. Customer data models must be fully functioning, otherwise project will not be able to participate in this ASO Study and withdrawn. |

## Level 3 PPA Schedule

| Due Date | Milestone |
|---|---|
| February 24th | Customers opt in/out |
| March 3rd | Eversource provides final study cost |
| March 17th | Customers make payment and submit technical data/models |
| March 24th | Eversource provides model feedback |
| April 7th | **Cure Period**<br><br>Timeframe for customers to get project's modeling rectified and any missed requirements as part of good faith effort to meet deadlines |
| April 14th | Eversource provides model acceptance/rejection notice. Customer data models must be fully functioning, otherwise project will not be able to participate in this ASO Study and withdrawn. |

# Technical Data Challenges and Lessons Learned

| Challenges | Lessons Learnt |
|---|---|
| Lack of or improper PSCAD model documentation provided with PSCAD model submission in PowerClerk. This caused Eversource to take longer time to understand the PSCAD model functionality and at times needed inverter manufacturer support to resolve PSCAD model related questions. | Eversource will now require PSCAD model documentation to be included with the PSCAD model submission |
| PSCAD Models were submitted in a .exe file format. Due to security reasons, Eversource does not run executable files from an external source. All customers who had submitted PSCAD models in .exe file format had to be informed to re-submit PSCAD models with the appropriate PSCAD file extensions. This resulted in additional time needed to validate PSCAD models. | Eversource will accept PSCAD Models containing the following files:<br>Model documentation (.pdf) – REQUIRED!<br>Site-specific PSCAD case (.pscx) – REQUIRED!<br>Additional PSCAD model files (e.g. .pslx, .pswx, .obj, .lib, .dll) – as applicable<br>OEM inverter configuration files (e.g. .txt, .pmvs, etc.) – as applicable |
| PSCAD Models were submitted with default parameters and was configured with default parameters by the inverter vendor. These PSCAD models were not configured to match the project one line diagram. Eversource had to spend significant time and effort to configure these PSCAD models to match their one line diagram as part of the PSCAD model validation process. | Eversource will only accept PSCAD models that are configured to be 'site-specific' and the models must match the project one line diagram in order to pass the PSCAD model validation process. |

# Technical Data Challenges and Lessons Learned

| Challenges | Lessons Learnt |
|---|---|
| The voltage and frequency protection setpoints of the PSCAD model were not configured to match the ISO-NE SRD requirements. Eversource had to set the voltage and frequency setpoints of the PSCAD models to match the ISO-NE SRD resulting in delays in completing the PSCAD model validation process. | Eversource will only accept PSCAD models with all voltage and frequency protection setpoints set as per the ISO-NE mandated protection settings. |
| PSSE stability models not provided or incorrect for the >5MW DER projects. This caused additional time. For example:<br>• REECB1 model is not acceptable | A stability model in standard PSSE Version 34 library format is required for projects 5MW or greater. The PSSE dynamic model file is in .dyr format including inverter stability models and voltage and frequency settings. Please refer to **Eversource Model & Technical Data Request List For Affected System Operator (ASO) Transmission Studies** for the acceptable PSSE stability models. |
| BESS Project operating narratives were not clearly provided, such as the charging from the grid capability. Additional time and discussions with the customer needed to provide clarity on BESS operating narrative. | Eversource has formulated a detailed BESS related questionnaire that is to be submitted along with any DER application, thus making the study process more efficient. |
| PSSE and/or PSCAD models submitted do not match the project one-line diagram. Multiple options of one-line diagrams and models caused confusion and additional time to seek clarity from Customers. | Eversource requests all ASO Study participants to submit consistent technical data, one-line diagram and models for the ONE project option intended for Proposed Plan Application (PPA) approval. |

