National Metrology Institute VTT MIKES

Energiaan liittyvä metrologian tutkimus

MNK-kokous, MML FGI, 1.12.2023

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Sisältö

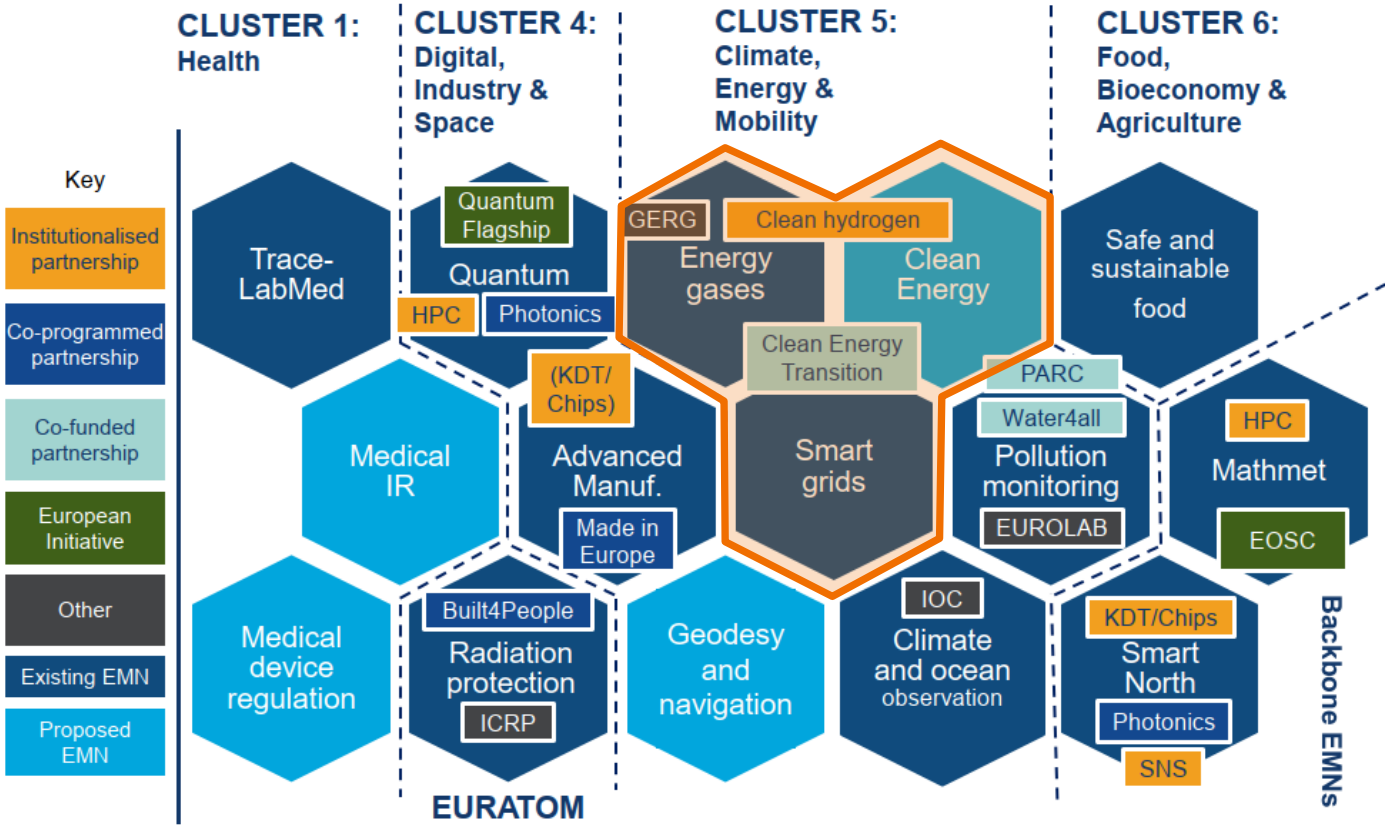
- Eurooppalaiset metrologiaverkostot
- Käynnissä olevia tutkimushankkeita
- Hankkeiden vaikuttavuudesta ja tutkimusstrategioista

