



June 30, 2021  
Webinar Questions and Answers

*“System Inertia Monitoring”*  
with Ian Dytham and Anna Blackwell

**Question:** How is the planning of new transmission system done in UK? Which entity is responsible for planning of new transmission lines?

**Answer:** National Grid ESO carries out an annual [Network Option Analysis \(NOA\)](#) identifying transmission network reinforcements to meet future network requirements. The Transmission Owners are then responsible for deciding how these reinforcements are delivered.

**Question:** What is the size of the largest Gen and what is total load?

**Answer:** The GB system is secured for up to 1320MW largest loss depending on actual generation. The largest single interconnector (import and export) on the GB network is 1000MW.

**Question:** Is UK transmission system connected to Europe or it is studied as an island in dynamic simulations?

**Answer:** The GB network is connected to Ireland and Continental Europe by 6GW of DC [interconnectors](#) with an additional 1400MW currently commissioning and additional links being built.

**Question:** Why is the minimum inertia lower for earlier years (2010-2013) than for 2018-2019?

**Answer:** The absolute minimum was lower for a short period of time due to outages to significant planned maintenance on major generator and interconnectors. Prior to 2011 we only had 2 interconnectors, to France and a much smaller link to Ireland.

**Question:** Is the inertia level data between 2008-2019 from modelling? Any approach taken to check the actual inertia in these years is indeed within the shown range (even at a rough level)?

**Answer:** The inertia data is calculated using our estimation calculation based on the level of actual synchronised plant and demand.

**Question:** Is there a full form of ODFM?

**Answer:** [Optional Downward Flexibility Management \(ODFM\)](#) is a service which allows National Grid ESO to access downward flexibility that is not currently accessible in real time and expand our ability to control output from providers we cannot currently access through the Balancing Mechanism.

**Question:** What is the meaning of delivery fully within 1 second?

**Answer:** The provider must be able to go from zero to their full contracted response provision within 1 second of being called.

**Question:** 12GW of additional inertia for Phase 1. What is the technology used?

**Answer:** This is a combination of different plant. It was a requirement that they must provide 0MW of active power. Providers consist of sync compensators and new build fly wheels. Details of this pathfinder event can be found [here](#)

**Question:** What is BMU and how do you estimate it?

**Answer:** BMU = Balancing Mechanism Unit. These are the participants who are available for NGENSO to balance generation & demand in real-time and provided metered data to NGENSO. Generator forecasts are provided by the generator or their energy aggregator.

**Question:** how PMUs can be used for estimation of system inertia?

**Answer:** We require a PMU to monitor each of the boundary circuits of any inertia region plus a within region PMU location.

**Question:** With PMU, what frames per second reporting is selected to monitor the system inertia?

**Answer:** We receive PMU data sampled at 50 frames per second however to measure inertia using the GE system we are currently down sampling to 10 frames per second. The Reactive Technologies XMUs are measuring at 50 frames per second.

**Question:** Are PMUs helpful for asynchronous generation as well?

**Answer:** The solutions we are installing will measure total system inertia, ie synchronous generation and residual inertia from asynchronous generation and passive load.

**Question:** How is inertia of renewable resources evaluated or estimated?

**Answer:** We are measuring total system inertia and are not evaluating at an individual unit level.

**Question:** About loss of mains protection modification, did you modify voltage protection as well? Did manufacturer and/or Producer needed to study that the new settings were not having detrimental effects on their installations?

**Answer:** Voltage protection was not altered. The settings changes applied were agreed via the relevant Industry panel and were assessed so as to not cause adverse system issues or impact the installations. More details can be found [here](#).

**Question:** How will the PMU data help during the dynamic (sub-second) conditions, considering that PMU only reports few data during this period and that IEC/IEEE 60255-118 does not specify the accuracy of the PMU beyond 80-120% of the rated voltage and 10-200% of the rated current?

**Answer:** We are currently only using PMUs to monitor the system not to control any post-event provision.

**Question:** GridMetrix modulator, what is the injected frequency?

**Answer:** More information on the Reactive Technology system is available [here](#) or we can ask them to provide a future briefing.

**Question:** About signal injection into the system to estimate inertia, what is the power of the signal?

**Answer:** More information on the Reactive Technology system is available [here](#), or we can ask them to provide a future briefing.

**Question:** Can both methods measure artificial inertia such as from battery power injection during fault?

**Answer:** Yes, however we are measuring total system inertia and are not evaluating at an individual unit level.

**Question:** How often do you feed data into the ML model?

**Answer:** Data is fed to the GE forecasting ML model at 30-minute intervals.

**Question:** Does/ can the GE approach provide the regional inertia estimate and forecast as well as national- is the accuracy the same? Is this something the reactive technology product can also do? Also- does it matter if all the synchrophasor measurements are coming from one vendor (GE) or can it take account of differences of approach- across P and M class specification? is a new specification needed/ preferred?

**Answer:** The GE product requires regional measurement to get the full GB value and we can see the results at each region. Currently in test phase and as such do not know the accuracy of the product.

The synchrophasors we are using are installed by the TOs and can be any vendor as determined by the TOs. The standards for sharing synchrophasor data between SO & TOs are set in the STCPs and they will be regularly reviewed by the industry.

We have contracted with Reactive for a GB level inertia value. This does not have a regional variation available to NGESO.

**Question:** Do you need PMU coverage of all tie lines between regions to estimate the inertia for that region?

**Answer:** Yes, we need to be able to monitor the flow across all transmission circuits on the region boundary for the GE system. Not currently having these is preventing additional regions from being added.