# Technical Data Challenges and Lessons Learned

EVERSOURCE

| Challenges | Lessons Learnt |
|---|---|
| Missing and/or unclear information in the project one-line diagram. | Eversource requests all ASO Study participants to provide a stamped one-line diagram with special emphasis on including the following information:<br>▪ Project total size (kW-AC and kWh if applicable)<br>▪ GSU information (impedance, X/R, kVA, voltages, grounding)<br>  ▪ Rated kVA<br>  ▪ Impedance %Z<br>  ▪ X/R Ratio<br>  ▪ Rated winding voltages<br>  ▪ Taps (e.g., +/-2 steps, each at 2.5%)<br>  ▪ Winding configuration (ie. YNd1)<br>  ▪ Grounding (e.g., Neutral Ground Reactor Rating: 77Ω, X/R=4)<br>▪ Inverter information (make, model, version, quantity, rated kW & kVA)<br>▪ Presence of 32 or 32R directional power relay if applicable<br>▪ Inverter trip settings for frequency and voltage<br>▪ Inverter ride-through settings for frequency and voltage |

# Steady State Data and Model Requirements

- Steady state powerflow model not required for projects less than 5MW in size
- Steady State Analysis (Powerflow Modelling for Level 3 projects ≥5MW)
  - PSS/E .raw or .idv file extensions, preferred
  - Should be parameterized to represent site-specific equipment at facility
  - As applicable, the powerflow model must represent elements up to and including the point of interconnection such as:
    - Generators
    - Lines
    - Transformers
    - Capacitor/Reactor Banks, if any
    - Buses
    - FACTS/dynamic reactive devices, if any
    - Station service loads, if any

# Stability Data and Model Requirements

- Stability dynamic model not required for projects less than 5MW in size.
- Eversource will use DER_A dynamic model for projects less than 5MW in size.
- Stability Analysis (Dynamic Data and Modelling for Level 3 projects ≥5MW)
  - PSS/E .dyr file extension using standard PSS/E library models.
  - Should be parameterized to represent site-specific equipment at facility
  - All elements having a dynamic response shall be included
    - Generators
    - FACTS/dynamic reactive devices, if any

# PSCAD Data and Model Requirements

- PSCAD Models are not required for non-inverter based generation
- PSCAD Models are required for all inverter-based generation 1MW and above
- PSCAD Modelling Requirements:
  - Must be site specific
  - Must be in PSCAD v4.5.3 and above format (.pscx, .pslx, .pswx file extensions)
  - Should be parameterized to represent site specific equipment at facility
  - All elements and topology up to and including the point of interconnection must be represented
    - Generators
    - Lines
    - Transformers
    - Capacitor/Reactor Banks, if any
    - Buses
    - FACTS/dynamic reactive devices, if any
    - Station service loads, if any

# Eversource Data and Model Requirements

- The Eversource ASO Study Technical Data Requirements are in-line with the ISO-NE Planning Procedure (PP) PP5-6 model requirements.

- For more information on ISO-NE PP5-6 model requirements, please refer to the PP5-6, ISO-NE generator data submittal requirements and ISO-NE Compliance Bulletin on MOD-032 and ISO-NE Model Data Requirements and Reporting Procedures.

# Project Technical Data Submission via PowerClerk

# Example Data Package – Level 0 & 3 ASO

- One Line Diagram/Design
  - A stamped one-line diagram
- Additional_Attach
  - ESS_Questionnaire.xlsx if applicable
- Additional_Attach
  - PSCAD model supplier checklist (see Appendix E)
- Inverter Specification
  - Manufacturer datasheet(s) for inverter(s)
- PSCAD_Model
  - A ZIP file of site-specific PSCAD model & documentation

Note: These requirements reflect the ASO study only and are not intended to capture distribution impact study requirements or others

# Example Data Package – Level 0 & 3 ASO

EVERSOURCE

- One Line Diagram/Design
  - A stamped one-line diagram including:
    - Project total size (kW-AC and kWh if applicable)
    - GSU information (impedance, X/R, kVA, voltages, grounding)
    - Inverter information (make, model, version, quantity, rated kW & kVA)
    - Presence of 32 or 32R directional power relay if applicable
    - Inverter trip settings for frequency and voltage
    - Inverter ride-through settings for frequency and voltage