Energiaan liittyvät eurooppalaiset metrologiaverkostot

Eurooppalaiset metrologiaverkostot

- EMN = European metrology networks
- Yksi EURAMETin toiminnan kolmesta peruspilarista:
  - Suurekohtaiset tekniset komiteat
  - Eurooppalainen metrologian tutkimusohjelma
  - **Eurooppalaiset metrologiaverkostot**
- Yhteistyö erityisesti ulkoisten sidosryhmien kanssa
- Erityisfokuksessa toimintamahdollisuuksien varmistaminen Horizon Europe –kauden jälkeen

EMN Liaisons with other Partnerships & Initiatives



Lähde: Jörn Stenger, Strategy Status, 17th EURAMET GA / Plenary Session

Energiaan liittyvät EMN:t

- Energy gases:
  - measurement science expertise to support the implementation of the energy transition to renewable gaseous fuels.
- Smart electricity grids:
  - focus on transforming electricity grids into smart grids, with smart meters and appliances, renewable energy resources, and efficient infrastructure
  - support for standardisation, testing, and the research and development of national smart grid development and implementation strategies
- Clean Energy
  - metrology related to the generation (conversion from solar and wind energy) and utilization (conversion to mechanical energy, light etc.) of energy. Later also: temporary storage of energy

Käynnissä olevia ja tänä vuonna päättyneitä tutkimushankkeita

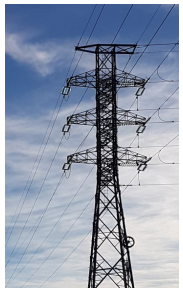
Hankkeiden teemat

Tuulienergia

- Jäljettävät mekaaniset ja sähköiset mittaukset tuuliturbiinien hyötysuhteen määrittämiseen
- Tuulienergiajärjestelmien mekaanisten mittausten (muoto, vääntomomentti) luotettavuuden parantaminen

Vety ja biometaani

- Kaasun koostumus ja ominaisuudet: Mittausmenetelmät, laadunvarmennus ja standardointi



Sähköverkot ja liikenne

- Mittaus- ja kalibrointimenetelmät sekä komponenttien testausmenetelmät
  - Nopeat vaihtelut
  - Digitaaliset muuntimet
- Raideliikenteen sähkötehon mittaus

