EMN Smart Electricity Grids

Workshop and open consultation

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Federal Institute of Metrology METAS
15th May 2024

Agenda

- Motivation for the European Metrology Networks
- EMN on Smart Electricity Grids
- Main achievements of the EMN
- Strategic Research Agenda

EMN on Smart Electricity Grids

European Metrology Networks (EMNs)

The overall EMN objective is to create **sustainable structures** in **areas of strategic importance** for the future of European metrology by:

- Creating and disseminating knowledge
- Gaining international leadership and recognition
- Building coordinated infrastructure

- Advanced Manufacturing
- Climate and Ocean Observation
- Energy Gases
- Laboratory Medicine
- Mathmet
- Pollution Monitoring
- Quantum Technologies
- Radiation Protection
- Safe and Sustainable Food
- **Smart Electricity Grids**
- Smart Specialisation in Northern Europe

EMN on Smart Electricity Grids

Scope: all electricity grid related metrology challenges to support the energy transition

Aim: enhance stakeholder interactions, identify additional R&D support, increase coherence in R&D efforts, make next step in coordination of national activities, and maximise R&D impact.

Members:

- 19 NMIs & DIs + 2 universities are formal network members and partners
- > 50 Stakeholders expressed their support



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Main initial objectives for the EMN development

1. **To <u>coordinate alignment of national R&D strategies</u> and develop a <u>joint strategic research agenda</u> (SRA)**
   - Overview of stakeholder needs, including prioritisation
   - Long term R&D planning in SRA
   - Implementation roadmap to systematically cover needs

2. **To create a <u>joint sustainable European metrology infrastructure</u> of European NMI facilities and services**
   - Overview of services and large facilities
   - Promote smart specialisation to reduce overlap and maximise coverage of stakeholder needs



Main initial objectives for the EMN development

3. **To create a <u>widely visible identity</u> as voice of the European electricity grid metrology community and to set up <u>strategic liaisons</u> with relevant (European) stakeholder organisations**

4. **To realise a <u>virtual knowledge hub</u>**
   - Single website for results from multiple R&D projects
   - Single point of contact

5. **To set up an extensive <u>knowledge transfer program</u>**
   - Develop training courses
   - Stimulate exchange of researchers





Main achievements of the EMN



Advocate for metrology in electricity grids sector

NMI Collaboration **structured vision-led**

Shared strong identity

Stakeholder engagement

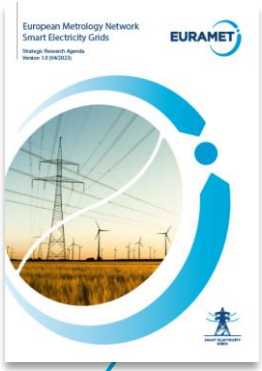
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Metrology landscape

Website

Knowledge Transfer



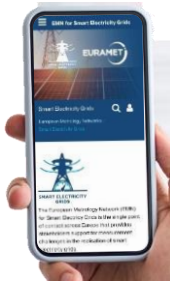


Strategic Research Agenda





Excellence course



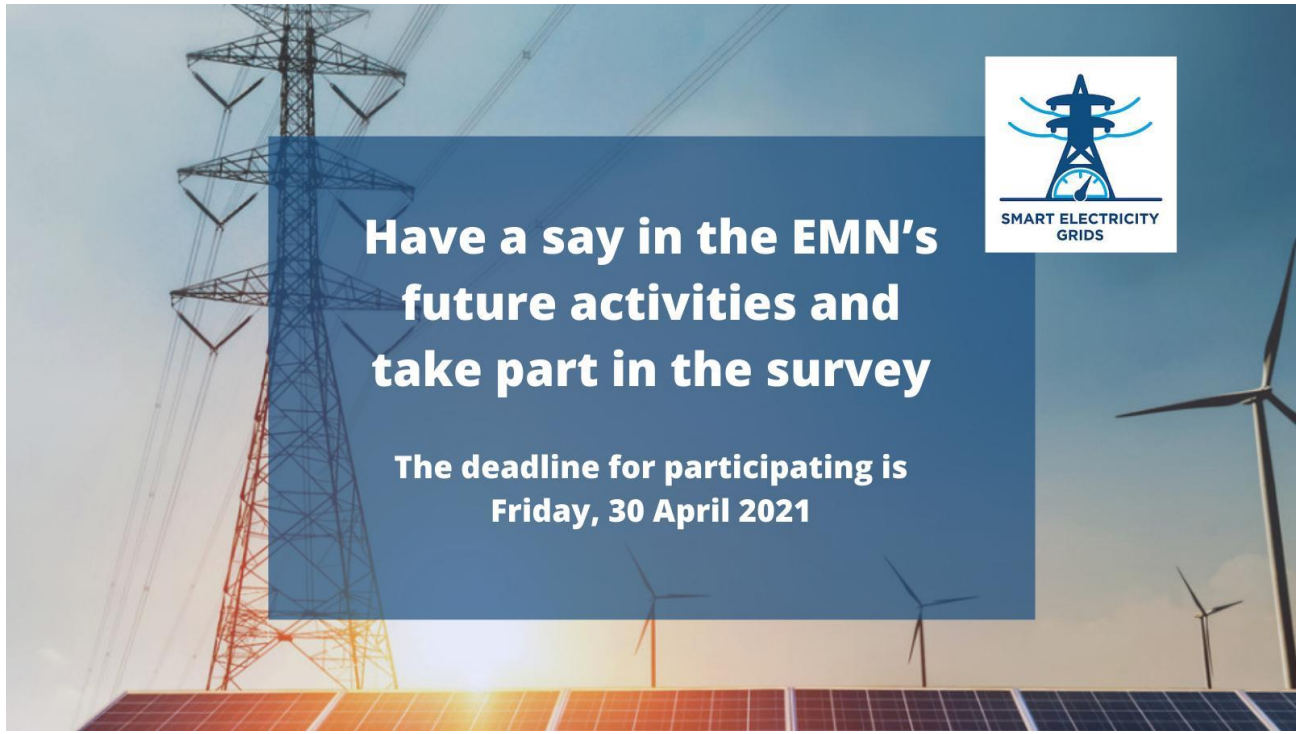
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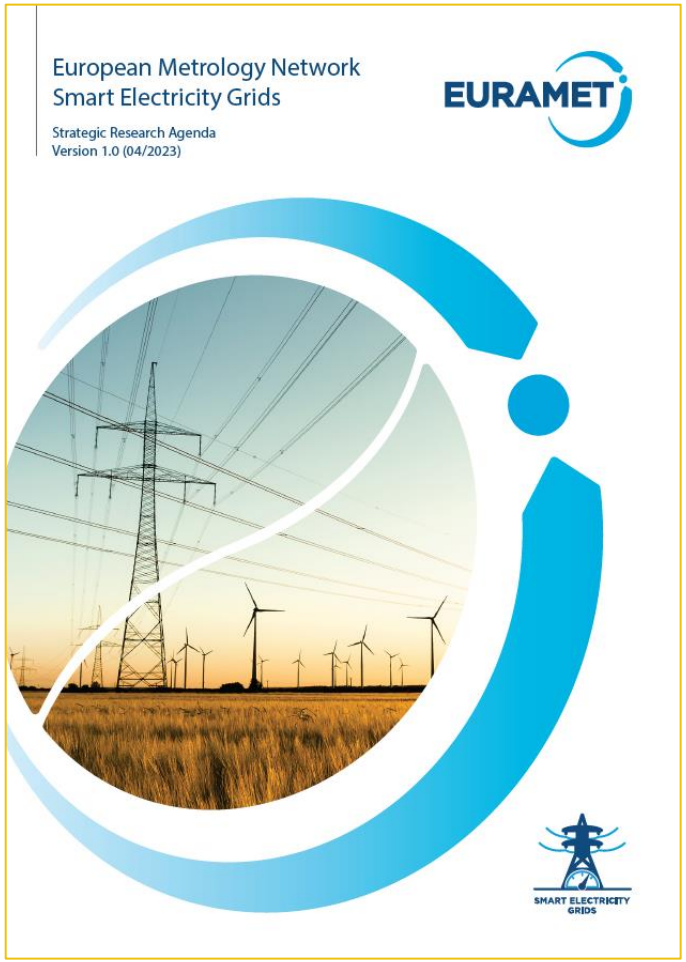
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Method for the development of the SRA

