European Metrology Programme for Innovation and Research

Delivering Impact

Consumer trust increased by new reference device

Renewable energy sources are being used more frequently and on a wider scale to aid the decarbonisation of the energy grid. However, these energy sources are less predictable, resulting in more complex and challenging conditions. This created a metrological need to develop traceable measurement systems for emerging instrumentation technology required for controlling and monitoring of the power grid in real time.

Europe's National Measurement Institutes working together

The European Metrology Programme for Innovation and Research (EMPIR) has been developed as part of Horizon 2020, the EU Framework Programme for Research and Innovation. EMPIR funding is drawn from 28 participating EURAMET member states to support collaborative research between Measurement Institutes, academia and industry both within and outside Europe to address key metrology challenges and ensure that measurement science meets the future.

Challenge

The energy grid is becoming increasingly more decarbonised. However, renewable energy sources are more variable compared to conventional energy sources, resulting in a great need to develop the metrological network required to control and monitor the energy grid. The changes in the energy grid system have also resulted in a need for associated alternative digital high voltage sensors and digital metering systems. The standard IEC 61869 concerning electronic current and voltage transformers has been regularly updated and aims to aid the transition of analogue instrument transformer technology towards new digital instrumentation both for transmission- and distribution grid. New metrological methodologies and techniques are needed to support this change as well. In 2018, new additions to the standard for stand-alone merging units (SAMU) were included.

Merging units are able to convert analogue power system measurements, such as voltage or current measurements, into digital signals called Sampled Values (SV). The two most common analogue power system measurement technologies are the iron core based conventional current and voltage instrument transformers and low power instrument transformers. Merging Units are available for both types of instrument transformers, because of technical reasons these are obligatory in case of LPIT. Transforming information into SVs is essential as SVs are needed for quick monitoring and controlling technologies, which supports the transition to a modern, future power grid. These updates generated a metrological need for new test and calibration systems for Merging Units to ensure their reliability and increase consumer trust in these new systems.

Solution

During the project FutureGrid II some reference Merging Units were developed as part of a collaboration between the partners. One Merging Unit that belongs to VTT was calibrated using a novel method that takes into account the delay caused by analogue front ends of the internal analogue-to-digital (ADC) cards. This calibration method has been described in the good practice guide 'Good Practice Guide on the performance of the reference standard SAMU as a calibration reference for the calibration of instruments with digital input or output'.

The overall uncertainty achieved during SAMU calibrations was 10 ppm and 28 ns (around 10 µrad), which was satisfactory for a reference standard for commercial SAMUs. The new reference Merging Unit is the first of its kind, and before the FutureGrid II project, no institute worldwide was able to provide calibration services for Merging Units. The German national metrology institute Physikalisch-Technische Bundesanstalt (PTB) is now offering this calibration service with great success and a wide range of customers have used this measurement service. 39 papers were published throughout the project in peer-reviewed journals, many of which included the development of the reference Merging Unit.

Impact

One of the many customers who used the Merging Unit calibration service offered by PTB was Siemens, who required the calibration service for the Siemens energy automation and smart grid department. Siemens is a renowned name and leader in the energy industry. The company was one of the first to use PTB's new calibration service for their Energy automation and smart grid department.

Their main customers are distribution and transmission grid operators as well as industries with high energy demand across various countries that operate with a nominal grid voltage of 10 kV and above.

Siemens was interested in using Merging Units in connection to energy meters on substations. However, customers were cautious of new technologies, especially in regard to measurements of their energy consumption and thus correlated to their energy bill.

Having their Merging Unit calibrated by PTB as an independent, national metrology institute has significantly improved customer trust in their products, which makes customers more willing to use these new technological advances and ensures that the use of Merging Units will increase. This ensures that the newest technology is used across large areas and will aid the transition towards a modernised power grid across Europe.

Developing a reference SAMU to aid the modernisation of the power grid

The project was able to improve the power grid infrastructure and offer new measurement services that ensure high accuracy and comparability of new technological developments, the development of a reference Merging Unit being one of many successful project outputs. Moreover, various calibration and measurement services for digital current- and voltage sensors within a range of up to 100 kV and 2 kA were developed.

New algorithms that are coordinated with SV protocols were developed for phasor measurement units (PMUs), which allows a greater insight into what is happening within an extensive energy grid network. Additionally, several tools and devices were developed to allow the use of SV in digital substations, such as a Merging Unit with an integrated PMU.

The success of the FutureGrid II project was communicated with stakeholders via two workshops, and with the wider scientific community through 39 published peer-reviewed papers and 33 conference presentations and posters. Two good practice guides were published, one of which describes the calibration procedure for the reference Merging Unit.

EMPIR EURAMET

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Enrico Mohns

PTB, Germany
enrico.mohns@ptb.de

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