COMPARING SINGLE AND MULTIPLE TURBINE REPRESENTATIONS IN A WIND FARM SIMULATION

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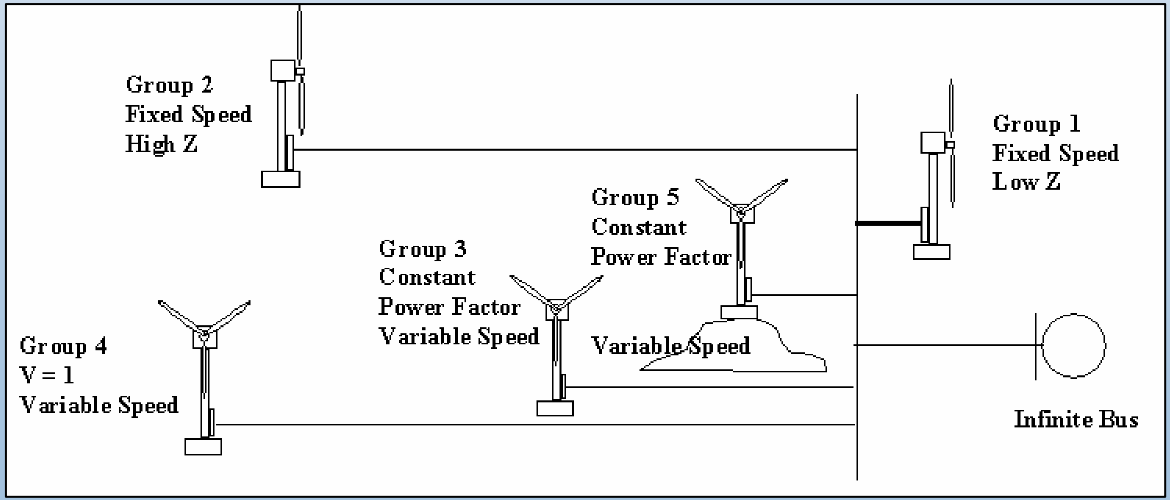
OBJECTIVES

- Investigate different characteristics of wind turbines operating under normal and transient events.
- Understand the signature of each unique characteristic of the turbines.
- Represent the wind farm as a collection of unique groups of wind turbines.

APPROACH

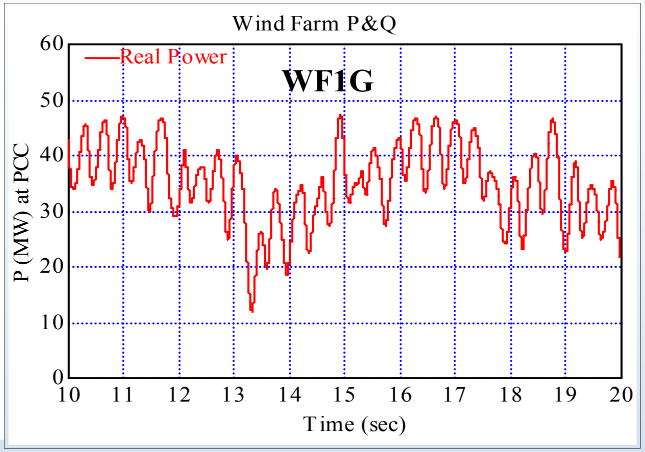
- Simulate a single turbine with different attributes (line impedance, wind speeds, etc.) represented.
- Compare the signature of each unique attribute of each turbine to show the differences in dynamic responses.
- Represent a multi-turbine system on the power system network using a group of turbines with unique attributes.