- Track I: Online survey
- Track II: Interviews
- Track III: Workshops

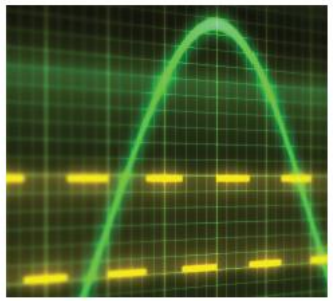


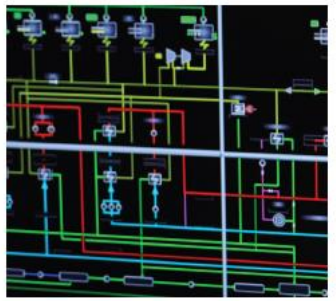
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[Link]









Management Summary

Recognising the strategic importance of the electric grid as the backbone of a secure, clean and efficient energy supply in Europe, the European Association of National Metrology Institutes established the European Metrology Network Smart Electricity Grid (EMN SEG) in 2019. The EMN SEG is a coordinated effort by European national metrology institutes to develop a sustainable structure providing close collaboration in measurement science and techniques in smart electricity grids. Accurate, reliable and traceable measurements are key to guarantee stability and flexibility of modern grids through monitoring and quality control in an increasingly volatile production and consumption environment.

This document is the first official edition of a Strategic Research Agenda (SRA) for the EMN SEG. It has been compiled following a broad consultation of representative stakeholders and specialists of the SEG community. Its purpose is to give an overview of the major metrological challenges faced by electricity grids in an era of major changes, driven by the need for a more sustainable energy supply. It presents a vision and ambition for Europe over the coming five to ten years for addressing needs expressed by stakeholders via further strengthening and coordinating a sustainable and effective research strategy at European level.

This SRA firstly introduces the rationale behind the institution of metrology networks and the specific case regarding smart electricity grids. Subsequently, nine themes identified as bearing particular relevance to smart electricity grids are explored in the core chapter, ranging from modern-day embodiments of revenue meters to digital substations, and emerging fields such as DC grids and efficiency. For each theme, outstanding measurement challenges are pinpointed and structured in implementation roadmaps.

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

Strategic Research Agenda

Revenue Metering

Power Quality

Grid Monitoring & Data Analytics

Digital Substations

Instrument Transformers and Sensors

High-Voltage Testing

Efficiency

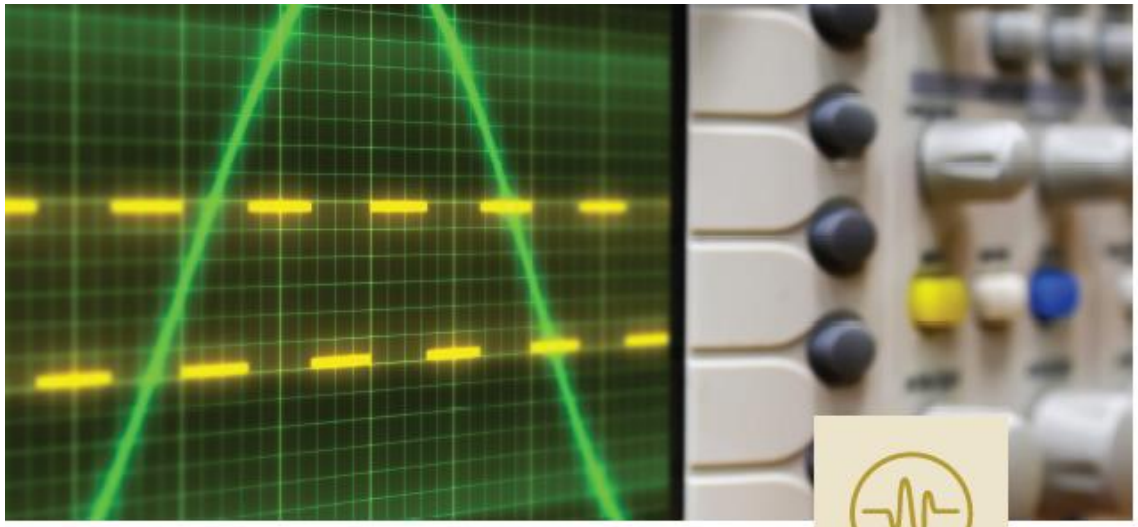
DC Grids and Applications

Grid integration

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4.2 Power quality

Issues with the quality of electric supplies have been known since the beginning of electrification. The advent of power electronics, and more recently of inverters in connection with the multiplication of renewable energy sources, have led to an increase of non-linear loads and sources connected to the distribution grids. This produces harmonics of the 50 Hz sine waveform and, together with a wide range of other disturbances, can pose a risk to the safe operation of grids by stressing equipment connected to it. Hence, power quality (PQ) is sometimes referred to as the set of limits of electrical properties that aims at ensuring that electrical systems function in their intended manner without significant loss of performance or breakdown. Monitoring both the current and voltage contribution to power quality allows for the prevention of outages and damages, and for the analysis of issues in retrospect. The European standard EN 50160 specifies power quality in low- and medium-voltage grids, whereas the IEC standards IEC 61000-4-30, -4-7 and -4-15 define power quality quantities and methods.

