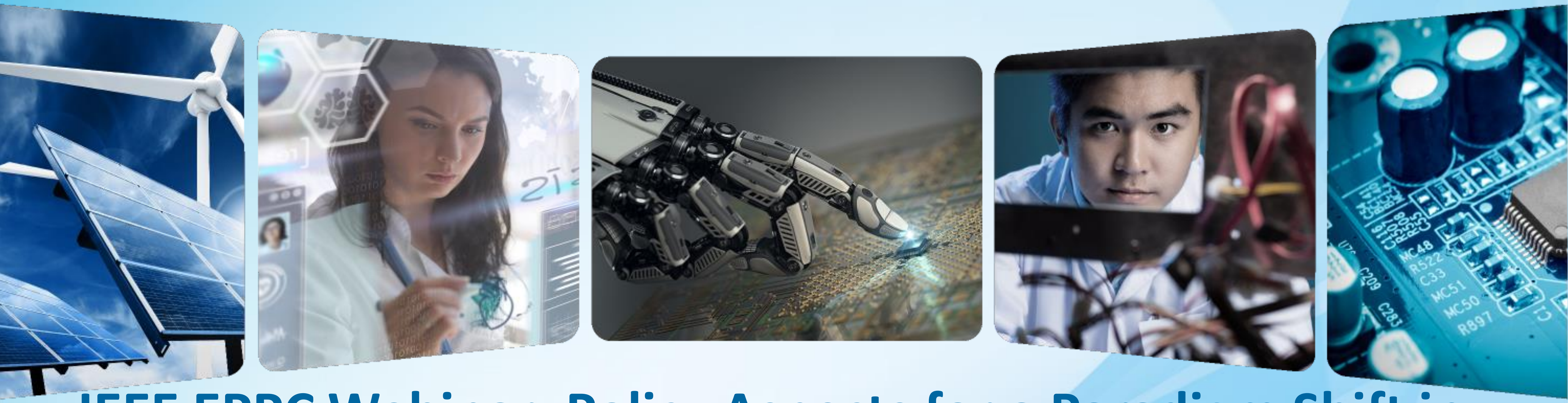

IEEE EPPC Webinar: Policy Aspects for a Paradigm Shift in Maintaining Grid Stability

Moderator: Costas Vournas
Professor Emeritus NTUA, Chair EPPC Energy WG

December 1, 2021

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Outline and Panelists

- Introduction by the moderator
- Dr. Chavdar Ivanov, Energy WG Member, Managing Director GridDigIt
  - Grid Stability Policy Document
- Dr. Jens C. Boemer, Member IEEE-SA, EPRI USA
  - IEEE Std. 1547, 2030.5, P2800 and related work
- Ms. Norela Constantinescu, Head of Section Innovation, ENTSO-E
  - Stability Management in Power Electronic Dominated Systems
- Mr. Mario Dionisio, Policy Officer, DG Energy, European Commission
  - DC Technologies in the energy system
- Mr. Jakub Fijalkowski, Policy Officer, DG Energy, EC

The contributions and statements in this webinar reflect the opinions of the panellists and not necessarily those of IEEE or the panellists' employers or affiliations

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Overview of EPPC Energy WG

IEEE European Public Policy Committee (EPPC)

- Created in 2018, with an ad-hoc Committee/Initiative since 2011
- 13 Voting Members (Chair: Jef Beerten) appointed by the N&A Committee
- *Purpose:*
  - Coordinate IEEE public policy activities in Europe
  - Expand the dialogue between public authorities and technologists in Europe
  - Give members a voice and means to educate policy makers
- *EPPC Work:*
  - Technical work is carried out by two working groups (i.e., Energy and ICT)
  - Policy documents
  - Meet and build relations with policy makers and other policy stakeholders
  - Organize and attend events
- *Resources:* https://www.ieee.org/about/ieee-europe/index.html

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IEEE EPPC Working Group on Energy

- Created in 2014, renewed in 2017, 2019 and 2021
- *Membership (2021):*
  - 12 Members chaired by Costas Vournas
  - Appointed by the EPPC
- *Purpose:*
  - To identify technology areas where input for policy makers is needed
  - To provide policy makers with impartial and sound advice on energy policy matters
- *Deliverables:*
  - To draft written materials (e.g., policy documents, responses to consultations)
  - Disseminate and interact with energy policy makers
  - Run webinars

EPPC Policy Documents

- ✓ EPPC activities give IEEE members a voice in public policy discussions
- ✓ The aim is to inform and interact in European policymaking
- ✓ Calls for engagement are launched to involve members in the development of EPPC policy documents.
- ✓ ***Get Engaged:*** https://engage.ieee.org/EPPC-Newsletter-SignUp.html

