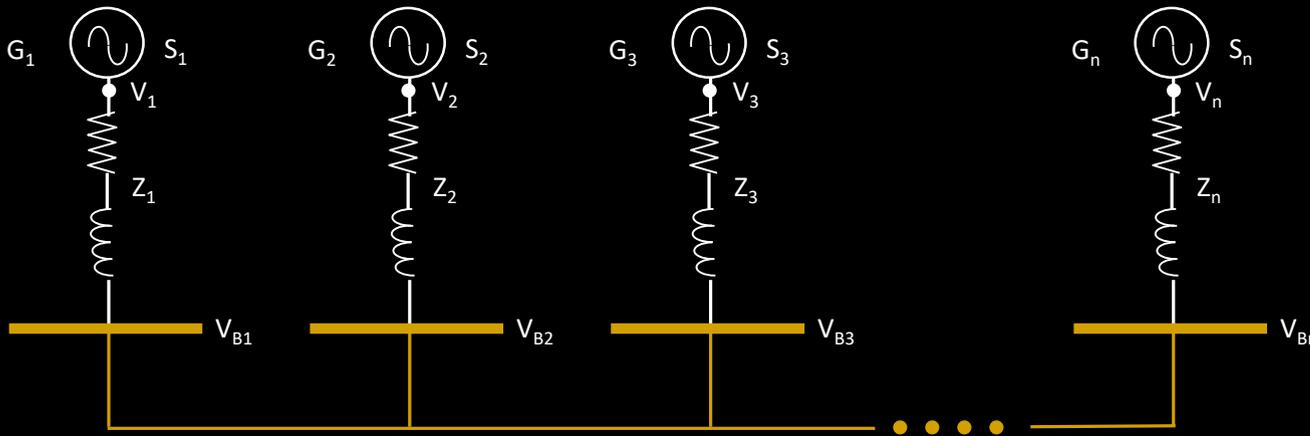# Aggregating Wind and Solar Generators

The best way to demonstrate this method is to consider multiple generators with physical values (not pu).

Let: $S_1 = S_2 = S_3 \ldots = S_n$ = Nameplate MVA of each generator

Let: $V_1 = V_2 = V_3 \ldots = V_n$ = Rated generator Voltage

Let: $Z_1 = Z_2 = Z_3 \ldots = Z_n$ = Internal Impedance of each generator

Get the per-unit values
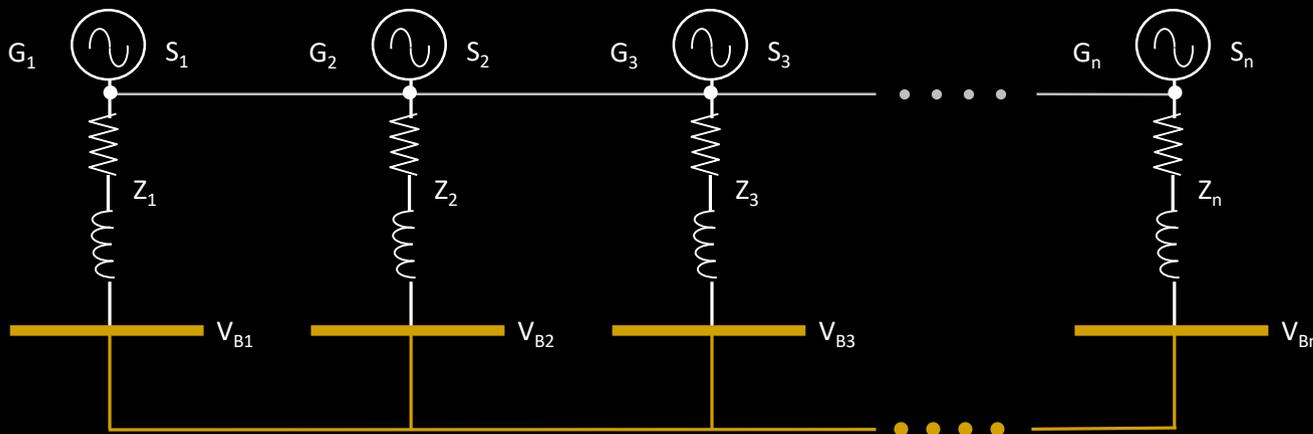to reference later:

$$S_{Base} = S_n$$
$$V_{Base} = V_n$$
$$Z_{Base} = \frac{V_n^2}{S_n}$$
$$Z_{pu} = \frac{Z_n}{\frac{V_n^2}{S_n}}$$
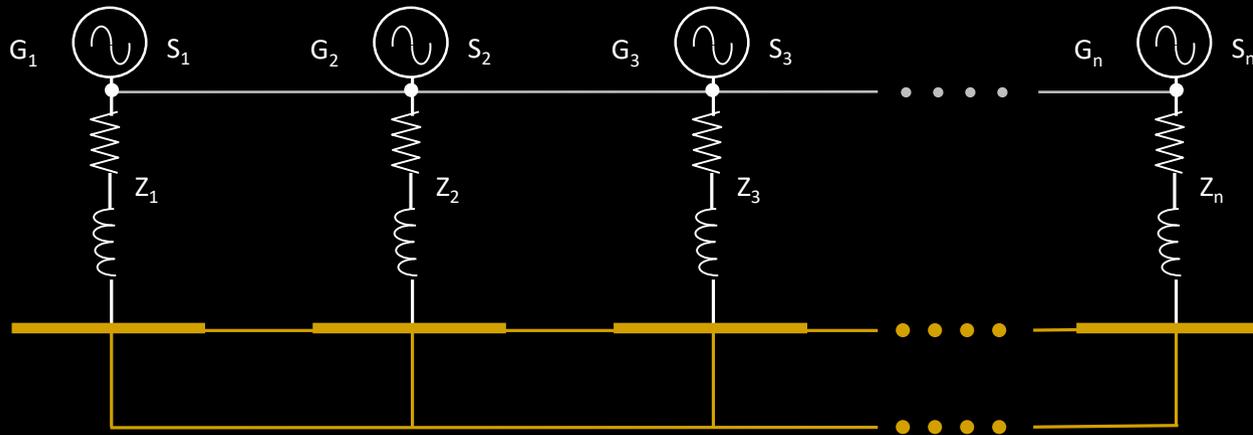$$Z_{pu} = \frac{Z_n S_n}{V_n^2}$$

Since the internal generator voltages are all equal…
They "could" be connected together (with no resulting current flow)

If all of the generators are outputting the same power…
The generator terminal voltages are all equal and could be connected together (with no resulting current flow)

We now have n generators in parallel which could be modeled as one with resulting S' = nS
We also have n equal impedances in parallel which could equalized to Z' = Z/n
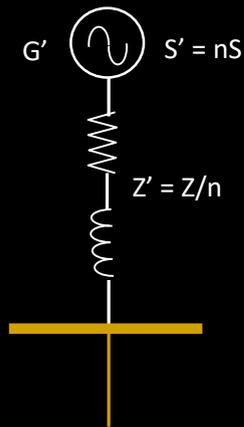
$$S'_{Base} = nS_n$$
$$V'_{Base} = V_n$$
$$Z_{Base} = \frac{V_n^2}{nS_n}$$
$$Z_{pu} = \frac{\dfrac{Z_n}{n}}{\dfrac{V_n^2}{nS_n}}$$
$$Z_{pu} = \frac{nZ_nS_n}{nV_n^2}$$
$$Z_{pu} = \frac{Z_nS_n}{V_n^2}$$

Now get the per-unit values
of the equivalent generator

<-- This is the same pu Impedance as a single generator

Summary

To aggregate n equivalent Wind Turbines or Solar Inverters to a single equivalent generator...
1) Use the per-unit Impedance of a single generator.
2) Use an MVA base that is n times the MVA base of a single generator.

Also works for the generator step-up transformers (GSUs)

G_{eq} $S_{eq} = nS$

$Z_{eq\,pu} = Z_{pu}$
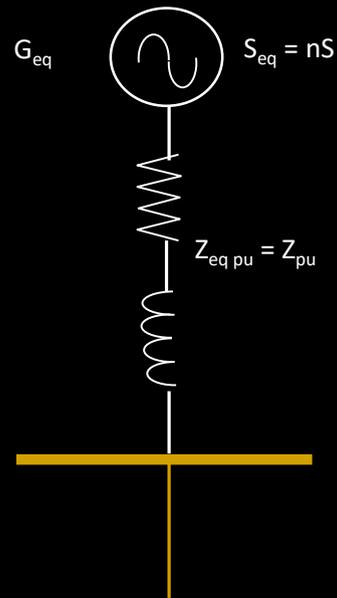
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Questions or Comments …
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