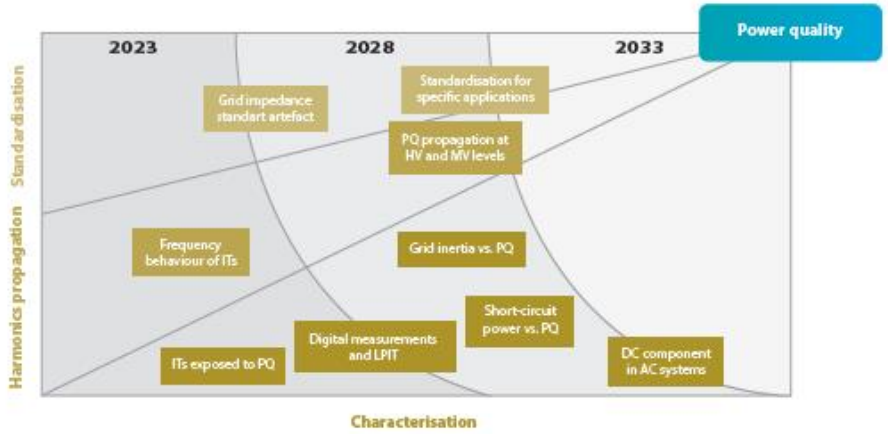
Traditionally, power quality is analogue to electromagnetic compatibility but limited to 9 kHz. Disturbances of significant levels have been observed up to 500 kHz: supraharmonics up to 150 kHz and effects owing to narrow-band power line communication (PLC) up to 500 kHz. The low-voltage grid impedance is influenced by the impedance of devices or equipment connected to it, and as such is frequency dependent. This varying impedance has an impact on the grid stability, but also on the reliability of PLC signals, for instance, due to transmission losses. Even today, experimental instruments and methods that can precisely measure the line impedance are limited. Furthermore, various proposed methods tend to yield incompatible results. Consequently, there is a need to establish a metrological traceable grid impedance standard in order to compare different measurement techniques and open the road towards standardisation.

Some of the harmonic content of the power waveform is transferred to different voltage levels through power transformers. Instrument transformers that monitor current and voltage at power stations are designed for a nominal operation at 50 Hz

4.2.1 Measurement challenges - Power quality

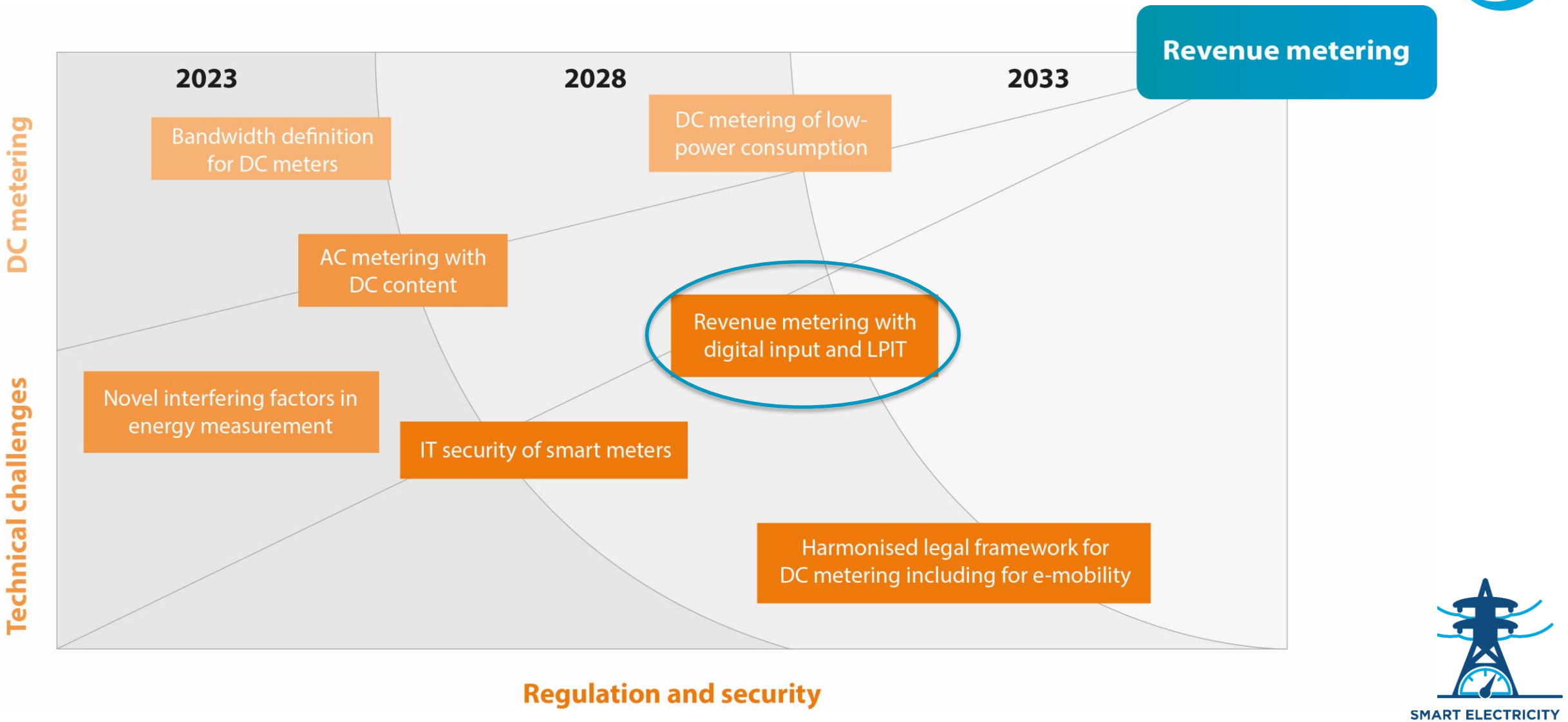
- Investigate the relation between RES-driven decrease of grid inertia and power quality
- Investigate the relation between RES-driven decrease of short circuit power and power quality
- Standardisation comparable to IEC 61000-4-30 for specific applications such as DC networks, railway infrastructure, and large ships
- Definition of a metrologically traceable grid impedance standard artefact and measurement method
- Measurement of propagation of PQ phenomena and events at HV and MV level and between voltage levels
- Development of characterisation methods for instrument transformer exposed to power quality phenomena
- Characterisation of the frequency behaviour of instrument transformers with investigation of propagation patterns of harmonics and other high frequency components
- Determination of the DC component in AC systems
- Power quality with digital measurements and low-power instrument transformers