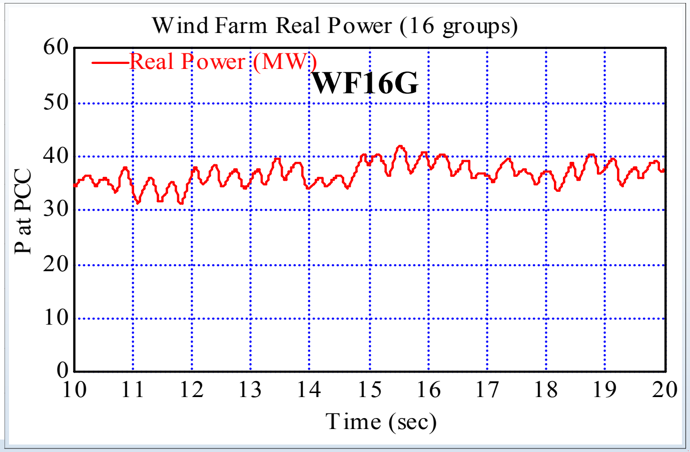


DYNAMIC – NORMAL OPERATION

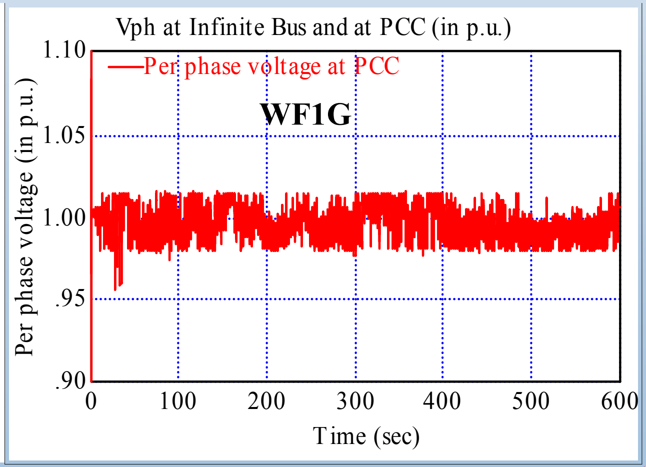
Tower Shadow Effect

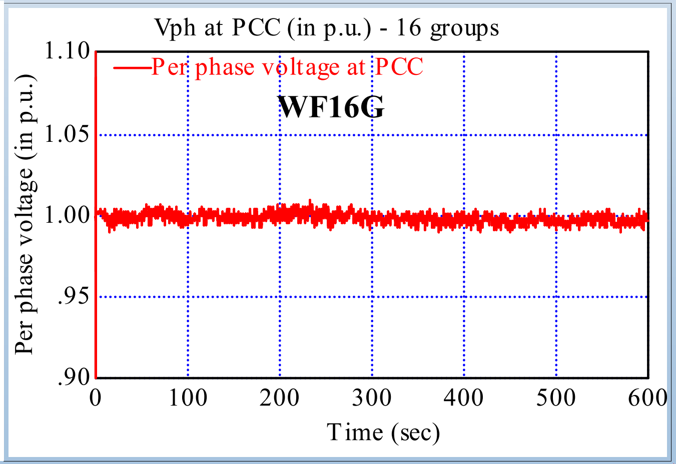
Power





Voltage



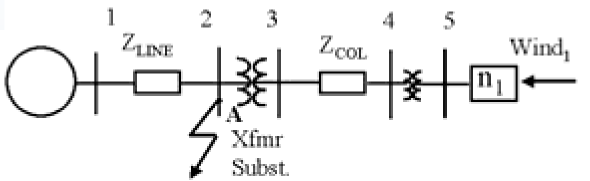


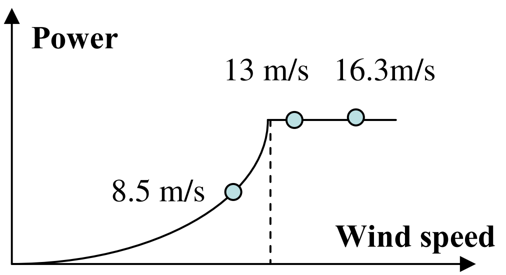
single turbine

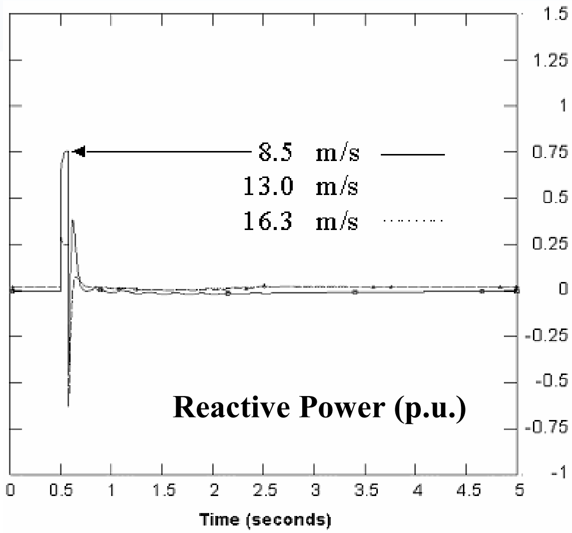
multiple turbines

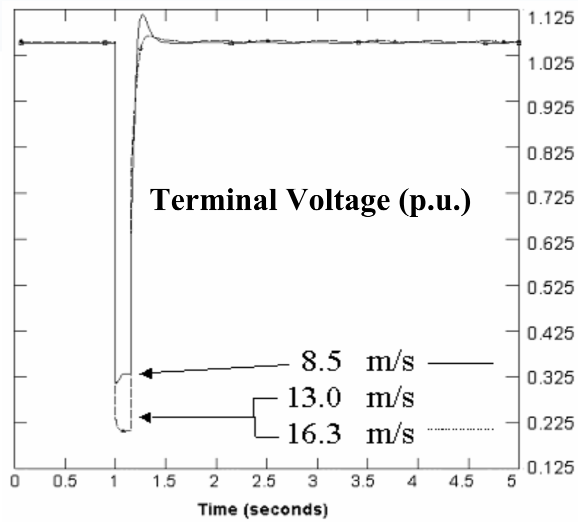
DYNAMIC – FAULT TRANSIENT

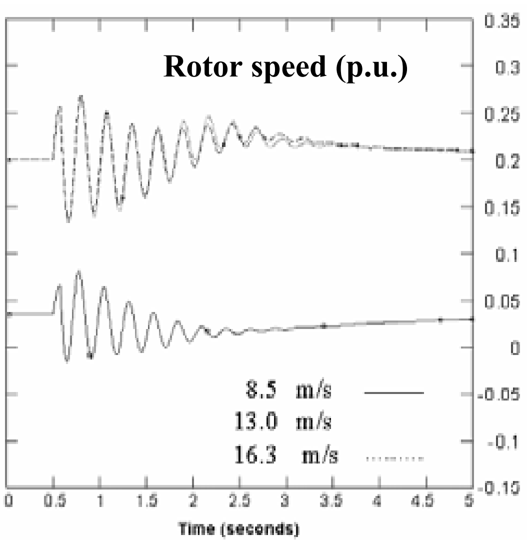