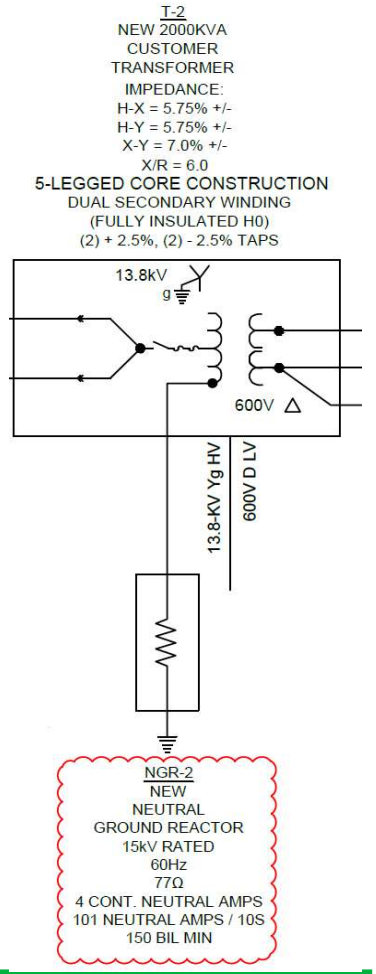
# Example Data Package – Level 0 & 3 ASO

- One Line Diagram/Design
  - A stamped one-line diagram including:
    - Project total size (kW-AC and kWh if applicable)

SYSTEM SIZE = 11,062.48 kW DC
4,999.00 kW AC NOM.
4,999.00 kW AC MAX.
3,740 kW / 11,220 kWH DC-COUPLED BESS

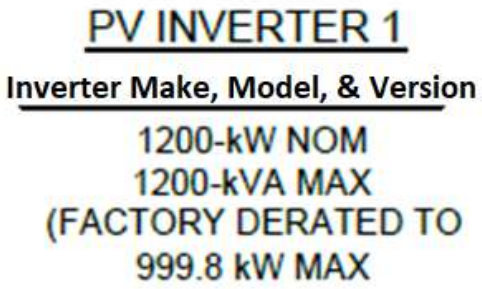
# Example Data Package – Level 0 & 3 ASO

- One Line Diagram/Design
  - A stamped one-line diagram including:
    - GSU information
      - Rated kVA
      - Impedance %Z
      - X/R Ratio
      - Rated winding voltages
      - Taps (typical is +/-2 steps, each at 2.5%)
      - Winding configuration (ie. YNd1)
      - Grounding (ie. NGR: 77 ohm, X/R=4)



# Example Data Package – Level 0 & 3 ASO

- One Line Diagram/Design
  - A stamped one-line diagram including:
    - Inverter information (make, model, version, quantity, rated kW & kVA)



# Example Data Package – Level 0 & 3 ASO

- One Line Diagram/Design
  - A stamped one-line diagram including:
    - Inverter trip settings for frequency and voltage

| Inverter Protective Settings ISO-NE SRD Tables I & II | | | | |
|---|---|---|---|---|
| INTERNAL PROTECTIVE FUNCTIONS | TRIP OUTPUT | VOLTAGE SETTING PU | SETTING | CLEARING TIME (sec) |
| 27-1 - UNDERVOLTAGE | X | 0.50 | 300 V | 1.1 |
| 27-2 - UNDERVOLTAGE | X | 0.88 | 528 V | 2 |
| 59-1 - OVERVOLTAGE | X | 1.10 | 660 V | 2 |
| 59-2 - OVERVOLTAGE | X | 1.20 | 720 V | 0.16 |
| 81U-1 - UNDERFREQUENCY | X | | 56.5 Hz | 0.16 |
| 81U-2 - UNDERFREQUENCY | X | | 58.5 Hz | 300 |
| 81O-1 - OVERFREQUENCY | X | | 61.2 Hz | 300 |
| 81O-2 - OVERFREQUENCY | X | | 62 Hz | 0.16 |
| PRIMARY VOLTAGE (L-L) | 0.6 | kV | 600 | V |