4.2.2 Implementation roadmap - Power quality

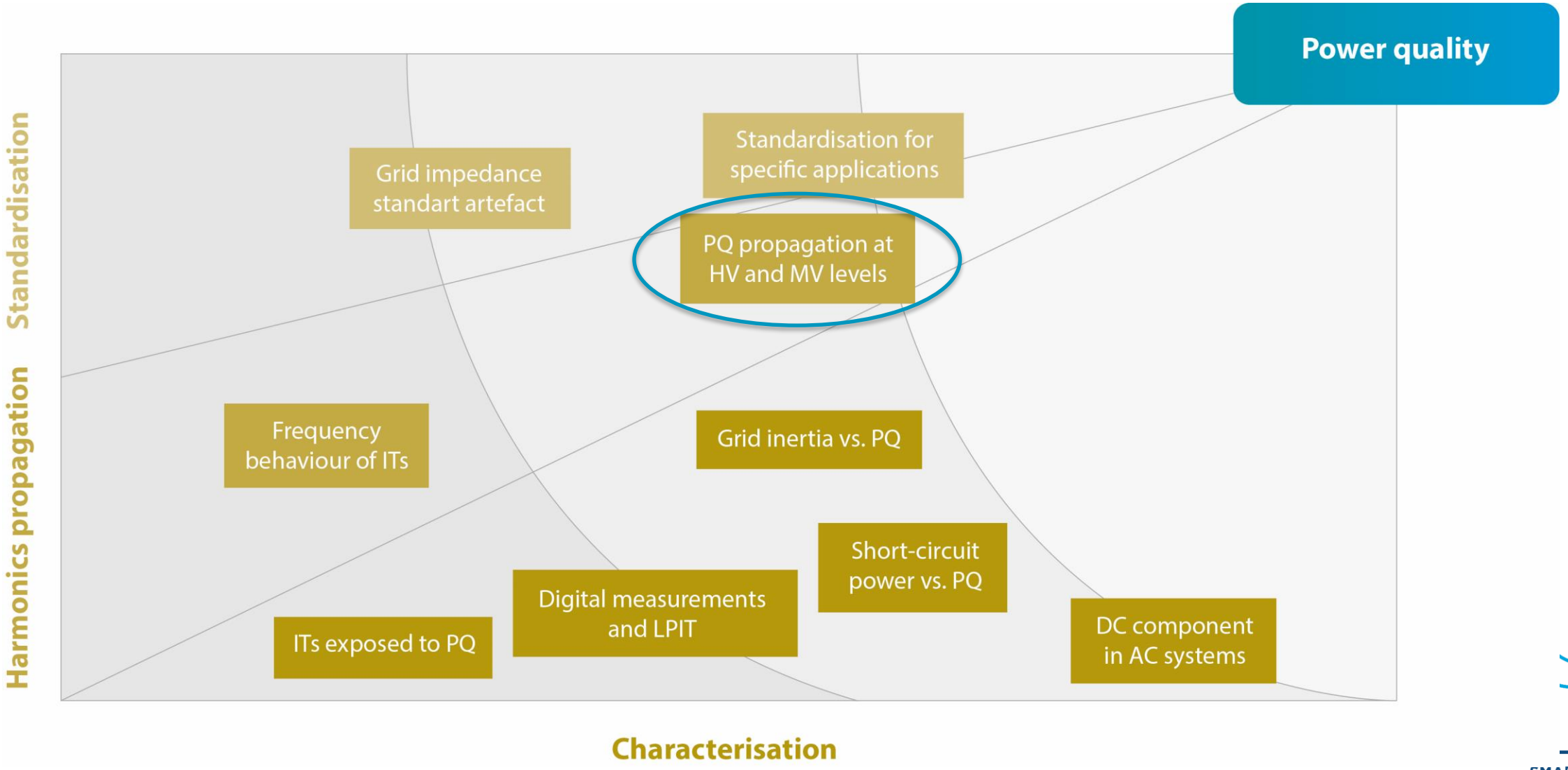


GRIDS

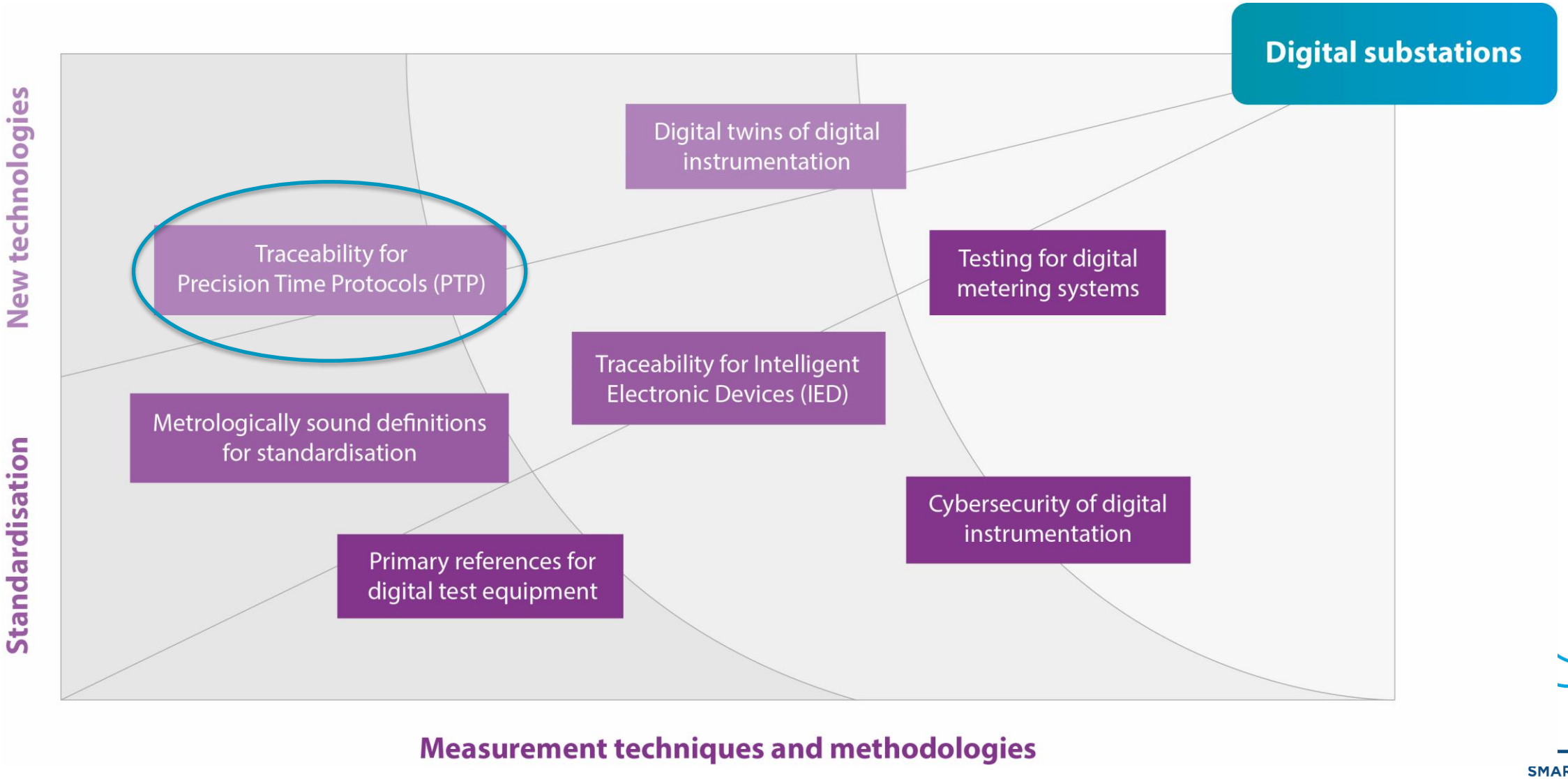