**Question:** How do you compute the GVA.s? Is it the average aggregate of PMU V\*A per second?

**Answer:** [GE](#) and [Reactive Technologies](#) may be willing to provide their methodology on request.

**Question:** For inertia monitoring, can we also suggest the actions to be taken when Inertia is below the required level?

**Answer:** Pre-fault actions are to purchase inertia services, for example the Stability pathfinder, purchase generation through the Balancing Mechanism (BM) or trade the interconnector flow.

**Question:** Wows, is all I can manage to say, incredible effort/project. If I was 20 years younger, I would beg to be part of it... on a serious note, your thoughts about scaling in the whole USA?

**Answer:** Not aware that size of the system is a problem provided there are sufficient data from measuring equipment.

**Question:** How can we have a look on sample measurements and GUI of the implemented Reserve estimation software?

**Answer:** For more information please contact [Reactive Technologies](#) or [GE directly](#)

**Question:** Very interesting presentation. I am just wondering what kind of inertia forecasting will be provided. Point/probabilistic/interval forecasting? How this will be used in control room?

**Answer:** We will receive half hour values for the next 24 hours which will be used to determine our commercial actions to manage system inertia. We will use the inertia measurements in real-time to re-assess our actions against forecast.

**Question:** So, for the two projects, how many PMUs/XMUs are being used now? How do you manage the communication infrastructure etc.?

**Answer:** We are looking at between 40 – 50 of each for accurate reading for the full GB network. We have built redundancy into the communication infrastructure of both systems so that we can accept failures in infrastructure but maintain service.

**Question:** How good is the correlation between inertia and nadir in frequency upon generation contingency?

**Answer:** Sorry, we are not sure what this question is asking however if you would like to come back to us with more information we will respond.

**Question:** How has the accuracy of the inertia monitoring systems been determined? Do the two systems differ significantly in terms of accuracy?

**Answer:** The GE system is in test phase currently, but only for a single region, and the Reactive Technologies system will enter test phase in late summer. Accuracy will be reviewed during the test phase.

**Question:** There is a slide showing that the cost of managing RoCoF was about \$350M in 2021. How was the cost of managing RoCoF calculated?

**Answer:** This is the cost of balancing actions taken by NGENSO on units or interconnectors. The Control Room operators tag costs daily against system conditions such as inertia.

**Question:** For GE and National Grid: time resolution of estimated inertia?

**Answer:** Real-time measurements are created every 5 minutes.

**Question:** Can we have a demo version of the software?

**Answer:** I'm sure both suppliers will be happy to provide a demo of their systems. For more information please contact [Reactive Technologies](#) or [GE directly](#)

**Question:** How far away the calculated inertia and the monitored one in the current test?

**Answer:** Our currently testing has provided us with promising results, showing good correlation with demand patterns and different generation patterns. We will not be providing specific results until we have sufficient data to assess both systems.

**Question:** With the incorporation of new systemic requirements (ex: 1 Hz/s - 500 ms), which do not allow the connection of DGs with sensitive protection settings, is there the possibility of making it difficult to identify real islanding conditions? How the distribution companies received the new system requirements?

**Answer:** Industry panels agree regulatory codes that confirm new system requirements. The settings changes applied were agreed via the relevant Industry panel and were assessed so as to not cause adverse system issues, such as identifying real islanding conditions. More details are available [here](#).

**Question:** For GE: Could GE's method be used into system which cannot separate into several region?

**Answer:** The size of the network will determine if regions are required to get the accuracy. For more information please speak to [GE](#)

**Question:** Will the RES (such as wind) be expected to provide inertia in the future? How this would impact the inertia monitoring and forecasting?

**Answer:** As the market for providing inertia grows we are expecting all market participants to consider how they may provide a service. We expect this to be market driven. The tools measure total system inertia and can therefore manage all types of inertia provision.

**Question:** Do you see a need for standardization of inertia monitoring to enable easy comparison of different systems?

**Answer:** No, we are keen for continued innovation in this space. All technology that is developed will need to communicate with existing technology. As an island transmission system our inertia is not impacted by other transmission systems, hence this is not a focus for us at this time.

**Question:** Are you using the PMU RoCoF to do dynamic frequency management?

**Answer:** Not at present but we are considering as part of our Zero Carbon by 2025 requirement.

**Question:** GE Inertia Solution applied a ML focus. Do you know what are variable that algorithm use??

**Answer:** This would need to be discussed directly with [GE](#).

**Question:** What is expected level of observability using PMUs by 2026.?

**Answer:** The TOs have committed to have PMU monitoring on all GB transmission circuits and generator feeds by 2026.

**Question:** What is the advantage of knowing the residual inertia? What can TSO do with that information?

**Answer:** As conventional generation decreases and renewables increase the amount of synchronised inertia is decreasing as a result the residual inertia represents an increasing percentage of the available inertia. Knowing how much exists can reduce the volume of actions that need to be taken and reduce cost to the end consumer.

**Question:** Is virtual inertia implementation based on energy storage possible to improve system inertia control?

**Answer:** With the [stability pathfinders](#) we are considering all possible methods of providing inertia.

**Question:** What are your assumptions regarding the IBR capabilities in your system? If your assuming Grid Following (current typical approach) or Grid Forming IBR capabilities in the future grid?

**Answer:** We are not sure that we fully understand the terminology, however the existing pathfinders are predominantly Grid Forming and that IBR (wind, solar, batteries) are already able to provide a service through that. Services such as Dynamic Containment are predominantly grid following. We have a system where grid forming and grid following will be useful to manage system inertia as we move forward.