# Example Data Package – Level 0 & 3 ASO

- One Line Diagram/Design
  - A stamped one-line diagram including:
    - Inverter ride-through settings for frequency and voltage

| Inverter Voltage Ride-Through Settings ISO-NE SRD Table III | | | | | |
|---|---|---|---|---|---|
| OPERATING MODE / RESPONSE | VOLTAGE SETTING PU RANGE | SETTING (MIN.) | SETTING (MAX.) | MIN. RIDE-THROUGH TIME (sec) | MAX. RESPONSE TIME (sec) |
| CEASE TO ENERGIZE | V > 1.2 | N/A | 720.1 V | N/A | 0.16 |
| PERMISSIVE OPERATION | 1.175 < V ≤ 1.20 | 705 V | 720 V | 0.2 | N/A |
| PERMISSIVE OPERATION | 1.15 < V ≤ 1.175 | 690 V | 705 V | 0.5 | N/A |
| PERMISSIVE OPERATION | 1.10 < V ≤ 1.15 | 660 V | 690 V | 1 | N/A |
| CONTINUOUS OPERATION | 0.88 ≤ V ≤ 1.10 | 528 V | 660 V | INFINITE | N/A |
| MANDATORY OPERATION | 0.65 ≤ V < 0.88 | 390 V | 528 V | Linear slope of 8.7 s/ 1p.u. voltage starting at 3 s @ 0.65 p.u.: *Tvrt* = 3 s + 8.7 s/1 p.u. (V-0.65 p.u.) | N/A |
| PERMISSIVE OPERATION *a,b | 0.45 ≤ V < 0.65 | 270 V | 390 V | 0.32 | N/A |
| PERMISSIVE OPERATION *b | 0.30 ≤ V < 0.45 | 180 V | 270 V | 0.16 | N/A |
| CEASE TO ENERGIZE | V < 0.3 | 179.9 V | N/A | N/A | 0.16 |
| Footnote a | In the Permissive Operation region above 0.5 p.u., inverters shall ride-through in Mandatory Operation mode | | | | |
| Footnote b | In the Permissive Operation region below 0.5 p.u., inverters shall ride-through in Mandatory Cessation mode with a maximum response time of 0.083 seconds. | | | | |

| Inverter Frequency Ride-Through Settings ISO-NE SRD Table IV | | |
|---|---|---|
| OPERATING MODE / RESPONSE | FREQUENCY RANGE (Hz) | MIN. RIDE-THROUGH TIME (sec) |
| N/A | f > 62.0 | N/A |
| MANDATORY OPERATION | 61.2 < f ≤ 61.8 | 299 |
| CONTINUOUS OPERATION | 58.8 ≤ f ≤ 61.2 | Infinite |
| MANDATORY OPERATION | 57.0 ≤ f < 58.8 | 299 |
| N/A | f < 57.0 | N/A |

# Example Data Package – Level 0 & 3 ASO

- Additional_Attach
  - ESS_Questionnaire.xlsx if applicable

**Energy Storage System Project Design Information Requirement**

| | | |
|---|---|---|
| **Application ID #** | | |
| **Customer Name** | | |
| **ESS Location** | Street Address | |
| | City/Town | |
| | Zip Code | |

| | | |
|---|---|---|
| **1** | **Design Documentation** | |
| | Please provide both a one-line diagram and a site plan as a separate attachment to this questionnaire | |
| **2** | **System Configuration** | |
| | Is the ESS design Behind-the-Meter or Independent Power Producer? | |
| | For Behind-the-Meter, will the site export or be non-export? | |
| | Is the ESS electrically connected with DG or other generation? | |
| | DG Type (select from dropdown list) | |
| | AC or DC coupled? | |
| | Will the site be limiting export? If so, identify relay information: | |

# Example Data Package – Level 0 & 3 ASO

- Additional_Attach
  - PSCAD model supplier checklist

## Appendix E: PSCAD Model Checklist

This document is a model requirements checklist which must be completed by the supplier of the model and submitted alongside each PSCAD model. Model suppliers must review every item in the checklist and indicate compliance for each item. If the supplied model does not meet any of the requirements an explanation of the deficiency must be provided in the comments column.

| *Model Submission Summary (to be completed by model supplier)* | |
|---|---|
| Submission date: | |
| Project Name: | |
| Primary contact information for model related questions: | |
| Secondary contact information for model related questions: | |
| Manufacturer: | |
| Equipment type: (eg. PV or BESS) | |
| Equipment version: | |
| Documentation file(s): | |
| Model Files supplied: | |
| | |
| | |

