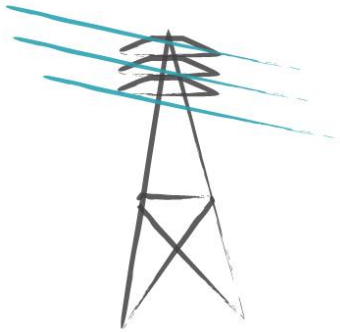

WECC

Evaluating Dispersed Generation Resources

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Michael Dalebout

Manager of Registration

WECC Compliance Workshop – Portland OR – November 14, 2017

Impact to Reliability

Ensure dispersed generation units are evaluated correctly to provide the full protections of the CIPv5 Standards, as applicable.

Identifying the Aggregation Point

Michael Dalebout

Manager of Registrations

Dispersed Generation Resources: Inclusions

BES Inclusions:

I1 - Transformers with the primary terminal and at least one secondary terminal operated at 100 kV or higher unless excluded by application of Exclusion E1 or E3.

I2 – Generating resource(s) including the generator terminals through the high-side of the step-up transformer(s) connected at a voltage of 100 kV or above with:

- Gross individual nameplate rating greater than 20 MVA. Or,
- Gross plant/facility aggregate nameplate rating greater than 75 MVA.

I3 - Blackstart Resources identified in the Transmission Operator's restoration plan.

I4 - Dispersed power producing resources that aggregate to a total capacity greater than 75 MVA (gross nameplate rating), and that are connected through a system designed primarily for delivering such capacity to a common point of connection at a voltage of 100 kV or above. Thus, the facilities designated as BES are:

- The individual resources, and
- The system designed primarily for delivering capacity from the point where those resources aggregate to greater than 75 MVA to a common point of connection at a voltage of 100 kV or above.

I5 –Static or dynamic devices (excluding generators) dedicated to supplying or absorbing Reactive Power that are connected at 100 kV or higher, or through a dedicated transformer with a high-side voltage of 100 kV or higher, or through a transformer that is designated in Inclusion I1 unless excluded by application of Exclusion E4.

Dispersed Generation Resources: Inclusion 4

I4. Dispersed power producing resources that aggregate to a total capacity greater than 75 MVA (gross nameplate rating), and that are connected through a system designed primarily for delivering such capacity to a common point of connection at a voltage of 100 kV or above. Thus, the facilities designated as BES are:

- The individual resources, and
- The system designed primarily for delivering capacity from the point where those resources aggregate to greater than 75 MVA to a common point of connection at a voltage of 100 kV or above.

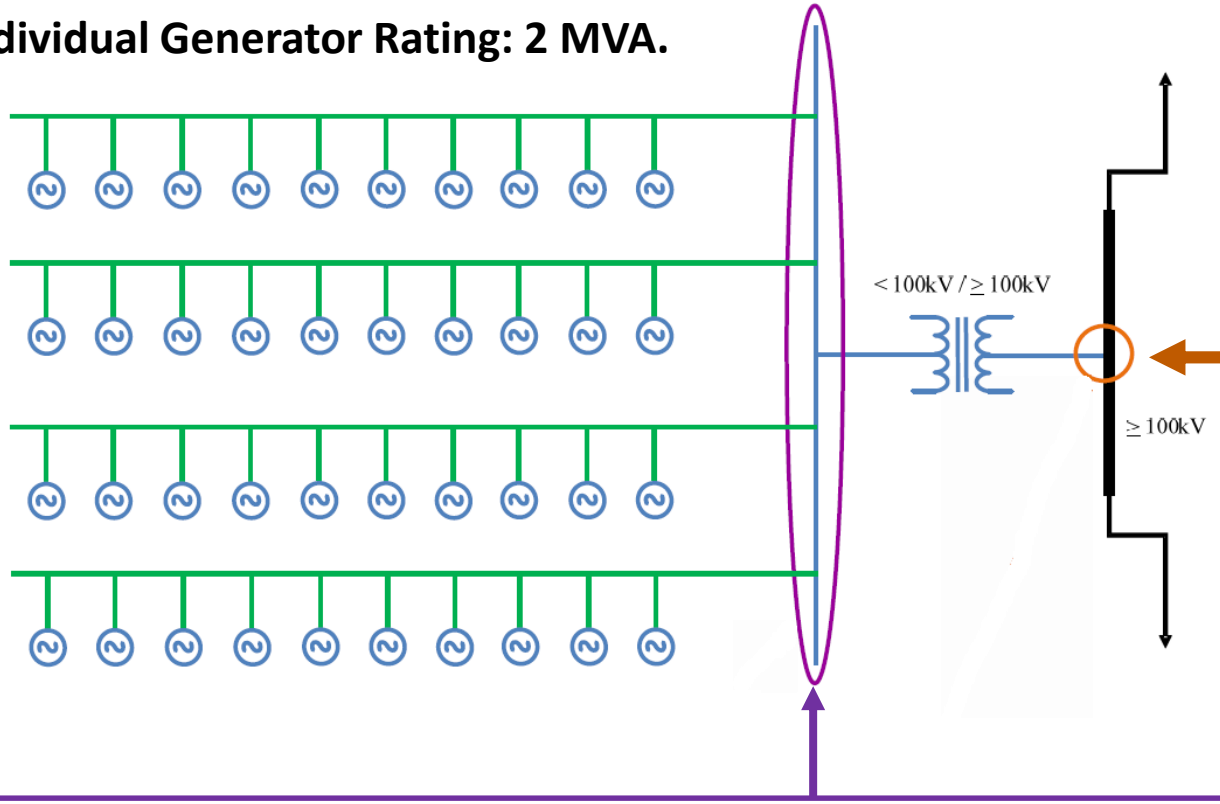
(NERC, 2014 April, BES Definition Guidance Document [v2], p. 19)