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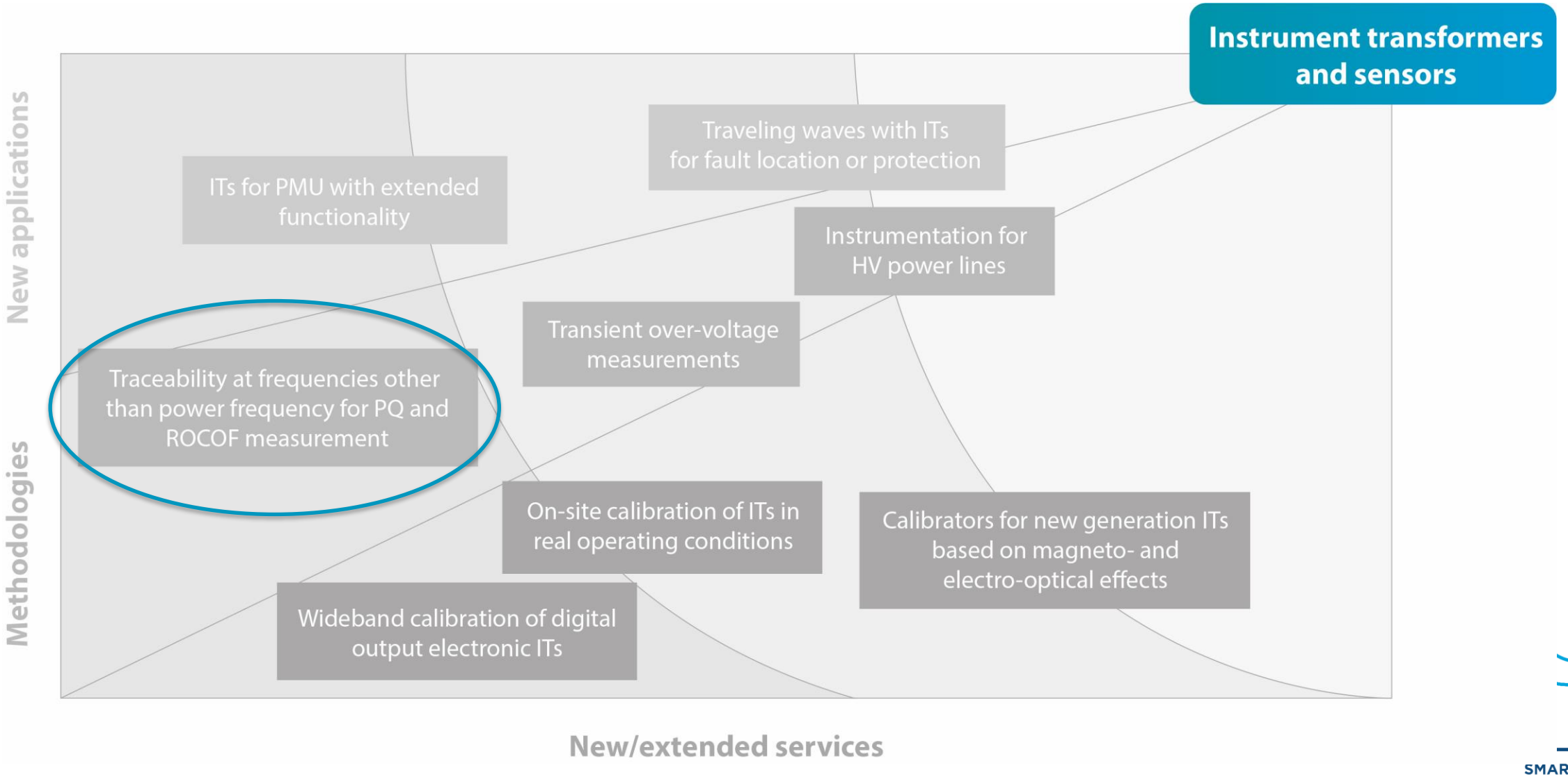
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