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Inertia Estimation Methodologies vs Measurement Methodology: Impact on System Stability

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The global energy sector has been undergoing a significant shift in recent years from being predominantly powered by synchronous, centralised fossil fuel plant to an energy mix characterised by a greater proportion of non-synchronous, decentralised generation. The increasing uptake of renewables, particularly wind and solar, necessitates a fundamental change in the way Transmission System Operators (TSOs) operate their networks and manage system stability.

Until recently, there was no known way to measure power grid inertia, so it has always been estimated. When the grid was predominantly supplied by large, fossil fuel power stations all connected at the transmission level and demand patterns were predictable, grid operators could see which power stations were running and easily estimate system inertia. However, as an increasing amount of power is being produced by renewable sources embedded at the distribution level, the generation hidden from view from the grid operator is growing, making their inertia estimates increasingly inaccurate. The GB grid operator (National Grid ESO) for example, currently only has limited visibility of the source of over 15 GW of embedded generation connected to the distribution network, which is a significant system weakness they have recognised.

Currently, in a bid to mitigate the risks associated with lack of accurate inertia visibility, TSOs have little choice but to curtail renewable generation in favour of fossil fuel generation, which limits the speed of renewable uptake. Germany, a world leader in deploying wind and solar capacity, is showing growing levels of curtailment. A consistent pattern has emerged relating curtailment to renewable penetration: as the wind and solar share of electricity grew from 10% to 26%, the share of curtailed wind and solar energy grew from about 0.2% to around 1.8%.

There are currently three ways of estimating inertia: summing inertia constants from transmission-connected generation, calculating Rate of Change of Frequency (RoCoF) during large frequency excursions and calculating inertia based on power events throughout the day. These estimations models provide static and historic views of system stability only. However none offer a controllable, accurate and continuous view of inertia from transmission, distribution and demand – a view that TSOs require to safely integrate greater amounts of renewable generation and maintain system stability. For this reason, Reactive Technologies partnered with National Grid ESO to conduct an innovation project in which a novel technology was proven to accurately measure system inertia in real time. We propose discussing existing inertia estimation methodologies and compare them to a patented measurement methodology pioneered by Reactive Technologies, and proven with National Grid ESO, and discuss the operational implications of the technological breakthrough for TSOs experiencing high levels of renewable penetration and greater system volatility.