Uusiutuvat polttoaineet

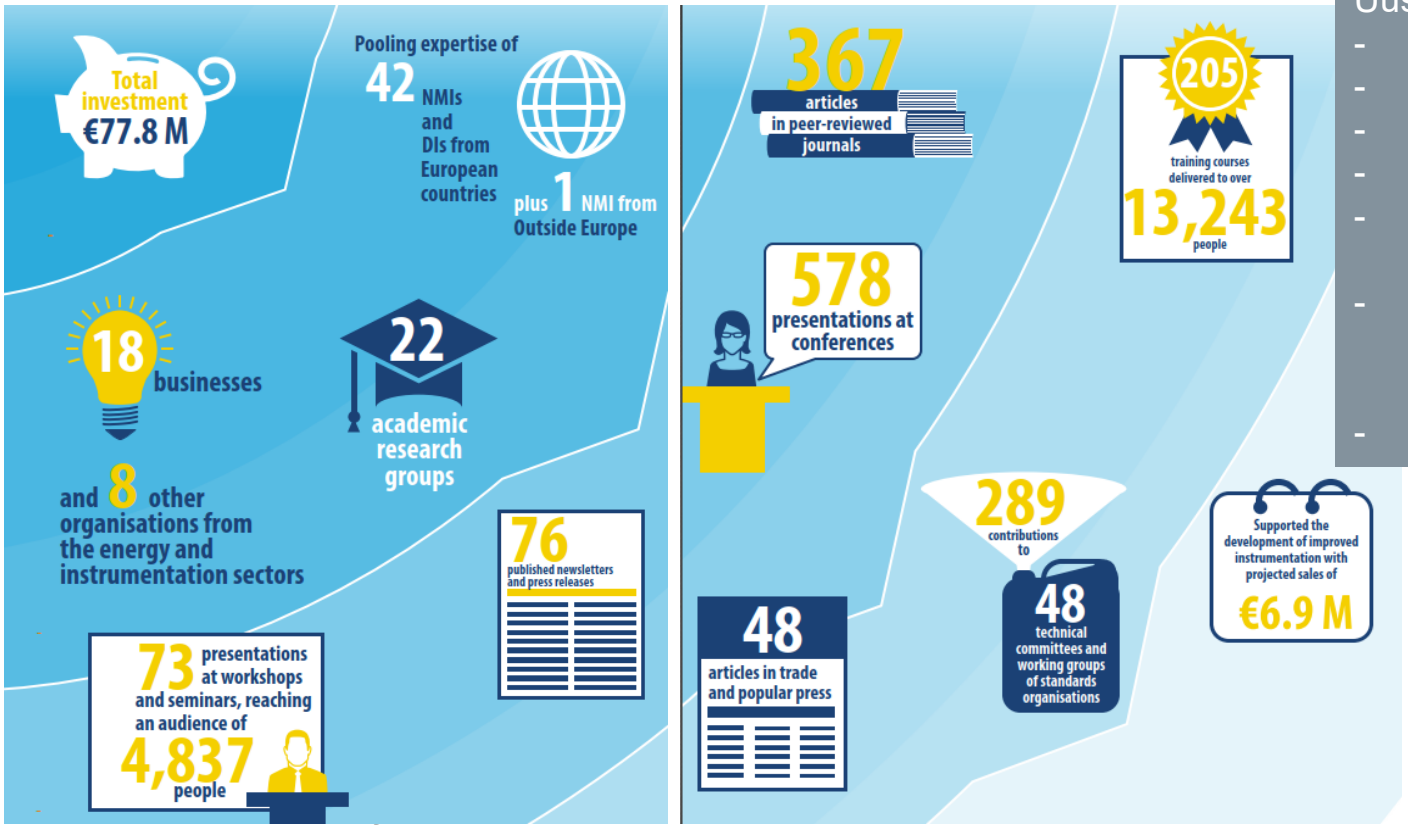
- Virtausmittausten luotettavuuden parantaminen erilaisille polttoaineille

Vuonna 2024 alkavat EPM -projektit

23IND05	Flow measurement traceability for hydrogen in gas networks (No Finnish participation)
23IND01	Electric energy and supply reliability

Hankkeiden vaikuttavuudesta ja tutkimusstrategioista

EMRP hankkeiden vaikuttavuus



Teknisiä saavutuksia:
Uusia

- kalibrointiteknologioita
- referenssimateriaaleja
- kalibrointifasiliteettejä
- kalibrointimenetelmiä
- mittaus-, analysointi- ja analytiikkamenetelmiä
- Kansainvälisiä standardeja ja Good Practice Guide -dokumentteja
- suunnittelutyökaluja

Lähde:
Towards secure, sustainable energy, EURAMET, August 2019

https://www.euramet.org/metrology-for-societys-challenges/metrology-for-energy

EMN Energy Gases: Strategic Research Agenda

Table 8: Priority of measurement needs from survey and workshop

Measurement needs	Priority at workshop	Priority from survey	Timescales
Flow metering for hydrogen refuelling stations	High	Medium - High	2020- 2025
Energy metering of hydrogen enriched natural gas - Flow metering	High	Medium	2020- 2025
Energy metering of hydrogen enriched natural gas - Calorific value	High	Medium	2020- 2025
Energy metering of hydrogen enriched natural gas - Gas quality	High	High	2020- 2025
Validation of online purity analysers (hydrogen and biomethane)	High	High	2020- 2030
Representative sampling of gas	High	Medium - High	2020- 2025