# Example Data Package – Level 0 & 3 ASO

- Inverter Specification
  - Sample manufacturer datasheet(s) for inverter(s)

**Inverter Make, Model, & Version**

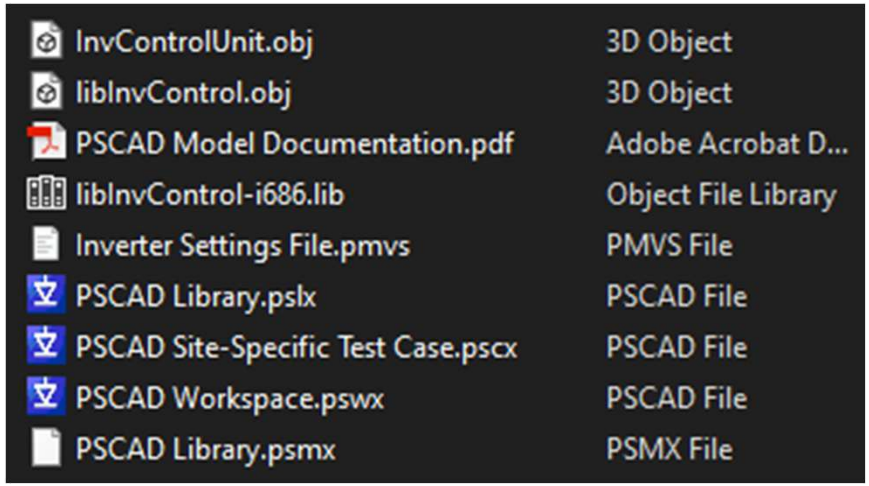
**Bidirectional Energy Storage & Microgrid PCS**

DG

| MODEL | | | | | | |
|---|---|---|---|---|---|---|
| AC | AC configuration \| max. cables per phase **(1)** | 3-wire (3P3W) \| 6 x 600 kcmil or 6 x 300 mm² | | | | |
| | Nominal AC voltage (+/- 10%) **(2)** | 480 VRMS | 600 VRMS | 630 VRMS | 660 VRMS | 690 VRMS |
| | Nominal AC current (export/import) | 1255 ARMS | | | | |
| | AC export/import capacity @ 40°C **(3)** | 1043 kW | 1304 kW | 1369 kW | 1435 kW | 1500 kW |
| | Export power overload capacity @ 40°C, starting from 66% full load. | 120 % for 3 sec and 116 % for 5 min | | | | |
| | Reactive power capacity **(4), (5)** | Power Factor 0,8...1 leading/lagging | | | | |
| | Allowed grid short ckt. current ratios | Current mode: >4 \| Voltage mode: all | | | | |
| | Max. fault current allowed from AC source | 100 kA (AC RMS) throated version \| 180 kA (AC RMS) non-throated version | | | | |
| | Nominal frequency range | 50 / 60 Hz (configurable) | | | | |
| | Harmonic distortion | UL1741 / IEEE 1547, <2% TDDi at rated power per IEEE 519<br><3% according to VDE-AR-N 4110/4120 | | | | |
| | Efficiency (@ 690 VAC): Peak \| CEC \| Euro | 98.8% \| 98,4% \| 98,5% | | | | |
| DC | DC voltage range, maximum **(6)** | 720 - 1500 VDC | 900 - 1500 VDC | 945 - 1500 VDC | 990 - 1500 VDC | 1035 - 1500 VDC |
| | DC voltage range, at nominal power **(6)** | 761 - 1200 VDC | 951 - 1500 VDC | 999 - 1500 VDC | 1046 - 1500 VDC | 1094 - 1500 VDC |
| | Recommended minimum battery voltage | 1,65 x nominal AC voltage | | | | |

