EFFECTS OF WIND GENERATION ON TRANSIENT STABILITY IN THE NEM

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I. Aims

- To determine the effects of wind generation on the transient stability of the National Electricity Market (NEM).

II. Introduction and Background

Introduction

- Increases in demands for renewable electricity will see an increase in installed wind generation by 14,000MW [1].

Transient Stability Theory

•Transient stability is the ability of the synchronous in a power system to maintain synchronous in the event of a large disturbance to the network. Loss of synchronism will indicate that the system is transient unstable [2-4].

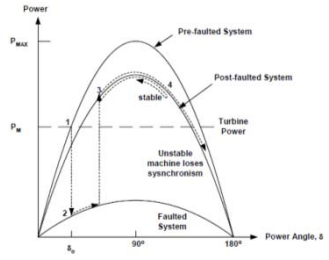

Figure 1: Power – Angle Relationship of Synchronous Generator [2]

- The transfer limit is the amount of power that can be transferred across a transmission line.
- For stability the limit is the amount of power that can be transferred before a fault will cause generators to lose synchronism.
- The more power that can be transferred, the more stable the system is.
- This project determines whether the transfer limit across the Queensland – NSW Interconnector (QNI) is affected by wind generation.

Figure 2: National Electricity Market [5]

Wind Turbine Types

•Type I and II are now considered obsolete
• Type III and Type IV turbines can control active and reactive power.
•Type IV offers superior performance during a fault [6,7].

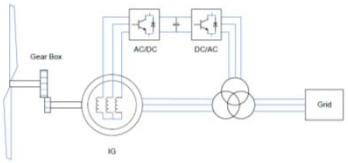

Figure 3: Type III Wind Turbine Configuration [6]

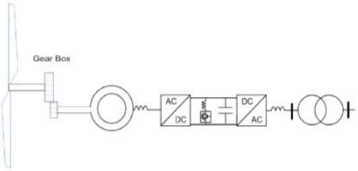

Figure 4: Type IV Wind Turbine Configuration [6]

III. Method and Results

Method

- Affect on stability is determined by the level of generation that can be installed before a material change in the transfer limit occurs.
- A material change is has been defined by AEMO as a change of 50MW or 3% of the maximum power transfer [8]
- 4 cases are used with wind farms modeled at different locations in each case.
- Wind farms are modeled at Marulan, Wellington, Tamworth and across these three locations.

Figure 5: Capital Wind Farm near Bungendore, NSW [9]

Results

Results	Level where transfer limit was materially changed (MW)	
Scenario	QLD – NSW	NSW – QLD
Type III – Marulan	600	200
Type III – Wellington	600	200
Type III – Tamworth	>600	>600
Type III – Split	300	200
Type IV – Marulan	>600	500
Type IV – Wellington	>600	400
Type IV – Tamworth	500	400
Type IV – Split	>300	300

- For wind farms greater than 200MW at one location will cause a material change in the transfer limit for Type III wind turbines

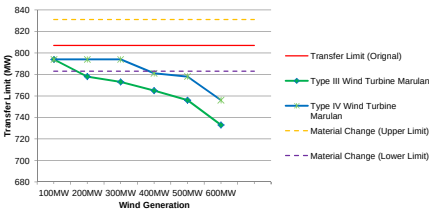

Figure 6: Change in Transfer Limit at Marulan

- For wind farms greater than 400MW at one location will cause a material change in the transfer limit for Type IV wind turbines

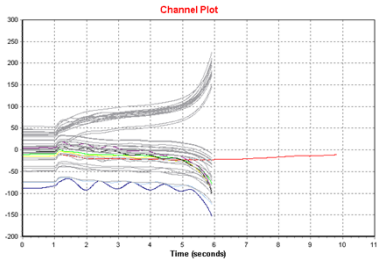

Figure 7: Rotor Angles of Generators in Unstable System

IV. Additional Considerations

- Additional modeling is required to determine effects of decreased synchronous generation and increased loads to obtain a thorough understanding of how wind generation will affect transient stability of the system.

V. References

[1] Australian Energy Market Operator, "Electricity Statement Of Opportunities," 2012.

[2] P. Kunder, "Power System Stability and Control," Electric Power Research Institute: McGraw-Hill, 1994, pp. 827-958

[3] J. Machowski, J. W. Bialek, and J. R. Bumby, "Power System Dynamics and Stability," John Wiley & Sons, 1997.

[4] J. D. Glover, M. S. Sarma, and T. J. Overbye, *Power System Analysis and Design (Fifth Edition)*: Cengage Learning, 2012.

[5] Intelligent Energy Systems, "Assessment of Inter-Regional Congestion," 2011.

[6] Australian Energy Market Operator, "Wind Turbine Plant Capabilities Report," 2013.

[7] C. J. Mozina, "Wind-Power Generation," *Industry Applications Magazine, IEEE,* vol. 17, pp. 37-43, 2011.

[8] Australian Energy Market Operator, "Final Determination: Criteria for Assessing Material Inter-Network Impact of Transmission Augmentations," 2004.

[9] I. Waldie, "The Capital Wind Farm in Bungendore, NSW, December 2010," *Getty Images*, 2010.