Synthetic inertia from wind power plant: Investigation of practical issues based on laboratory studies

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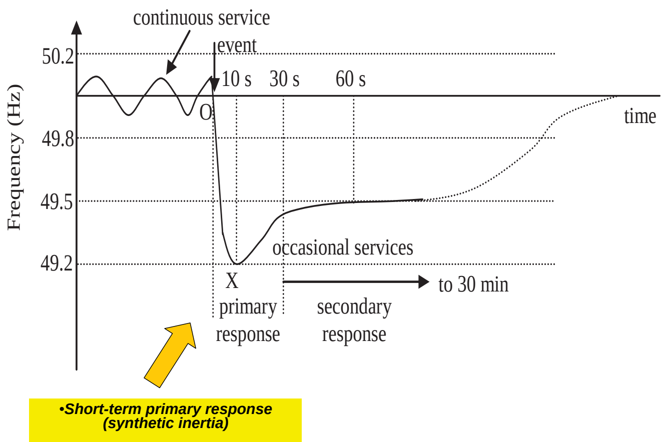
Abstract

- In addition to the impacts on network operation, provision of short-term frequency support has implications on the turbines themselves. In essence, the control implementation to deliver the 'synthetic inertia' response required for the power system will introduce additional and possibly significant torque demands on the turbine.
- It is therefore necessary to conduct experimental tests that shed light and provide understanding of the impact that different control strategies have on sensitive components of the turbines such as the power electronics.
- The impact of the sudden release of kinetic energy in the form of active power from the generators has be assessed for the partial-power back-to-back converter of the DFIG and the full-scale back-to-back converter of the FRC.

Fig. 1. Frequency event



Frequency event fundamentals

- **The kinetic energy stored in the rotating masses of generators and loads, i.e. the power system inertia, determines the sensitivity of the change in system frequnecy. The higher the power system inertia, the lower the rate-of-change of frequency in case of an imbalance between generation and demand.**
- **In the event of a suddent failure in generation or connection of a large load the system frequency starts dropping (region OX in Figure 1) at a rate mainly determined by the total angular momentum of the system (addition of the angular momentum of all generators and spinning loads connected to the system).**
- **The extracted power from variable-speed wind turbines is controlled by power electronic converters and there is no inherent relation between frequency of the system and the rotational speed of the tubrine. Hence, modern wind turbines cannot naturally provide an instantaneous power boost in response to a system frequency fall and thus contribute to power system inertia.**

The block diagram of the control loop implemented in the laboratory to enable the FRC wind turbine to provide synthetic inertia is illustrated in figure 2. It can be observed that the control concept is simple, and works on modifying the torque set point.

The lab implementation is shown in Fig. 3 for the FRC wind turbine.

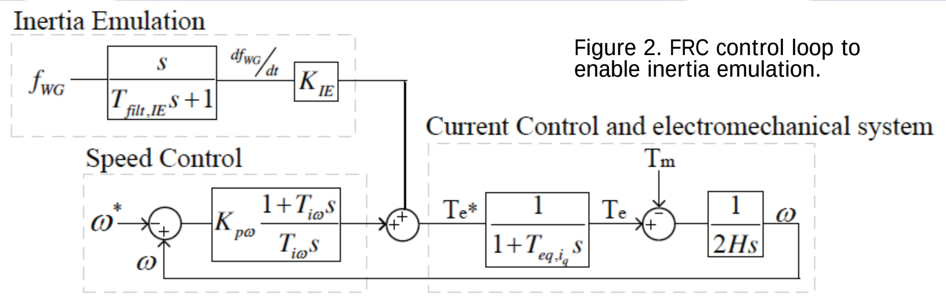


Figure 2. FRC control loop to enable inertia emulation.

Fig. 3. FRC implementation in the lab

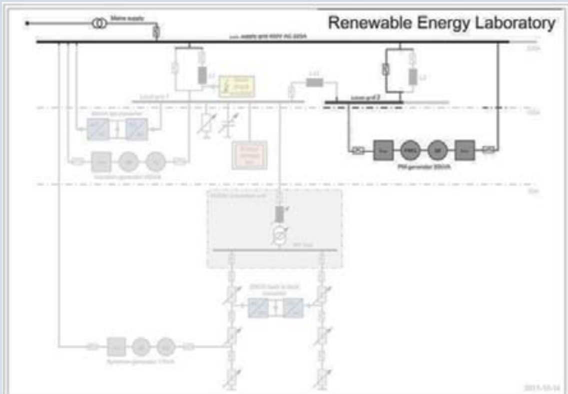


Fig. 5. Working in the lab.

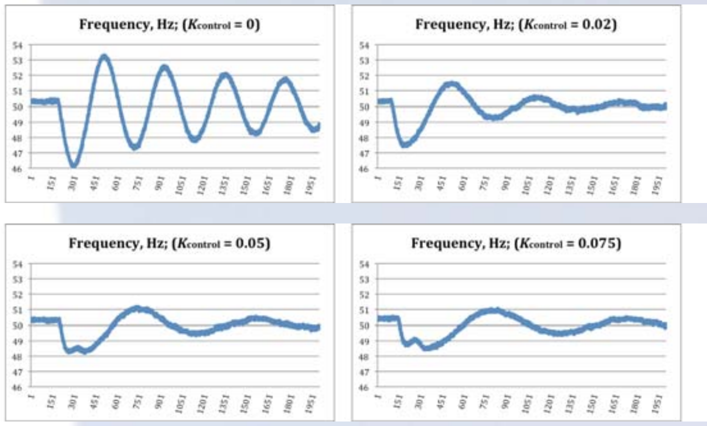


Fig.4 Results for Near-rated wind speed: In this scenario, the speed of the wind generator was set 1000 rpm.

Conclusions

- No drastic variations were observed in the currents or dc voltage in the power electronics. However, it is not possible to generalise at this stage that it will be the case in every case as further tests may be necessary.
- Of importance when considering the provision of synthetic inertia may no be in the sense of magnitudes but duration of the service provision.

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