Dispersed Generation Resources: Inclusion 4

Inclusions | NERC | Bulk Electric System Definition Reference Document

Figure I4-1: Dispersed Generation Site (Single Voltage Transformation) – Wind Farm

Individual Generator Rating: 2 MVA.

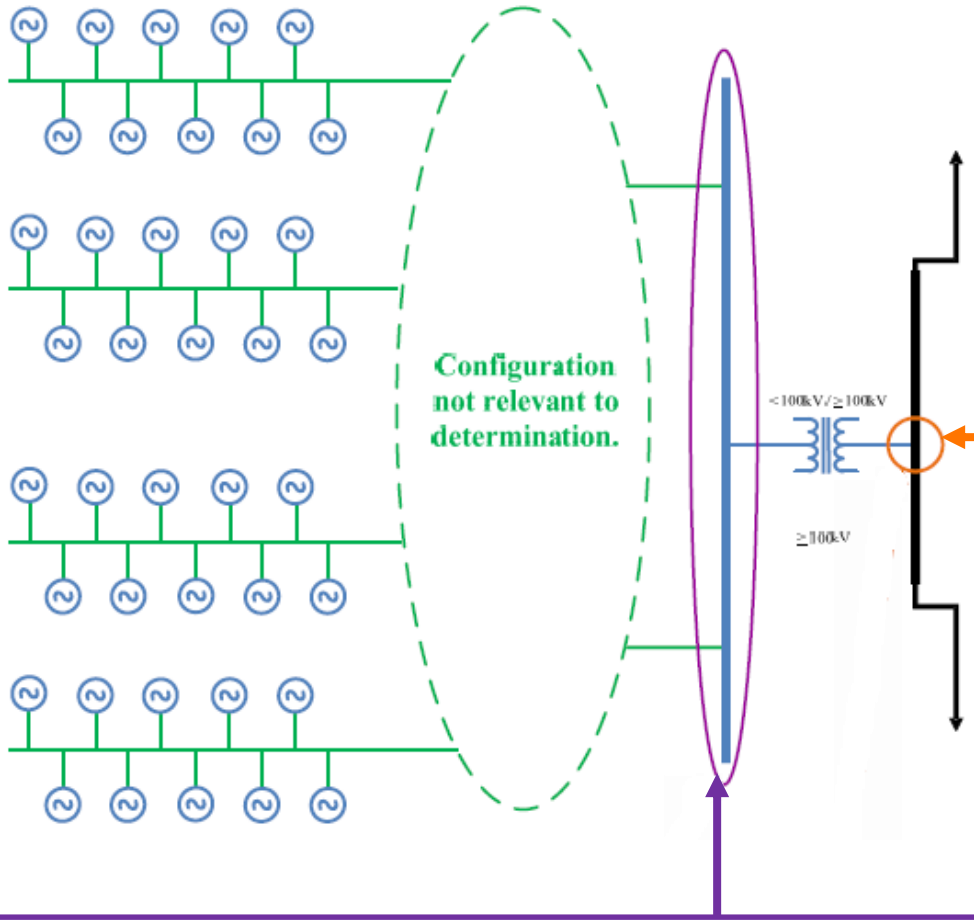


The common point of connection is where the individual transmission Element(s) of the collector system is connected to the 100 kV or higher Transmission system.

The point of aggregation is where the individual generator name plate ratings of the dispersed generation total > 75 MVA Capacity or greater to the BES (actual MVA rating = 80 MVA at the point of aggregation).

Dispersed Generation Resources: Inclusion 4

Individual Generator Rating: 2 MVA.