# Example Data Package – Level 0 & 3 ASO

- PSCAD_Model
  - A ZIP file of site-specific PSCAD model & documentation
    - Model documentation (.pdf) – REQUIRED!
    - Site-specific PSCAD case (.pscx) – REQUIRED!
    - Additional PSCAD model files (e.g. .pslx, .pswx, .obj, .lib, .dll) – as applicable
    - OEM inverter configuration files (e.g. .txt, .pmvs, etc.) – as applicable



# Example Data Package – Level 3 ASO < 5MW

Same as level 0 with following additions:

- Cond_Type_Details
  - Conductor type and distances in mile between inverters/GSUs (collection system)
  - Conductor type and length of dedicated feeder to POI in miles (generator tie-line)

MEDIUM VOLTAGE CABLE SCHEDULE

| TAG | COUNT & SIZE | NEUTRAL | INSULATION | CONDUIT | LENGTH +/- 10' |
|---|---|---|---|---|---|
| Ⓐ | (3) 155.4 AAAC | 155.4 AAAC | N/A | FREE AIR | 40' |
| Ⓑ | (3) 250kcmil AL | 1/3 CONC. | 15kV 100% MV-105 | 4" | 50' |
| Ⓒ | (3) 3/0 AL | 1/3 CONC. | 15kV 100% MV-105 | 4" | 835' |
| Ⓓ | (3) 1/0 AL | 1/3 CONC. | 15kV 100% MV-105 | 4" | 595' |

- GSU_Details
  - Saturation data

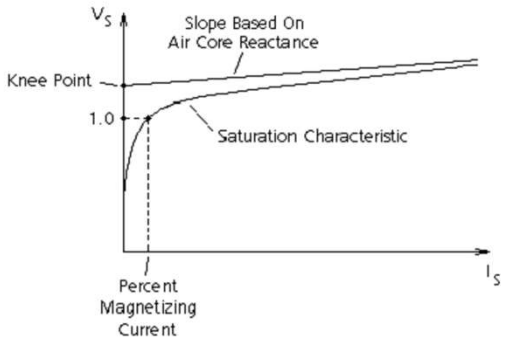



Figure 6-8 -- Typical Classic Core Saturation Characteristic

# Example Data Package – Level 3 ASO ≥ 5MW

Same as level 3 < 5MW with following additions:

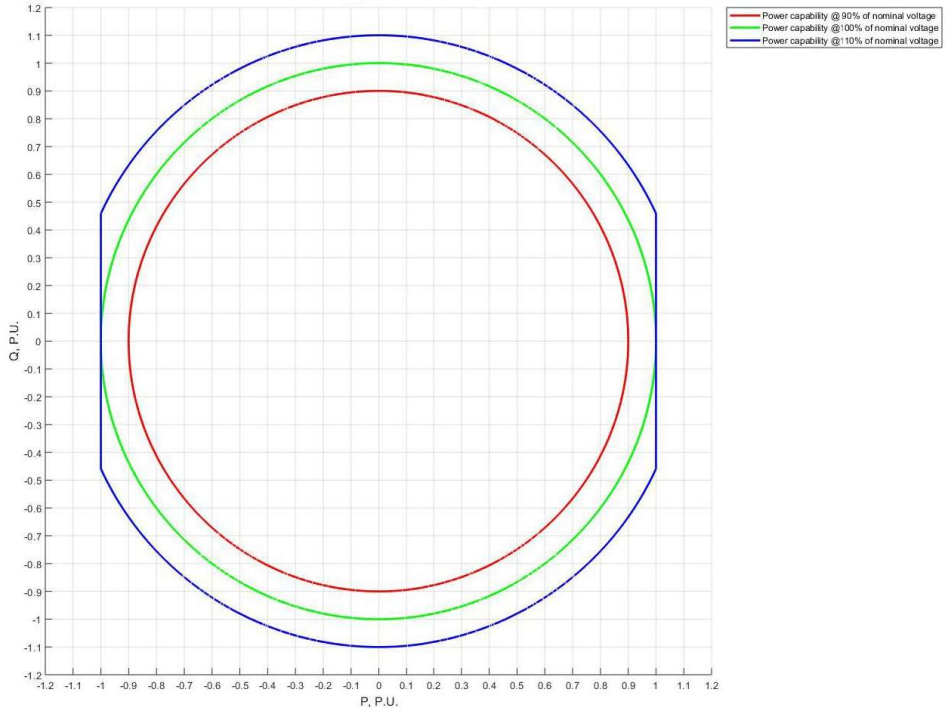
- Data_Sheet
  - Reactive capability curve or equivalent data

