Energy Networks Innovation Process

Example of Data Quality Statement

NGESO/NPL Inertia Measurements Project

General

The following paragraphs outline how the project will meet measurement and data quality objectives, including the measurement procedures and techniques to be used against each Work Package (WP), and the mechanisms to ensure the traceability, reliability and comparability of the measurement result.

WP1 - Analysis and comparison of inertia measurements from commercial systems

In this WP data from commercial systems continuously collected over periods of months/year will be analysed and compared. Data will also be compared with the calculated inertia derived from the inertia contribution of the synchronous generators connected at each period of time.

Meaningful comparison requires that a level of uncertainty is ascribed to each measurement. For data from the commercial systems, at least one system provides standard-deviation based confidence data and this will be used to calculate the type-A measurement uncertainty. Manufacturer's accuracy specification data will also be used. Other information such as data error flags will also be used to reject data from the comparison.

In comparing the results, the combined estimated uncertainty from all the systems will be used as a bench-mark expectation of agreement from which to judge whether the systems agree at a given period in time.

WP2 - Assess regional differences in frequency and ROCOF for GB system

This WP is a calculation and modelling based activity which will determine expected differences in the values of frequency and ROCOF for different areas of the GB grid. The overall uncertainty of the modelling depends on the uncertainty of the inputs, how they propagate through the equations in the model and any assumptions/unknowns used. The sensitivity of the model output to changes in assumptions and variations of the inputs will be assessed to estimate the uncertainty of the model outputs.

WP3 – Development of reference framework

It is important to point out that at the present, there is no reference standard for inertia. Inertia is effectively an operationalist [[i]] measurement, and the validity of the measurement must be assessed on the success or otherwise of the measurement as a metric in the context of the given use case. For example, the measurement of a time varying inertia characteristic which enables the successful management of the system frequency; or the correct prediction of the effect on frequency/ROCOF of the loss of the largest system in-feed.

Using the outputs of WP1 and WP2 and knowledge of the operational scenarios of the power system, a set of use-cases will be developed. Associated with these, a standard set of power system frequency characteristics (versus time), which are representative of common power system inertia measurement scenarios, will be developed. These characteristics will be used to derive test voltage waveforms that can be used to develop and test inertia measurement methods and instruments. Further test waveforms that include disturbing influences will also be developed.

To be part of a reference framework, each of these waveforms will need to be unambiguously specified so that they can be defined in a document/standard and reproduced using a signal generator. The sensitivity to changes in the parameters of this definition will need to be assessed to quantify the effect on the final reference waveforms (e.g. sampling rates, bandwidth, group delay).

Frequency and ROCOF algorithms will be adapted and/or developed. In particular, methods to account for the influencing factors such as system noise, voltage modulation (flicker), phase steps and low frequency interharmonics. The measurement update rate, bandwidth and accuracy trade-offs will each be analysed and understood which will inform the best algorithm configuration for a given use case. Testing and assessment of the algorithms against various influencing factors, for given use cases will be made to ascribe an accuracy to each measurement scenario.

WP4 - Development of reference instrument

This WP will implement algorithms in software to run in real time on an existing waveform measurement unit instrument (where GPS time tagged raw voltage and current waveform data is available along with the regular PMU functionality).

The instrument (hardware and software) will be calibrated against national standards of ac voltage and current and a measurement uncertainty will be estimated. Critical parameters such as response time, latency, phase errors, phase step response will be assessed making reference to the dynamic test methods defined in PMU standard C37.118 and also the emerging standard IEC TS62786-1 on frequency and ROCOF measurements. The consequences of imperfections in the instrumentation for the measurement of frequency and ROCOF will be assessed in the context of the waveforms expected in each use case.

Installed instrument VTs (and CTs) will be used in the measurements and investigations will be made as to the effect of these transducers on the measurement including accuracy and bandwidth (bandwidth effects on frequency measurement are minimal as the measurand is at 50 Hz).

WP5 - Comparison with NPL reference instruments

In this WP, several reference instruments (WP4) will be installed in the power grid at selected locations in parallel to NGESO's frequency and ROCOF measurements systems for 6-12 months. A comparison between commercial ROCOF measurements and the reference instruments will be made, including during abnormal events on the power system.

Account will be made of the site conditions such as the transducers, the wiring from the transducers to the instrument (e.g. loops of wire, long runs of wire which are prone to pick-up noise and cross channel (inter-phase) effects). Where possible and deemed necessary, assessments will be made to quantify the effects of non-ideal conditions (e.g. deliberately extending loops and wire runs).

Voltage connections to existing transducer secondaries should not significantly affect low frequency measurement accuracy, however, the selection of measurement locations should take into account the accuracy class of installed VTs.

The uncertainty of the reference instrument will be known from WP4 and taking into account the statistical data from the on-site measurement an uncertainty can be calculated for each measurement and combined with the statistical (and other) uncertainties of the commercial system to give a combined uncertainty as an expectation for the comparison.

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[i] https://en.wikipedia.org/wiki/Operationalization