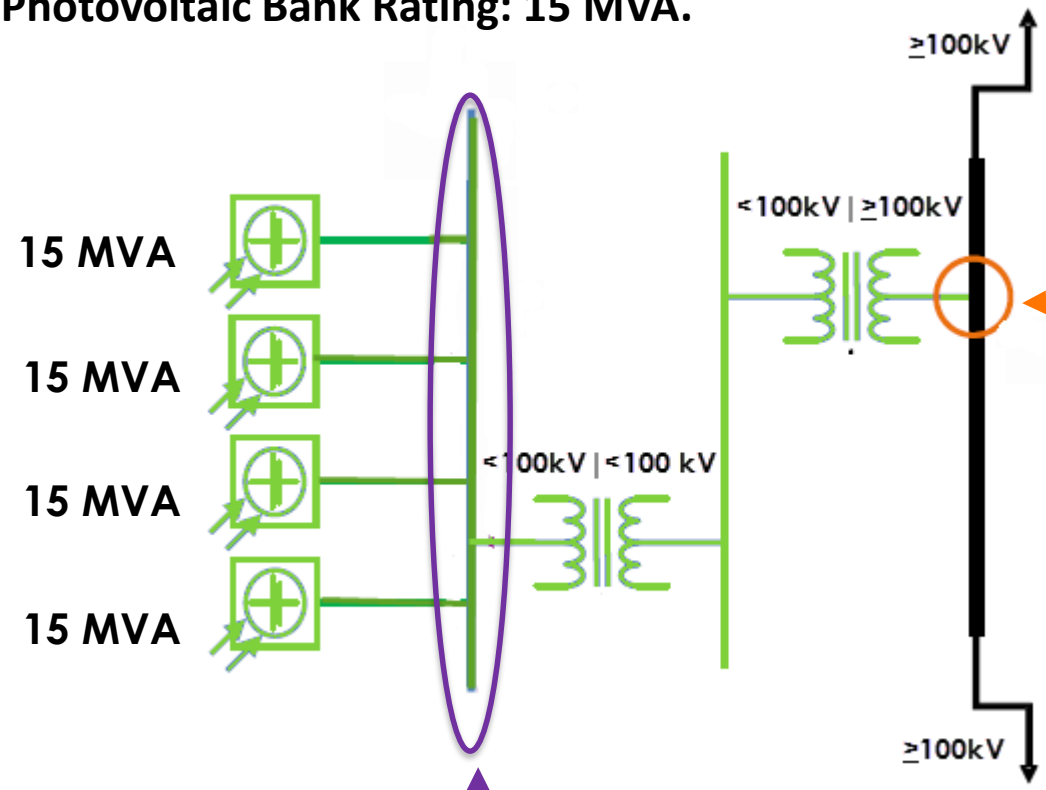


The common point of connection is where the individual transmission Element(s) of the collector system is connected to the 100 kV or higher Transmission system.

The point of aggregation is where the individual generator name plate ratings of the dispersed generation total > 75 MVA Capacity or greater to the BES (actual MVA rating = 80 MVA at the point of aggregation).

Dispersed Generation Resources: Inclusion 4

Individual Photovoltaic Bank Rating: 15 MVA.