Lähde:
Strategic Research Agenda, European Metrology Network for Energy Gases, Version 2.0 – English version

https://www.euramet.org/european-metrology-networks/energy-gases/strategy

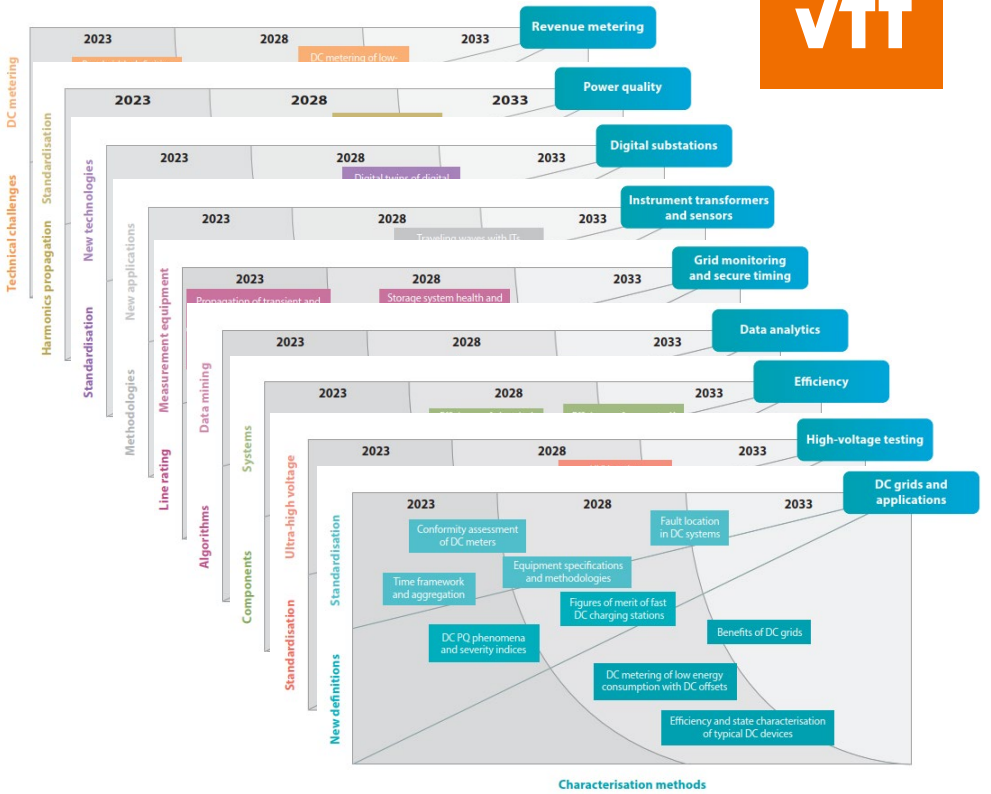
EMN Smart Electric Grids: Strategic Research Agenda

Roadmaps for 8 challenge areas

- Revenue metering
- Power quality
- Grid monitoring and data analytics
- Digital substations
- Instrument transformers and sensors
- High-voltage testing
- Efficiency
- DC grids and application

Listed measurement challenges for grid integration:

- Measurement concepts for power-to-X processes
- Measurement concepts for storage processes
- Measurement concepts for charging processes, e.g., EV
- Measurement concepts of coexisting DC and AC grids



Lähde:
Strategic Research Agenda, European Metrology Network for Smart Electricity Grids, Version 1.0 – English version
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https://www.euramet.org/smart-electricity-grids/strategy/strategic-research-agenda

Lisätietoa tutkimushankkeista

Lisätietoa myös:
https://cris.vtt.fi/en/organisations/ba66-national-metrology-institute-vtt-mikes/projects/

National Metrology Institute VTT MIKES

Sustainable advanced flow meter calibration for transport sector

Improving engine efficiency and emissions measurements

- Reliable fuel consumption and emissions measurements are needed to achieve emissions reduction in the transport sector. Thus, advances also need to be made in flow metrology that is crucial in determining engine efficiency.
- **Project** develops harmonised flow measurement methods that consider alternative fuels and actual operational conditions for the assessment of fuel flow meters deployed in close-to-engine applications.
- **MIKES** performs flow measurements with various liquids under various conditions using different flow meters and simulates the interaction between test liquid and flow meter

