INVESTIGATION INTO THE IMPACT OF WIND FARMS INTEGRATION ON THE POWER QUALITY AND THE STABILITY OF ASSOCIATED UTILITIES' NETWORK

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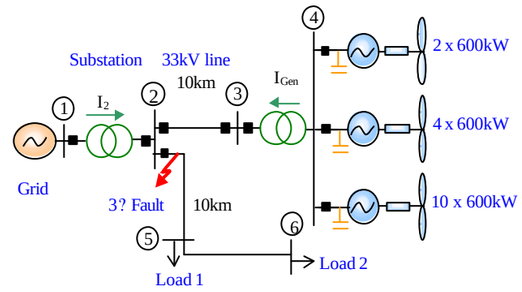
AIM

The main objectives of this project involve investigations into:-

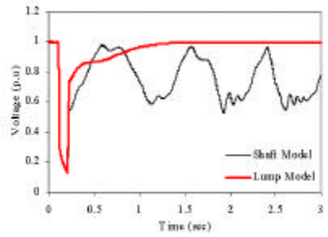
1) The effect of windmill modelling on the determination of wind generator's stability limits
2) Factors influencing the stability limits of wind generators supported by derive mathematical expression
3) The utilis ation of 'Direct method' in transient stability assessment related to wind power generator
4) The effectiveness of reactive power injection technique in the improvement of wind generator's stability



The investigated power system network.

1. EFFECT OF WINDMILL MODELLING ON THE STABILITY OF WIND GENERATOR

Practical systems are, in most cases, considered as discrete systems in order to obtain solution in a simpler manner. This assumption has been adopted in conventional windmill modelling. Results obtained in this project have shown that oversimplified windmill model can impose significant error in the value of wind power generator's CCT.



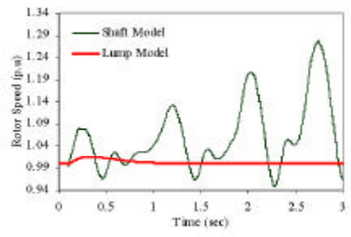


Fig. 1 and Fig. 2 show the variations of wind farm terminal voltages and generator speeds when subjected to the same fault duration. Detail windmill model (Shaft Model) shows sign of voltage collapse and generator instability, while oversimplified windmill model (Lump Model) shows that the generator regain its nominal operating condition.

2. FACTORS INFLUENCING THE STABILITY OF WIND GENERATOR

Grid-connected WPBEG consists of both mechanical system and electrical system which is then connected to the distribution system to form a part of the existing utility network. The works Carried in this project have shown that as an interconnected power system, WPBEG's stability is likely to be affected by various factors contribute by the constituent distribution system and also by windmill mechanical drive train parameters.

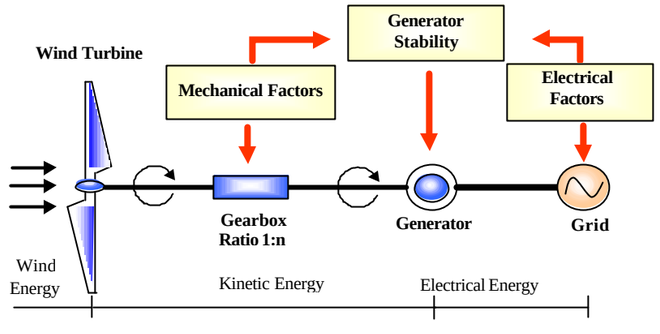
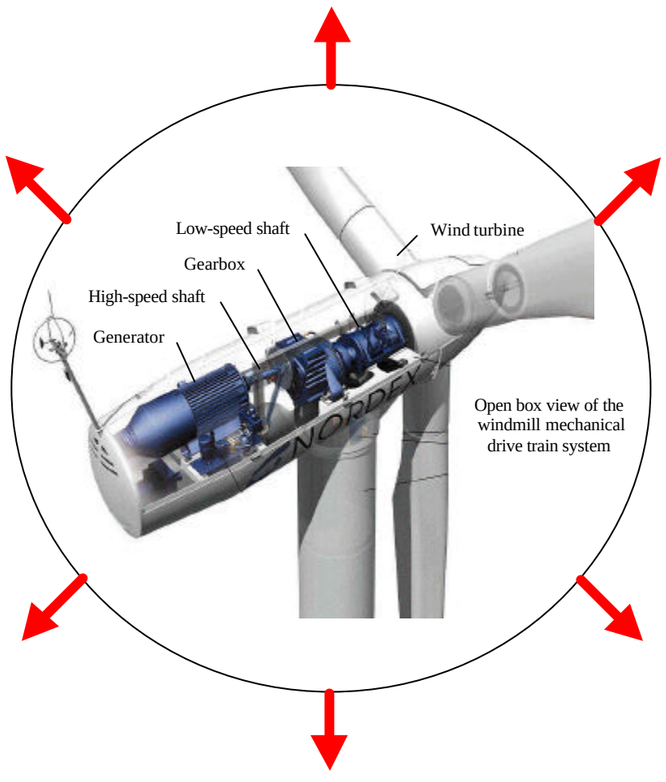


Fig. 3 As an interconnected power system, grid-connected WPBEG can be affected by mechanical system and distribution power system.



Open box view of the windmill mechanical drive train system

3. 'DIRECT METHOD' IN TRANSIENT STABILITY ASSESSMENT OF INDUCTION TYPE WIND GENERATOR

Transient stability assessment is one of the important aspects of modern power system planning, design and operation. It provides a means for the power system engineer to perceive and to comprehend the transient phenomena in power systems. It also provides an assessment of the ability of the system to withstand such disturbances. The work involved in this project proposed a **'direct method'** that can be used to determine the criterion for transient stability limit of a grid-connected induction generator that time-domain methods are unable to do.

4. EFFECT OF REACTIVE POWER INJECTION ON THE STABILITY OF WIND GENERATOR

The works presented in this project have shown that 'Reactive Power Injection' technique can be used to assist voltage recovery of wind farm during post-fault period. However, the magnitude of reactive power required to assist wind farm voltage recovery depends on many factors. These factors include:-

? The location of the reactive power injection devices
? The fault location
? The fault duration
? The magnitude of power injected by wind farm at the instant of fault.

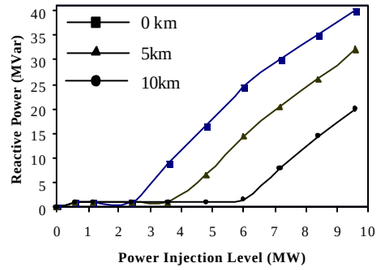


Fig. 4 The effect of fault location on the required injected var. Wind farm CCT is 103ms.

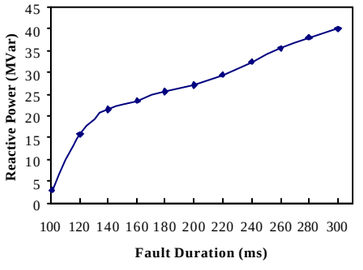


Fig. 5 The effect of fault duration on the required injected var for network fault located at bus 2. Wind farm CCT is 103ms.

5. CONCLUSIONS

This work has shown the following:

- The critical clearing time (CCT) of a WPBEG appears to be much longer for oversimplified windmill model.
- The CCT of the WPBEG can be influenced by various electrical and mechanical factors.
- Reactive Power Injection Techniques can be used to help WPBEG to achieve voltage recovery at post-fault.
- 'Direct method' can be used to assess transient stability limit of WPBEGs.