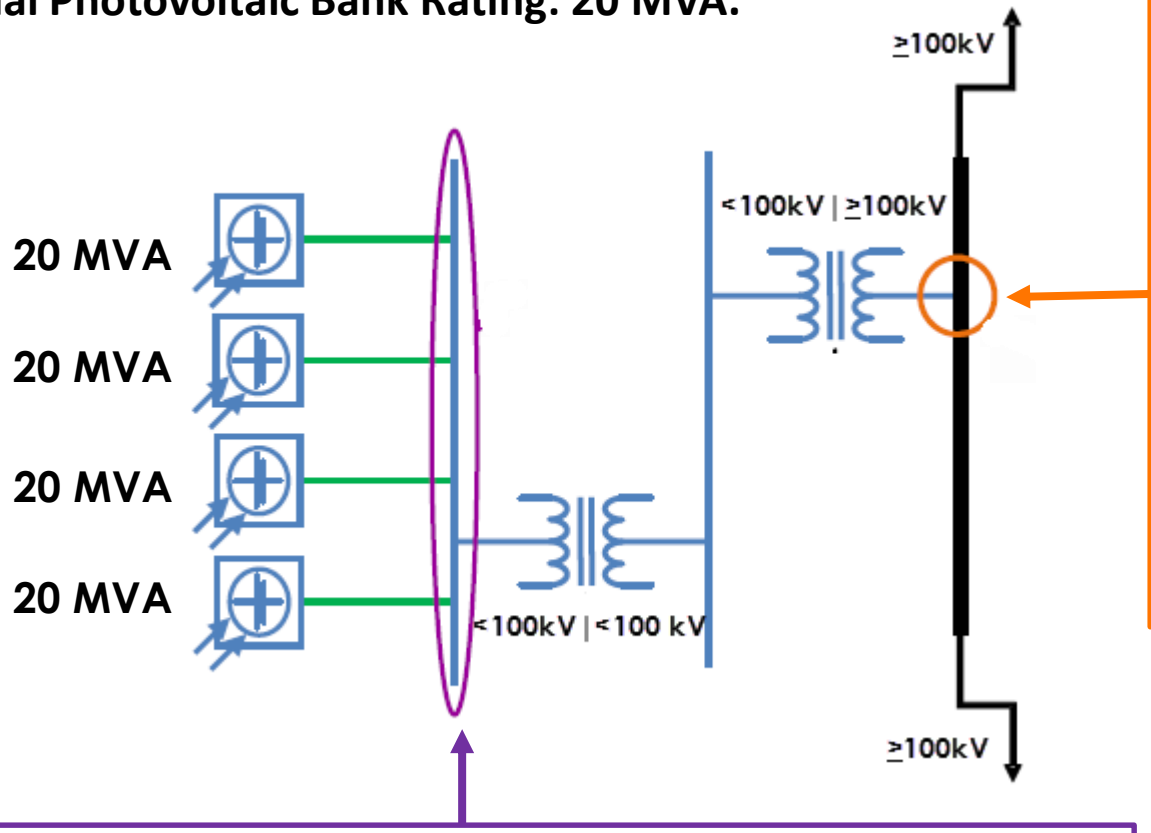


The common point of connection is where the individual transmission Element(s) of the collector system is connected to the 100 kV or higher Transmission system.

In this diagram, the system DOES NOT aggregate to a dispersed generation totaling more than 75 MVA Capacity or greater to the BES (actual MVA Rating = 60 MVA at the point of aggregation).

Dispersed Generation Resources: Inclusion 4

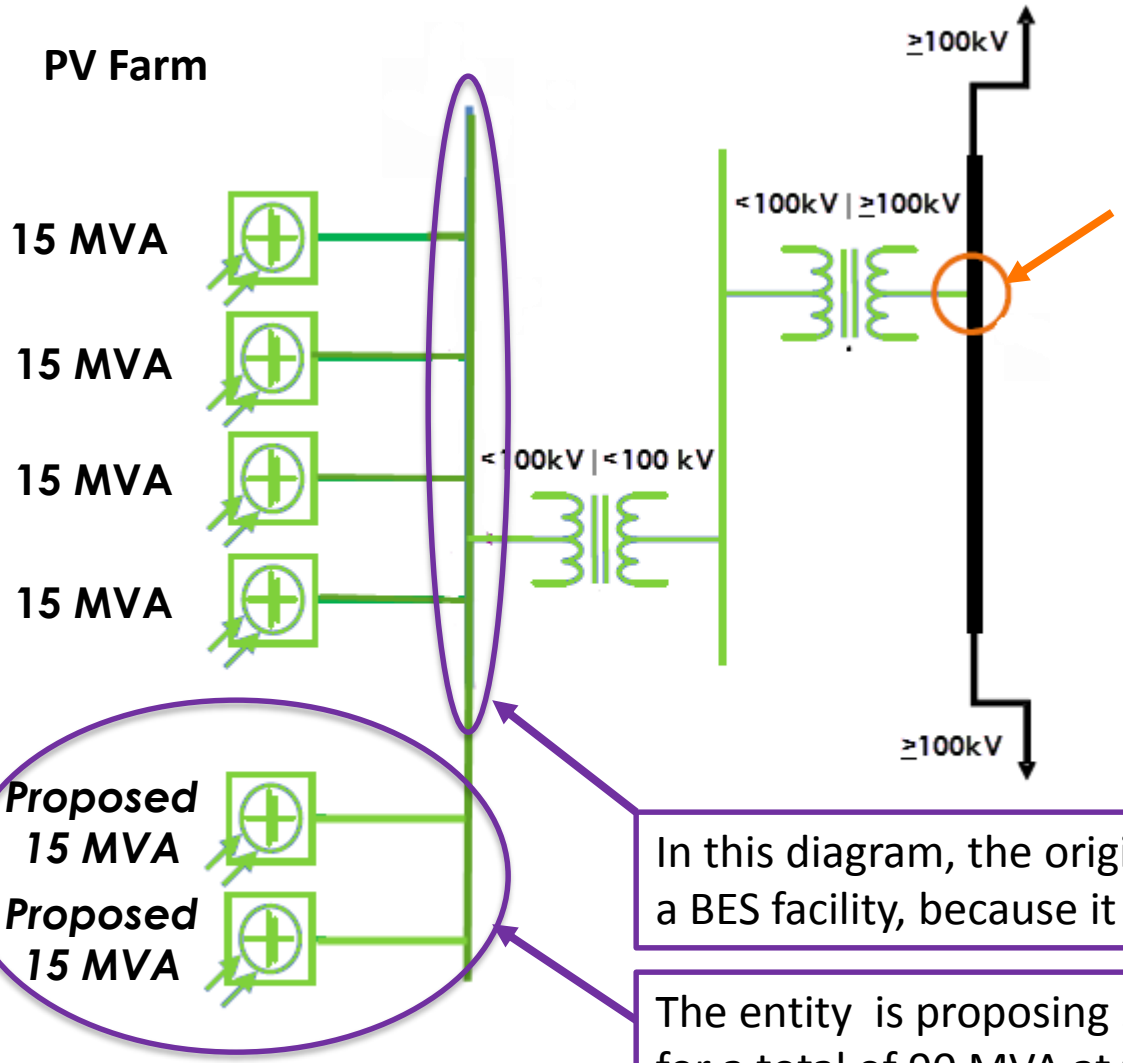
Individual Photovoltaic Bank Rating: 20 MVA.