- Stability_Model_List
  - Stability model in PSS/E standard library model format (.idv/.raw/.sav & .dyr) ISO-NE does not accept user- written models
  - The following PSSE v34 standard library renewable energy system models shall be used to represent the transient stability of inverter-based DER's:
    - Renewable Energy Generator/Converter Model: REGC_B
    - Renewable Energy Electrical Model: REEC_D
    - Plant Controller Model:
      - REPC_A for standalone PV, BESS and PV+DC coupled BESS
      - PLNTBU1 + REAX4BU1 for PV+AC coupled BESS and hybrid-projects which include multiple technologies controlled by a single plant controller

# Example Data Package – Level 3 ASO ≥ 5MW

Same as level 3 < 5MW with following additions:

- Data_Sheet
  - Reactive capability curve or equivalent data



# Example Data Package – Level 3 ASO ≥ 5MW

Same as level 3 < 5MW with following additions:

- Stability_Model_List
  - .idv or .raw or .sav file:

```
RATING,12,  RATE12 ,  RATING SET 12
0 / END OF SYSTEM-WIDE DATA, BEGIN BUS DATA
@!   I,'NAME        ', BASKV, IDE,AREA,ZONE,OWNER, VM,        VA,     NVHI,    NVLO,    EVHI,    EVLO
 70100,'BUS_POI     ', 115.0000,1,   1,   1,   1,1.00360,   5.7216,1.10000,0.90000,1.10000,0.90000
 70101,'BUS_SUB     ', 115.0000,1,   1,   1,   1,1.00422,   6.1851,1.10000,0.90000,1.10000,0.90000
 70102,'BUS_COL     ',  34.5000,1,  99, 999,   1,1.00122,  11.0458,1.10000,0.90000,1.10000,0.90000
 70103,'TM840_TER   ',   4.1600,1,  99, 999,   1,1.00182,   8.6118,1.10000,0.90000,1.10000,0.90000
 70104,'BUS_XFR     ',  34.5000,1,  99, 999,   1,1.00172,  11.1031,1.10000,0.90000,1.10000,0.90000
 70105,'BUS_GEN     ',   0.8000,2,  99, 999,   1,1.00201,  12.7407,1.10000,0.90000,1.10000,0.90000
 97000,'BUS_INF     ', 115.0000,3,   1,   1,   1,1.00000,   0.0000,1.10000,0.90000,1.10000,0.90000
0 / END OF BUS DATA, BEGIN LOAD DATA
@!   I,'ID',STAT,AREA,ZONE,      PL,       QL,       IP,       IQ,       YP,       YQ, OWNER,SCALE,INTRPT,
 70102,'1 ',   1,  99, 999,    0.004,    0.000,    0.000,    0.000,    0.000,    0.000,   1,     1,  0,
0 / END OF LOAD DATA, BEGIN FIXED SHUNT DATA
@!   I,'ID',STATUS,  GL,       BL
0 / END OF FIXED SHUNT DATA, BEGIN GENERATOR DATA
@!   I,'ID',      PG,       QG,       QT,       QB,     VS,    IREG,     MBASE,     ZR,       ZX,       F
 70105,'1 ',  100.300,    0.450,    0.450,   -0.450,1.01000, 70100,   120.175, 0.00000E+0, 9.99900E+3, 0.000
```

- .dyr file:

```
70105  'REGCA1'      1
@!/ Lvplsw
    0
@!/ Tg          Rrpwr       Brkpt       Zerox       Lvpl1
    0.0200      0.8000      0.9000      0.8800      1.0000
@!/ Volim       Lvpnt1      Lvpnt0      Iolim       Tfltr
    1.0000      0.0010      0.0000     -1.0000      0.0000
@!/ Khv         Iqrmax      Iqrmin      Accel
    0.0000      20.000     -20.000      0.7000/
```

# Q&A