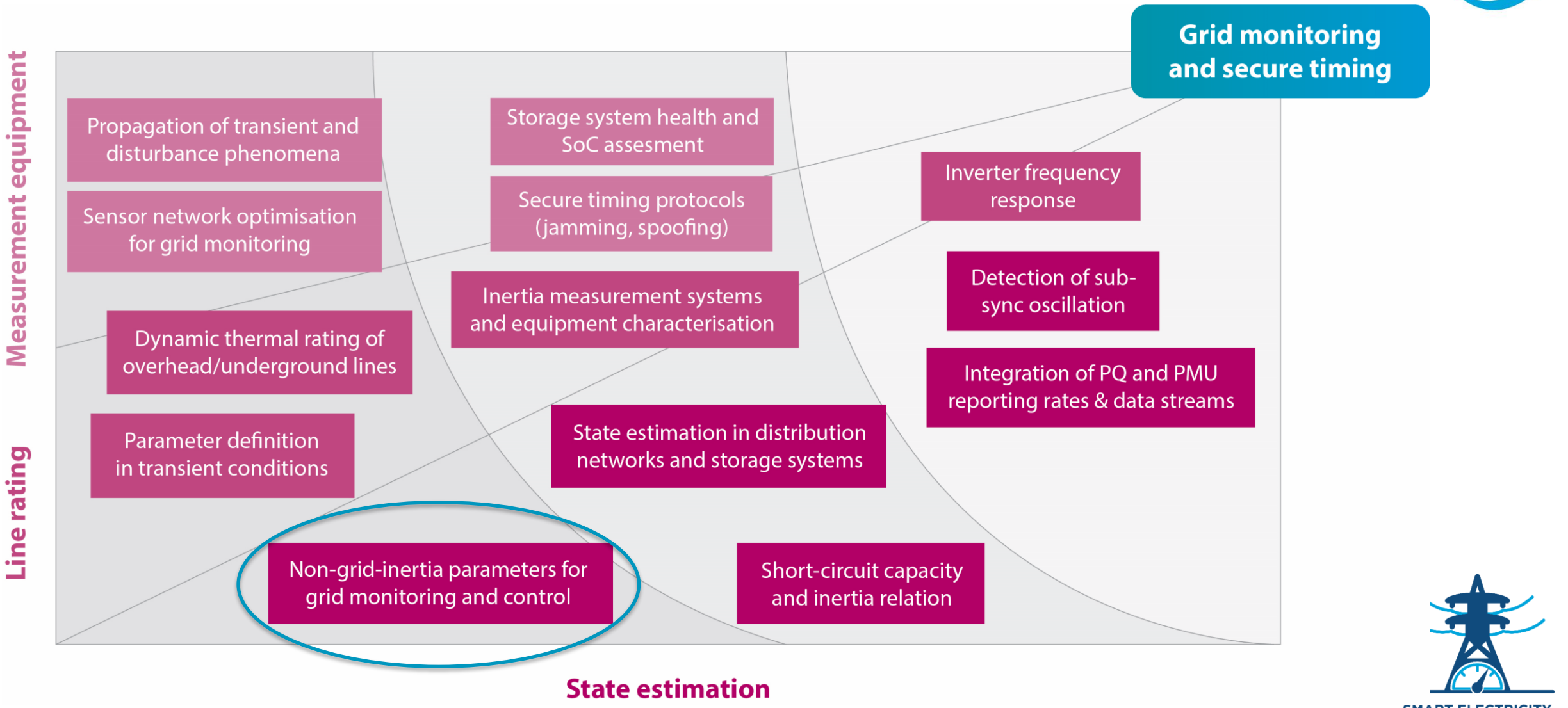
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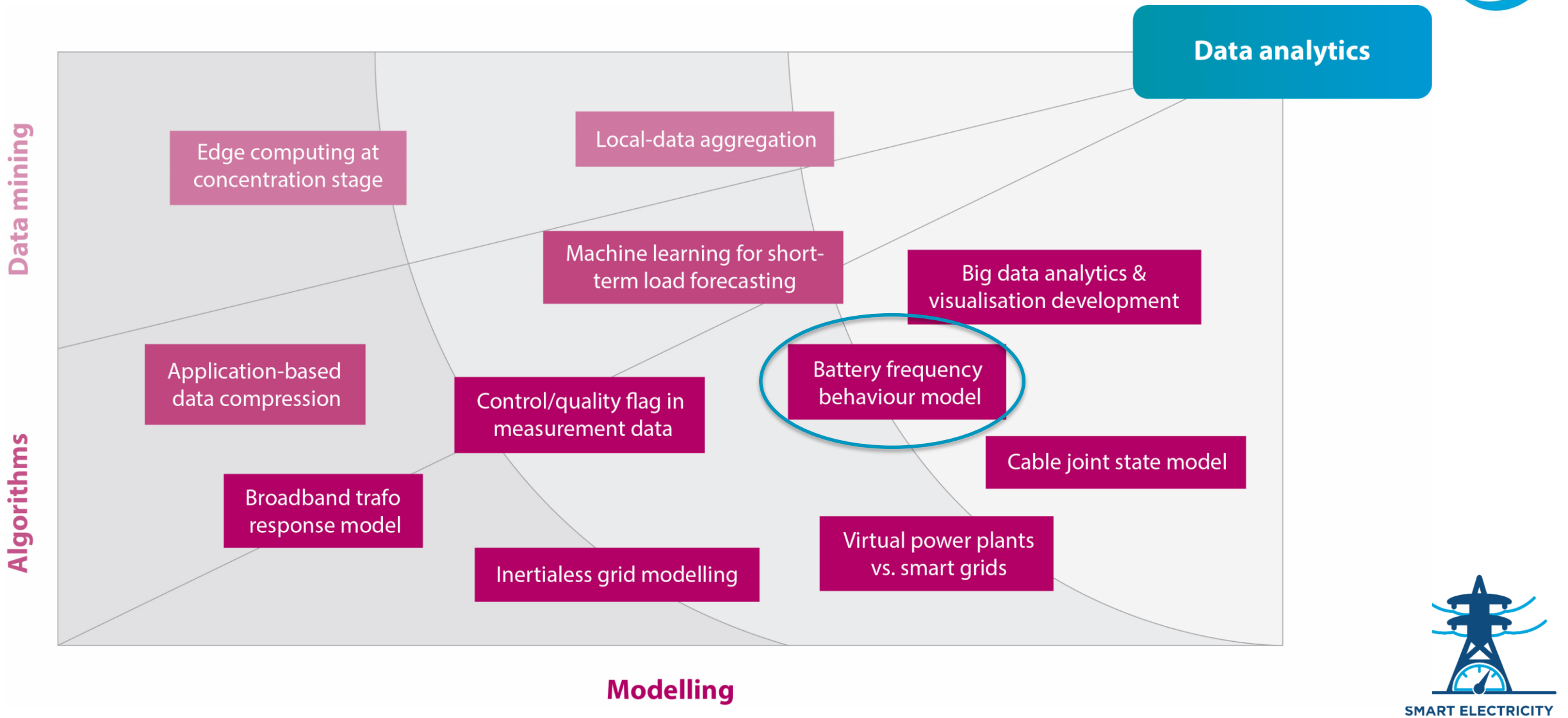