Various Wind Speeds

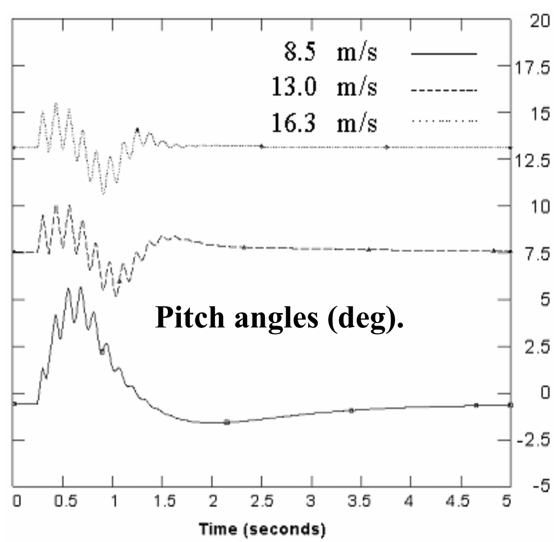


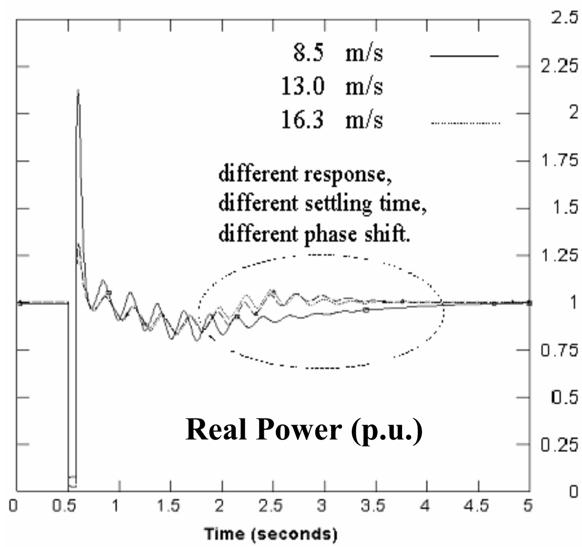






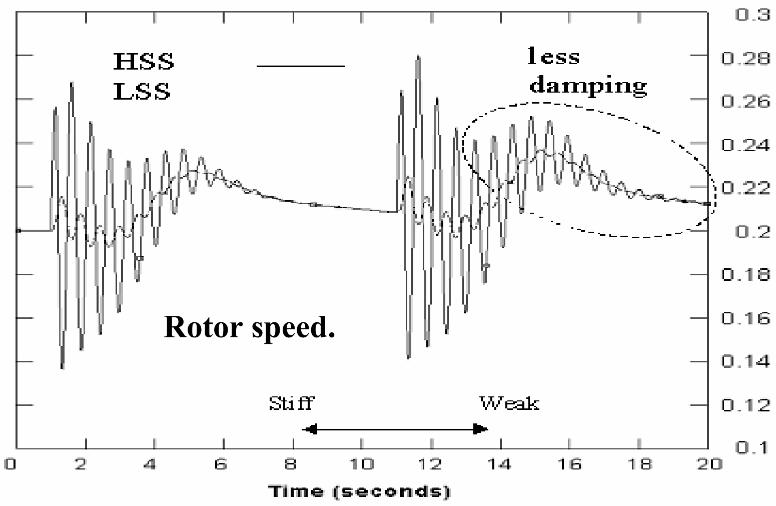


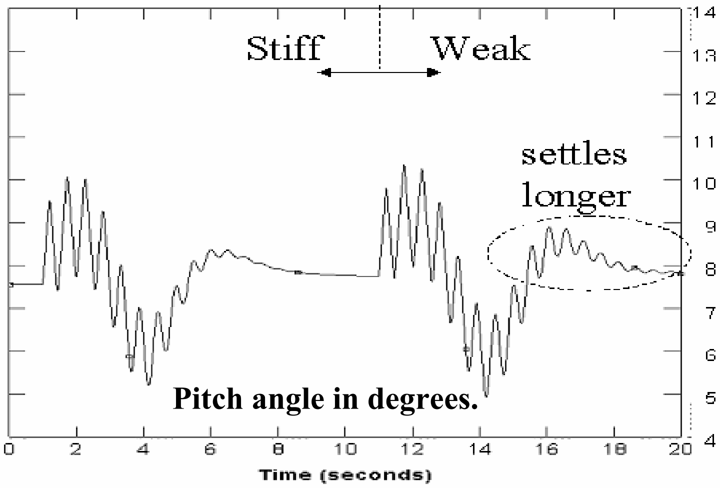


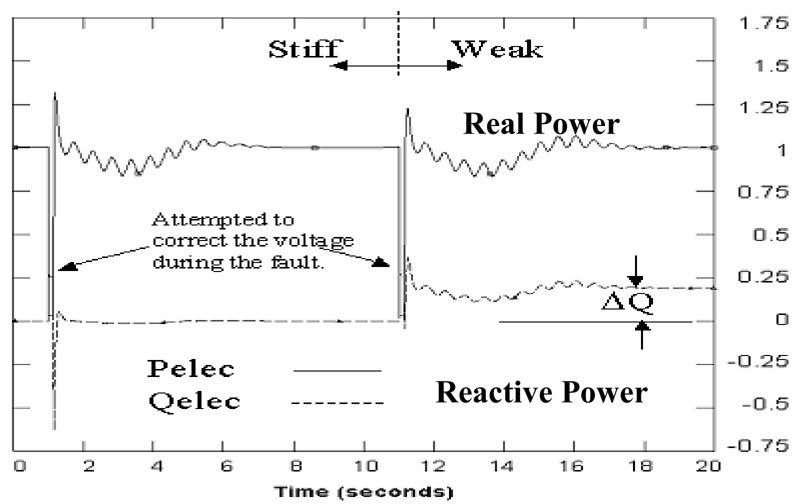


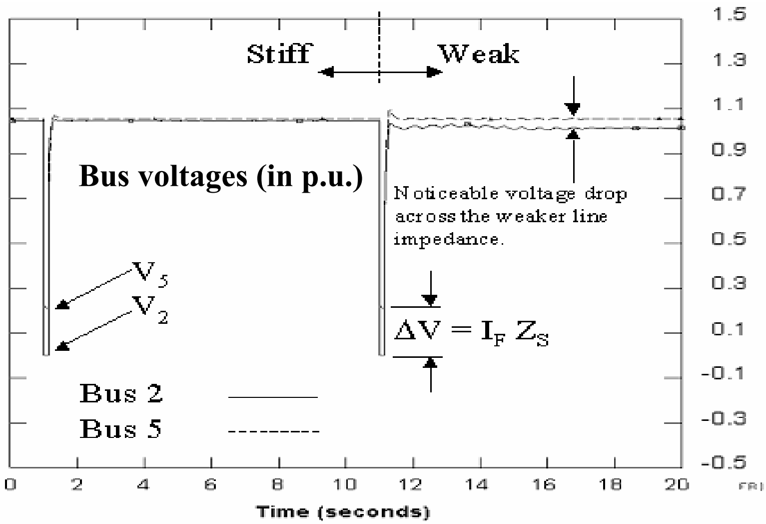
DYNAMIC – FAULT TRANSIENT

Weak Grid vs Stiff Grid

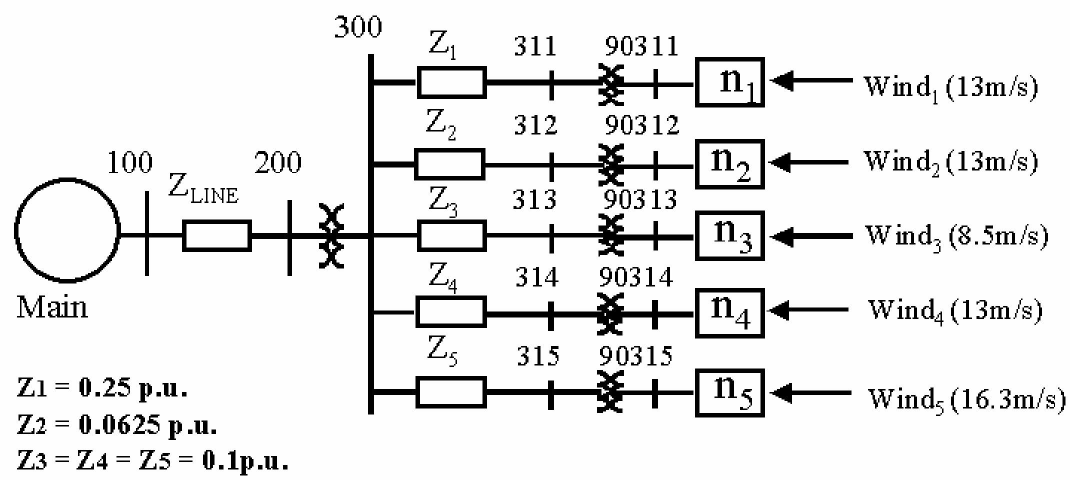




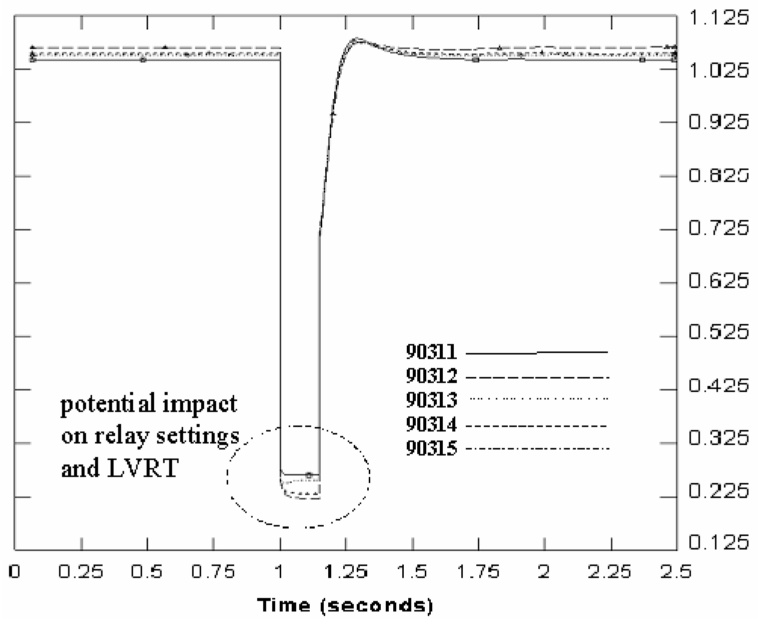




Multiple Turbine Representation



Single line diagram of a wind farm with 5 groups of turbines (20 MW/group).



Voltage at the terminals of wind turbines.

CONCLUSIONS

• Diversities characterizing wind turbines such as line impedances, wind speed differences, turbine types, relay protection settings, control strategies, and reactive power compensation etc. may affect the LVRT of each wind turbine.

• Wind turbines are electrically connected but mechanically independent with respect to each other. Mechanical-electrical interaction is less likely to be found in a large wind farm than in a single large conventional synchronous generator.

• In the event of a fault:

- single turbine representation leads to the worst-case scenario (a single fault event may disconnect the entire wind farm).
- multiple groups of wind turbines better represent a wind farm and lead to a best-case scenario (a single fault event may disconnect only a few turbines within the wind farm).