The common point of connection is where the individual transmission Element(s) of the collector system is connected to the 100 kV or higher Transmission system.

The point of aggregation is where the individual generator name plate ratings of the dispersed generation total > 75 MVA Capacity or greater to the BES (actual MVA Rating = 80 MVA at the point of aggregation).

Dispersed Generation Resources: Inclusion 4

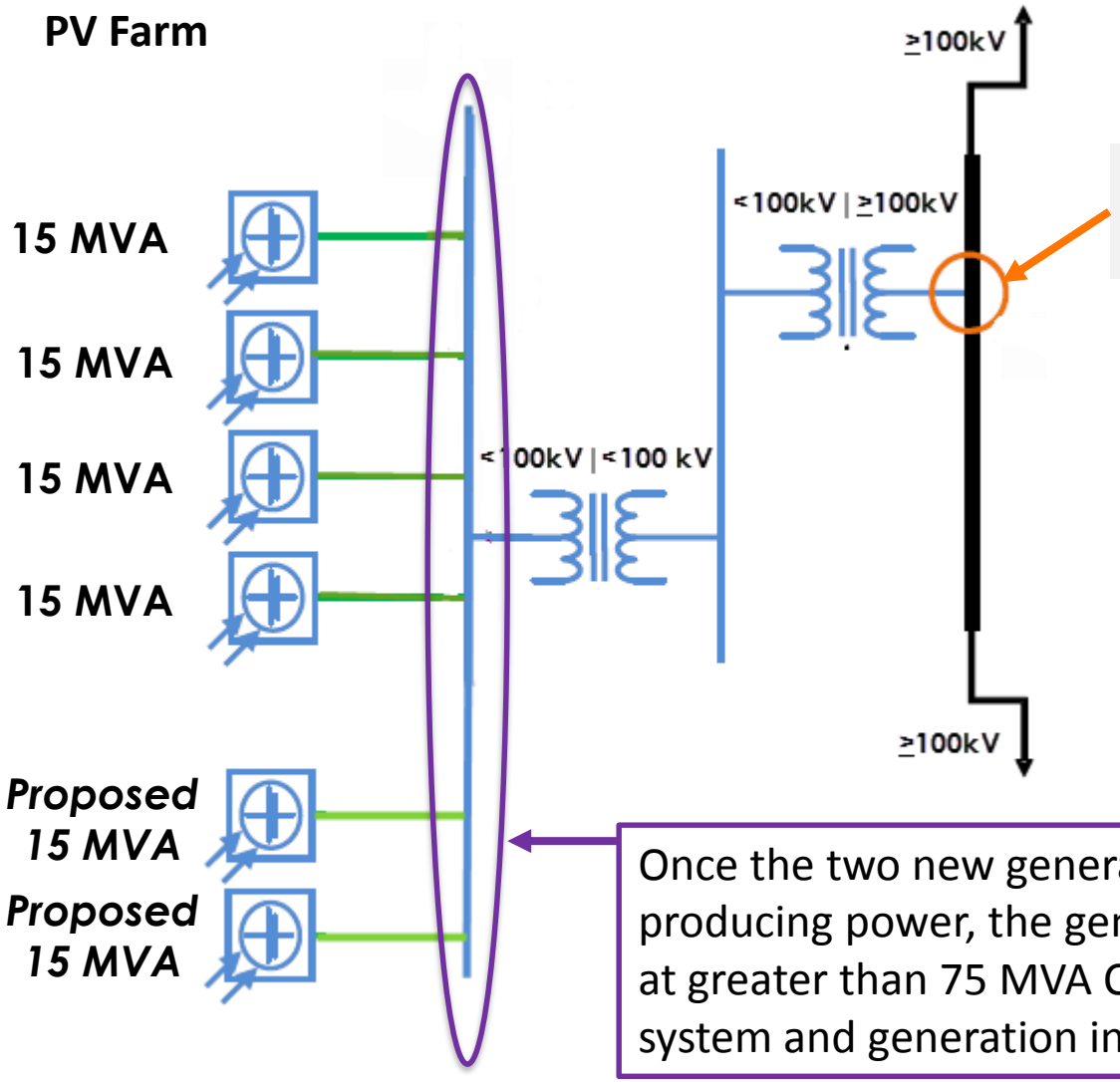


The common point of connection.

In this diagram, the original system does not qualify as a BES facility, because it totals 60 MVA

The entity is proposing 2 new 15 MVA set of PV Arrays for a total of 90 MVA at the aggregation point

Dispersed Generation Resources: Inclusion 4



The common point of connection.

Once the two new generators are interconnected and producing power, the generation tie line now aggregates at greater than 75 MVA Capacity, bringing much of this system and generation into the BES by application of I4.

Solar Inverters and MVAR Support

Dr. Joseph B. Baugh

WECC Senior Compliance Auditor, Cyber Security

Reporting by MW Rating

- Many entities with renewable generation resources are reporting individual or aggregated MW nameplate ratings, but may not be calculating the MVA rating.
- One recent entity submitted a question about a dispersed solar generation resource with a 74.8 MW aggregated nameplate rating aggregated at 92 kV and declared it as a non-BES Asset.
- My question back to the entity was "*Do the inverters associated with this dispersed generation resource provide any Reactive Power to the BES?*"

Dispersed Generation & Reactive Power

Why would a CIP Auditor care about Reactive Power?