Metrology for the hydrogen supply chain

Metrology tools to support the use of hydrogen as a source of energy

- The EU Green Deal sets ambitious targets for the transformation towards a climate neutral continent. Hydrogen plays a key role as an energy in this ambition, yet the metrological infrastructure to support the entire hydrogen supply chain is underdeveloped.
- **Project** provides novel standards and infrastructure to support the entire supply chain of hydrogen from production via storage to end use and ensures that health, safety and environmental requirements are met.
- **MIKES** updates its portable evaporative reference gas generator for HCl and NH_3 in hydrogen matrix, validates it through inter-comparison and demonstrates its suitability for field measurements.

Metrology for digital substation instrumentation

Solutions for more precise power grid measurements

Coordinated by MIKES

- Due to the wider use of decentralised renewable energy resources, future electrical power grids require real-time control and monitoring to ensure stability under more challenging conditions. Digital substation solutions are increasingly replacing analogue instrumentation.
- **Project** will provide yet missing solutions for calibration and timing of the new type of digital substation instrumentation.
- **MIKES** will extend reference SAMU hardware to allow handling of higher sampling rates needed for measurement of harmonics and DC power quality as well as define best practices for designing and deploying robust communication and timing networks.

Protocol for SI-traceable validation of methods for biomethane conformity assessment

Standards to support the use of biomethane as energy source

- Biomethane is a renewable energy gas that can be fed into natural gas networks and used as a vehicle fuel if it conforms with the specifications. To ensure conformity, measurement standards that contain SI-traceable levels of targeted impurities and other possible interferents are required.
- **Project** will support standardisation by developing efficient and cost-effective methods for preparation of traceable gas transfer standards for the performance evaluation of biomethane monitoring systems.
- **MIKES** optimises its liquid portable evaporative gas generator for dynamical generation of gas standards of at least three compounds — e.g. NH_3, amines, HF, HCl, halogenated VOCs and H_2O — in relevant concentration ranges and gas matrices.

Characterisation of AC and DC MV instrument transformers in extended frequency range up to 150 kHz

Supporting instrument transformer calibration up to 150 kHz

- The wider use of switching devices has increased conducted disturbances on grid voltage and current up to hundreds of kHz. Hence, standardized procedures for calibration and testing instrument transformers beyond frequencies covered by presently available infrastructures are needed.
- **Project** develops metrology necessary to support standardization for the calibration & characterization of instrument transformers up to 150 kHz.
- **MIKES** will develop a current generation system for simultaneous generation of fundamental and high-frequency current components and characterize the developed AC or DC reference current sensors.

ADMIT
AC & DC High Frequency Instrument Transformers

Metrology support for enhanced energy efficiency in DC transportation systems

New methodologies for DC transport efficiency determination

- DC railway & metro systems fed by unidirectional substations show significant energy losses as they cannot fully recover the energy generated by braking. Bidirectional substations should improve the energy efficiency but there are currently no equipment and procedures to determine their actual efficiency.
- **Project** will develop new methodologies for DC transport efficiency determination that combine accurate on-site measurements with circuit models of the railway electric system.
- **MIKES** will use its knowledge on on-site medium power measurements to develop an energy efficient measurement system suitable for DC substations and for on-site efficiency measurements.

Traceable mechanical and electrical power measurement for efficiency determination of wind turbines