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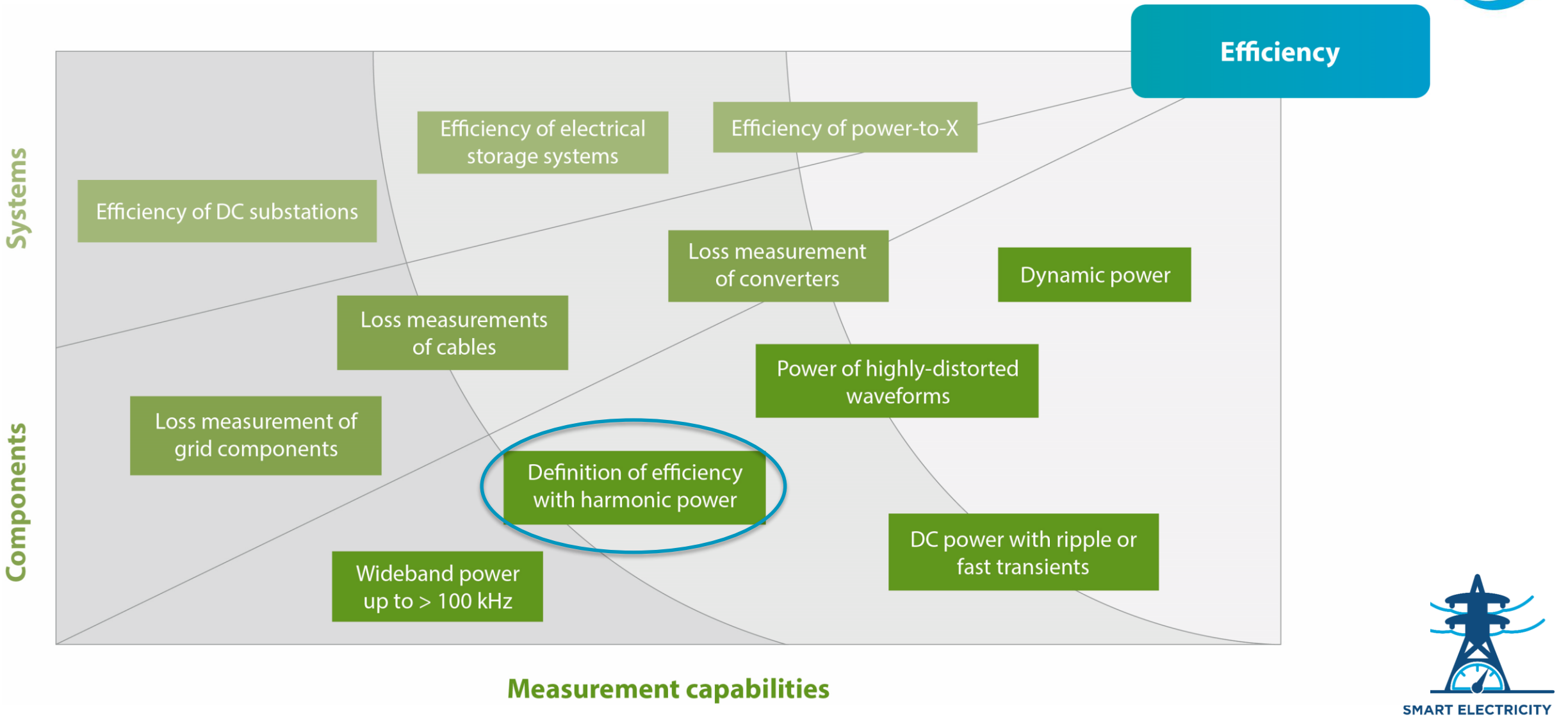