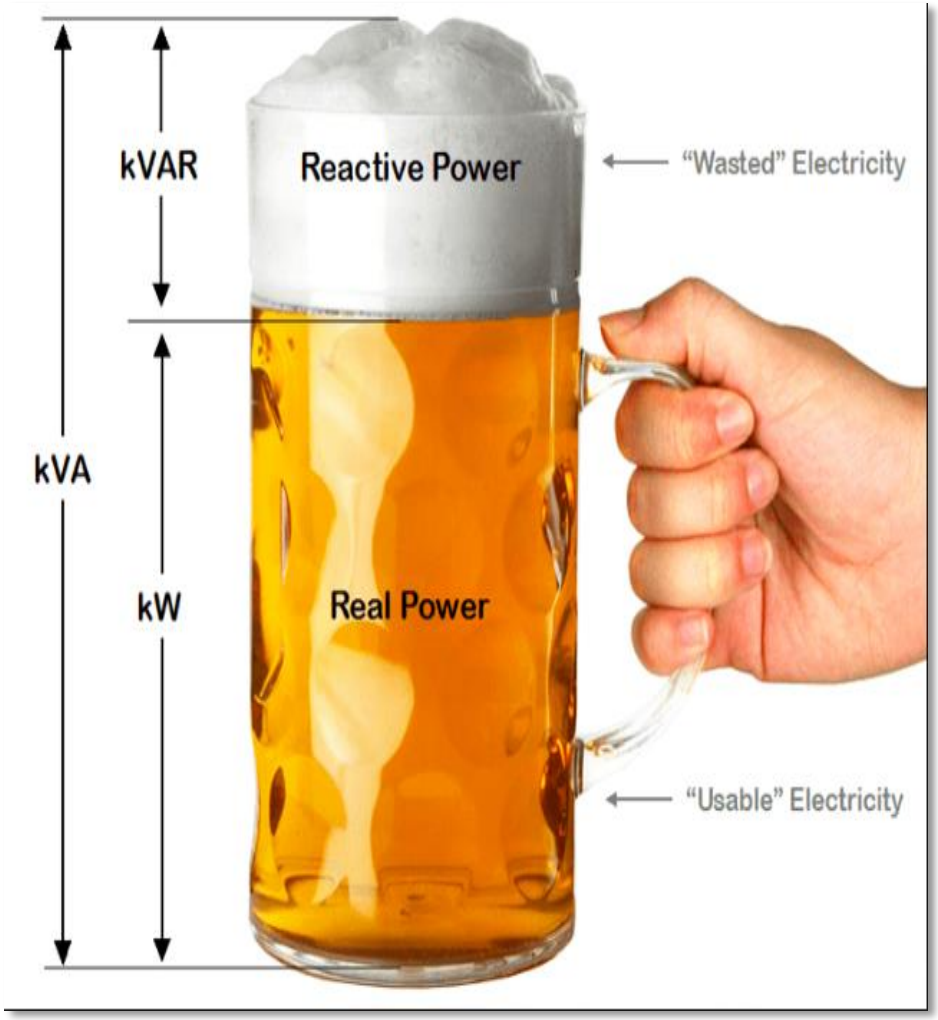


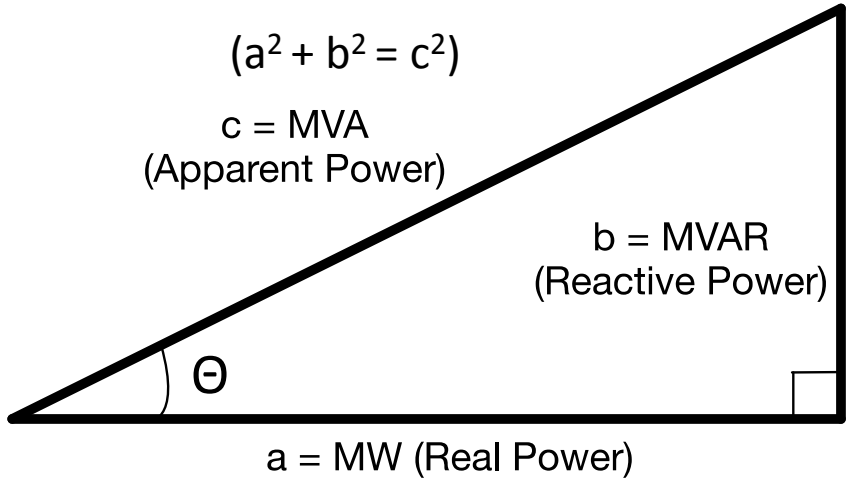
Image Source: Google Images

Dispersed Generation & Reactive Power

- As dispersed generation technology advances, "*some inverters … have an apparent power rating that exceeds the real power rating*" (Brucke, 2014, para. 1).
- If our dispersed generation example provides Reactive Power to the BES, it is possible this asset is actually over the 75 MVA threshold and should be classified as a BES Asset.
- Let's check our example using our old friend from 5th grade algebra, the Pythagorean Theorem ($a^2+b^2=c^2$), in its Power Equation format, to identify the MVAR value that would equal 75 MVA.