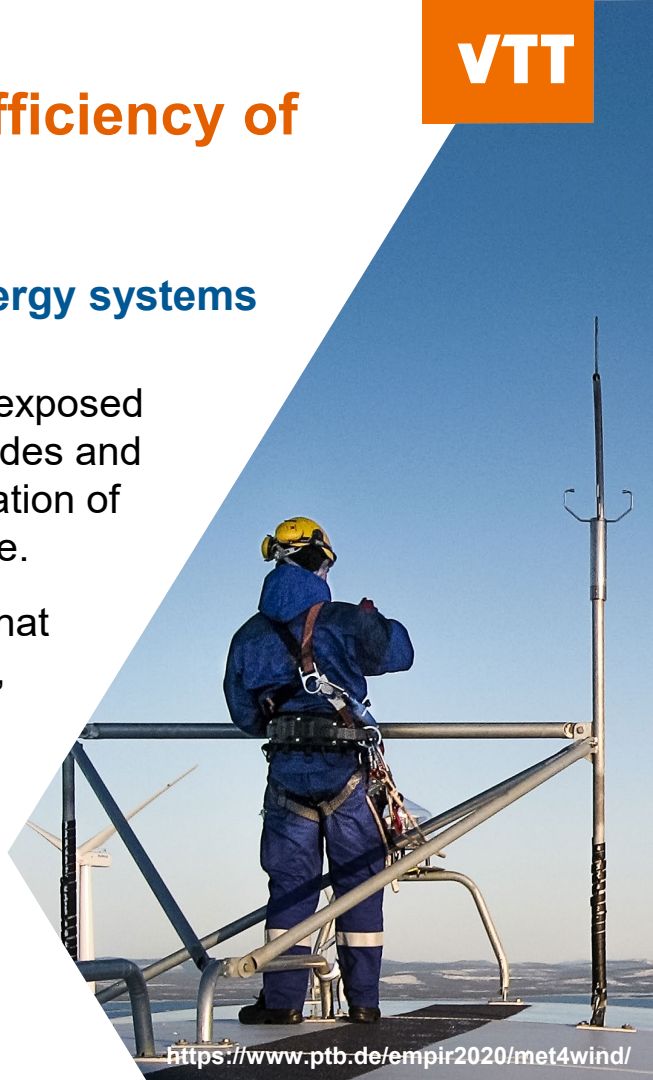
Improved testing methods to boost wind power innovations

- The wind energy sector needs standardised tests for the efficiency determination of nacelles and their components on test benches in order to improve the efficiency of wind turbine drive trains, quicken the development cycles and shorten the time to market.
- **Project** will establish practical and traceable methods for torque measurements up to 5 MN m and rotational speeds covering the operational speeds on low-speed and high-speed shafts.
- **MIKES** will establish torque transfer standards with a measurement range up to 100 kN m, which will be used to calibrate torque measurements on the high-speed shaft in different test benches.

Metrology for enhanced reliability and efficiency of wind energy systems

Reliable measurements for assuring quality of wind energy systems

- Mechanical components of wind energy systems (WES) are exposed to the highest loads. Torques of up to 20 MN m act on the blades and are transmitted to the drivetrain components. Reliable verification of manufacturing tolerances is a critical part of quality assurance.
- **Project** develops a range of new measurement capabilities that improves WES component lifetimes and production reliability, leading to more reliable, efficient, and quieter power plants.
- **MIKES** will perform form measurements on bearings, shafts and on surface texture of involute gear flanks as well as develop traceable measurements for bearing and rotor geometry.



Metrology for Future Energy Transmission

Metrology for future energy transmission

Metrology for high voltages to maintain grid efficiency

- The increased integration of remote renewable generation has driven transmission levels to ultra-high voltages in order to minimise energy losses and improve grid efficiency. High voltage testing beyond voltage levels covered by presently available metrology infrastructures is needed to secure availability and quality of supply.
- **Project** provides traceability for testing and calibration of components for future electricity grids and improves means for HVDC grid condition monitoring.
- **MIKES** leads the design of reference voltage dividers for 1200 kV and 1600 kV and develops methods for lightning impulse voltage calibration.

Support for standardisation of high voltage testing with composite and combined wave shapes

Improving reliability of high voltage electricity grids

- The reliability of high voltage electricity grids crucially depends on adequate testing of grid components. One of these tests involves the application of composite and combined wave shapes. However, at present, there is inadequate traceability of these wave shapes possibly resulting in incorrect test results.
- **Project** will investigate the interaction of impulse voltages superimposed with AC and DC voltages enabling optimised and traceable test setups to be created.
- **MIKES** coordinates development of a modular voltage divider and evaluation software package for combined and composite wave shapes.