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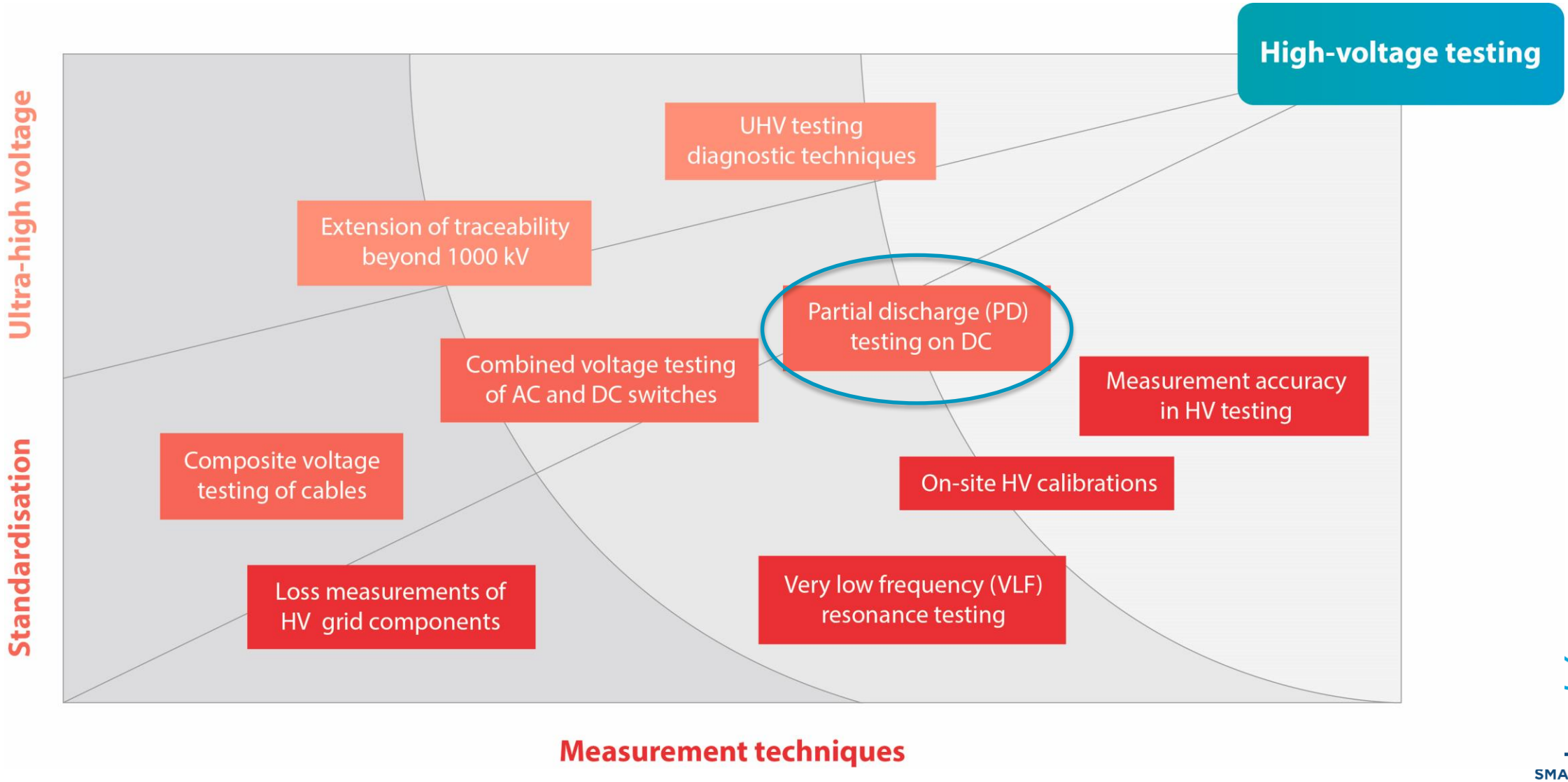
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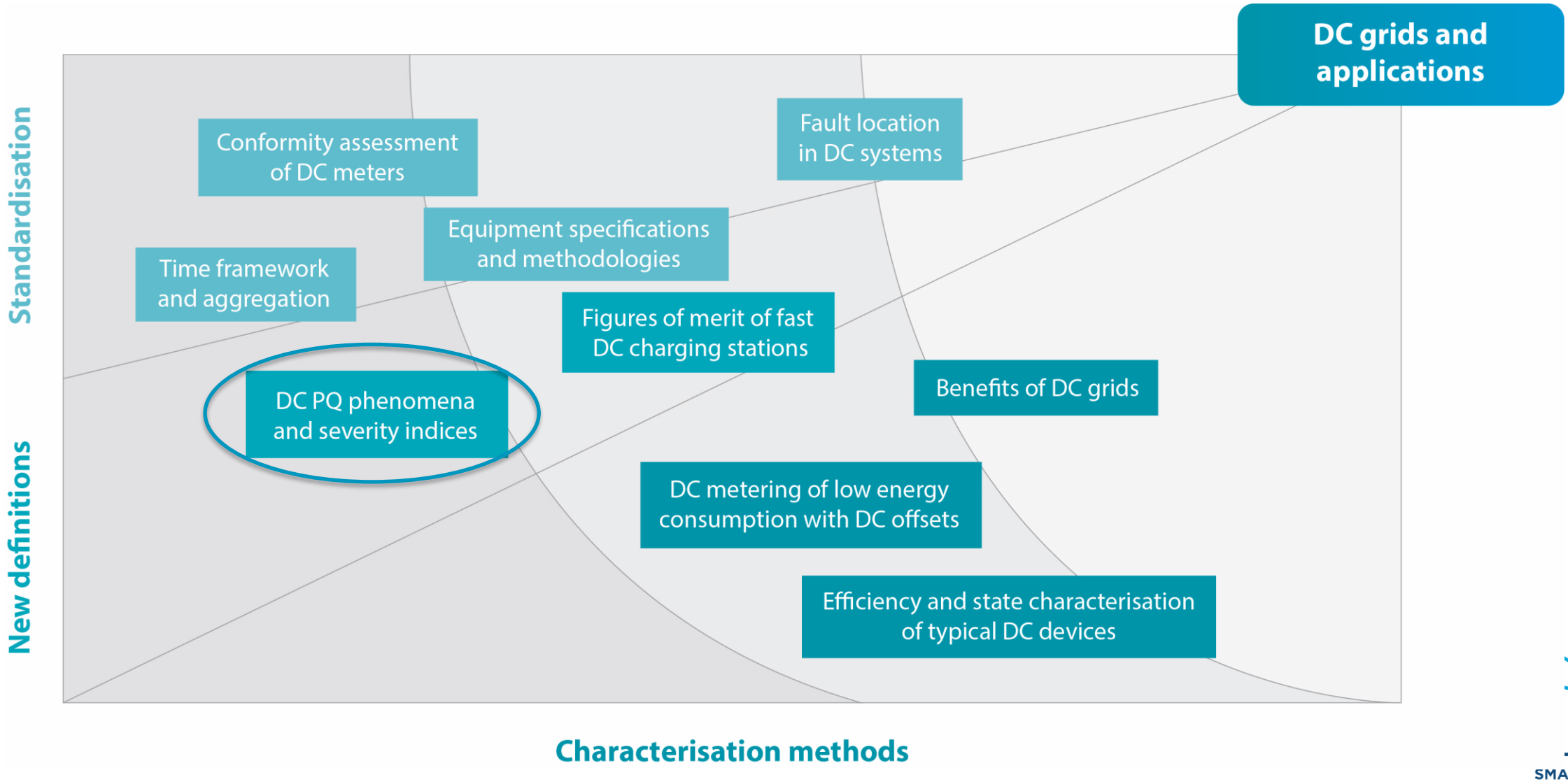
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Outlook for the SRA

- Strengthen links to the stakeholder community
- Update cycle on a 2-3 year basis using feedback from experts
- Next update in 2025-2026
- Any idea for Grid integration or Sector coupling?

Thanks

Keynote presentations

- High voltage measurement challenges

  Prof. Peter Vaessen

  Head of Innovation and Lab Development at KEMA

  Prof. of High Voltage Technologies at TU Delft

- What’s going on in IEC/TC85 and IEC/TC64 about DC applications?

  Franck Gruffaz

  Customer Advocate at Schneider Electric

  Pierre-Henri Herr

  Standardisation Manager at Socomec