Applying the Power Equation

- $MW^2 + MVAR^2 = MVA^2$
- $MVAR^2 = MVA^2 - MW^2$
- $MVAR^2 = (75)^2 - (74.8)^2$
- $MVAR^2 = 5625 - 5595.04$
- $MVAR^2 = 29.96$
- MVAR = **5.47**



Solve for **MVAR:** Let MVA = 75, MW = 74.8

- Thus, 5.5 MVAR or more provided to the BES by this dispersed generation resource at the point of aggregation increases the MVA rating > 75 MVA.

What About Wind Farms?

- Wind farms using induction generators typically implement internal capacitor banks (IEEE, *Wind Farm Electrical Systems*) and obtain VARs from the cap banks and generator power electronics to run the induction generators at an optimal power factor
- Some wind farms may also pull MVARs from the transmission system to operate

Calculating Wind Farm MVA Ratings

- Whether your wind farm provides MVARs to the BES to support transmission line voltages (Chen, 2005) or pulls MVARs from the BES to operate at an optimal power factor, calculate those values into the power equation to determine the overall MVA rating at the point of aggregation through the point of interconnection.

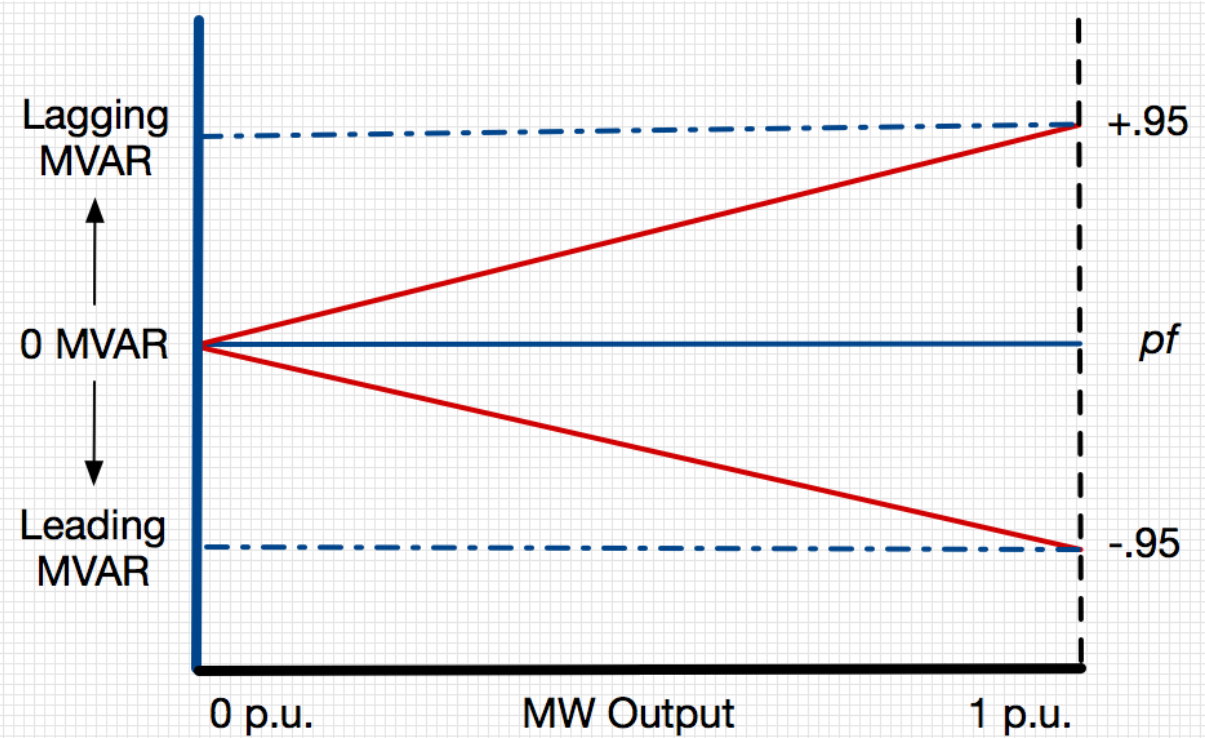
Calculating Wind Farm MVA Ratings

- Wind farm provides net MVARs to the BES

$$MVA^2 = MW^2 + MVAR^2$$

- Wind farm absorbs net MVARs from the BES

$$MVA^2 = MW^2 + (-MVAR)^2$$



FERC Order 827

- Effective on September 21, 2016, Order 827 (FERC, 2016 June 23) eliminated the Reactive Power exemption for new wind farms:

  "… newly interconnecting non-synchronous generators that have not yet executed a Facilities Study Agreement as of the effective date of this Final Rule will be required to provide dynamic reactive power within the range of 0.95 leading to 0.95 lagging at the high-side of the generator substation" (P. 1, pp. 40794).

FERC Order 827

- CAISO filed a clarification for Order 827 to include substantial wind farm equipment upgrades that included modern inverters
- FERC (2016 Oct 3) provided some relief for TOPs for upgrades to existing non-synchronous generation resources through the tariff process
- This decision may extend Order 827 provisions to older dispersed generation resources

What Does the MVA Rating Mean?

- The WECC CIP-002-5.1a team is always curious about BES Assets reported just below IRC threshold values.
- An aggregated MVA rating > 75 MVA indicates this dispersed generation resource is a BES Asset (Inclusion I4).
- Protect the dispersed generation resource through the point of interconnection to the BES, as applicable under Inclusion I4 and IRC 3.3.
- If your entity has one or more dispersed generation resources reported with MW ratings, expect a data request.

WECC CIP-002-5.1a R1 Data Request

- *Identify the types of inverters or other Reactive Power resources in use at each of <Entity>'s dispersed generation assets?*
- *Do any of the inverters provide Reactive Power support? If so,*
  - *What are the individual and aggregated MVAR nameplate ratings of such inverters?*
  - *Where are they located (provide a diagram)?*
- *Provide the MVAR ratings of any other associated Reactive Power resources.*
- *What is the total MVA rating of such dispersed generation Facilities at the point of aggregation and/or point of interconnection to the BES when MVARs are calculated into the power equation?*

Dispersed Generation MVA Summary

- Calculate MVA Ratings for your dispersed generation resources at the point of aggregation,
- Declare applicable dispersed generation resources as BES Assets, and
- Provide MVAR support, as applicable, at the high side of the generation substations.

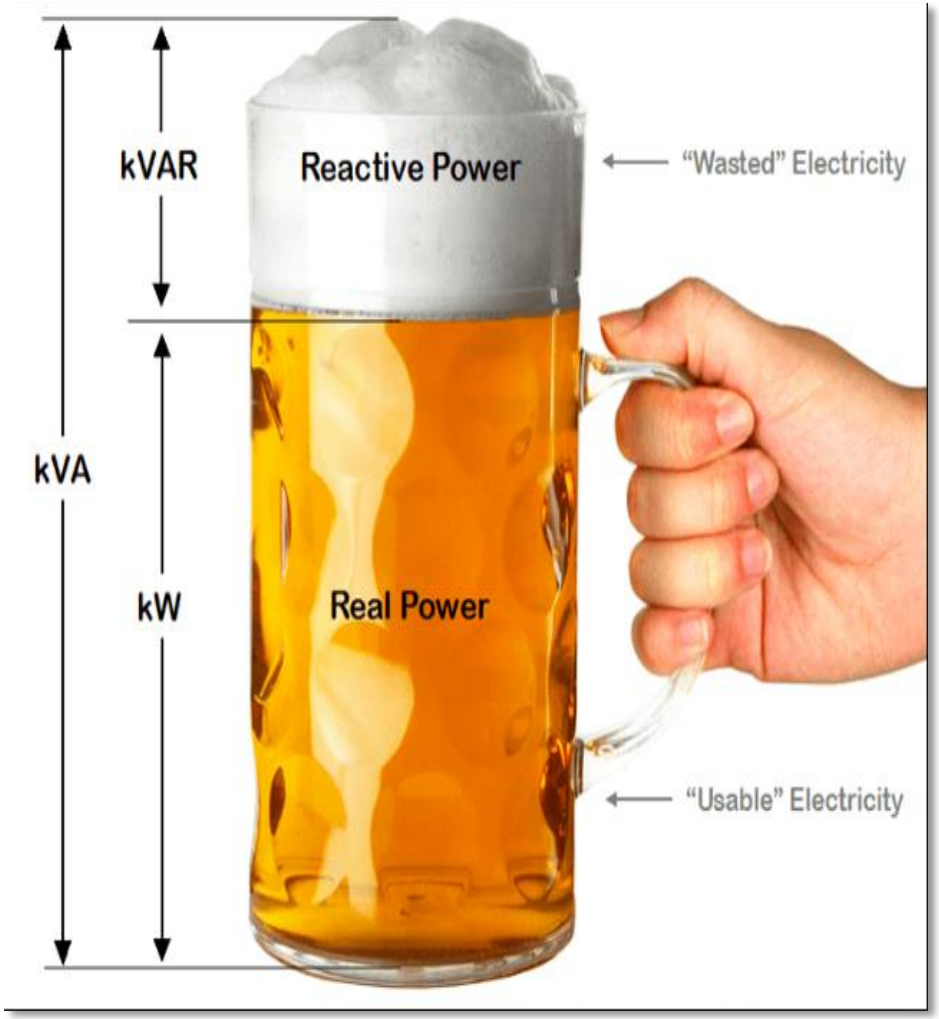


Image Source: Google Images

Questions & Contact Information

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