- ✓ *EPPC Policy Documents:*
  - ✓ https://www.ieee.org/about/ieee-europe/publications.html
- ✓ *Approved:*
  - ✓ "Heating and Cooling"
  - ✓ "Renewable Energy Systems"
  - ✓ "Smart Charging"
- ✓ *Under Revision*
  - ✓ *Transport Electrification*
  - ✓ *DC Electricity Distribution*
  - ✓ *HVDC Grids*
- ✓ *Under approval:*
  - ✓ "Grid Stability"
  - ✓ "Green Hydrogen"
  - ✓ Smart Buildings

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Overview of Grid Stability Policy Document
(pending approval)

- **Main Challenge**: Maintain stability with most Synchronous Generator Power Plants substituted by Converter Connected Distributed Generation during Energy Transition
- Need for Control **Paradigm Shift**: From centralized to **coordinated, distributed control** involving customers (loads), distributed resources (generators, storage)
- This has implications: Regulatory, in Research/Innovation and Standards.
- **Main Directions of Change** (to be facilitated):
- **Participation of consumers** and **distributed resources** to the provision of **frequency and voltage regulation**, as well as stability-related **ancillary services** including **load reduction** under **emergency conditions** (system integrity protection)
- Stronger **interaction** between **Distribution** and **Transmission** System Operators to provide system support by distribution grids, as well as **Regional Coordination** within Large Interconnections to allow cross-border support.
- **Coordination** and **harmonization** of international **standards** to allow seamless integration and interaction of distributed resources.

Dr. Chavdar Ivanov,
Member, WG on Energy,
Managing Director GridDigIt

Regulatory Recommendations

- Foresee technical minimum capability requirements and develop a regulatory framework and introduce incentives aimed at **favoring the participation of consumers (loads) and distributed resources** (e.g., photovoltaic and wind generators, and storage) in the **provision of stability** enhancing ancillary services, such as frequency regulation, voltage regulation, black-start capability, controlled islanding and stability-related services to the power grid.

- Introduce regulatory measures **encouraging, incentivizing, and potentially requiring the cooperation** between Distribution System Operators (DSOs) and Transmission System Operators (TSOs) in order to **provide grid support originating from distribution grids**.

- Request development of a new **methodology to maintain grid stability** with **wider scope complementing requirements** by Regulation (EU) 2017/1485 in the articles on dynamic security assessment and management.

Regulatory Recommendations

- Promote, via appropriate regulatory or policy **measures applying conformity assessment**, the integration of Information and Communication Technologies (ICT) including **data model-driven approaches** to achieve interoperability at all levels of the European power system.

- Encourage European TSOs to **redesign system protection schemes** in case of grid instability by incrementally replacing involuntary load shedding and/or rotating blackouts with **controllable or interruptible customers (loads) providing** also adequate compensation for such interruptible loads.

Research and Innovation Recommendations

- Stimulate research, development, innovation, and deployment of technological solutions that enhance power systems’ response to events and its stability. In particular, the IEEE EPPC encourages the European Commission to support specific **research on grid stability utilizing distributed resources including application of artificial intelligence for improving real-time situational awareness**, as well as the **utilization of probabilistic-based and risk-based tools**, necessary due to the intermittent nature of the renewable generation.

- Encourage research and innovation actions funded by instruments like Horizon Europe to **support work on pre-standardisation as well as to provide recommendations on regulatory frameworks** (including grid codes) and measures. Nowadays the interaction between research and standardization is minimal and takes place on a voluntary basis, which slows down the time to finalise crucial industry driven international standards.

Standardisation Recommendations

- Seek opportunities to **coordinate (and harmonise) on international standards activities**, taking into account, amongst others,
  - IEEE Std 1547-2018 IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces,
  - IEEE P2800 Draft Standard for Interconnection and Interoperability of Inverter-Based Resources (IBR) Interconnecting with Associated Transmission Electric Power Systems, and
  - IEEE Std 2030.5-2018 IEEE Standard for Smart Energy Profile Application Protocol,

  leading to a set of standards facilitating distributed control, competition, and cost reduction.

- Encourage standardization of **data model-driven approaches** to enable data interoperability at all levels of the power system. This applies to topics such as real-time stability monitoring in order to provide continuous protection of power system integrity as well as coordinated security assessment and dynamic security assessment. An **interoperable data model from an energy holistic point of view is essential to enable interactions** between system operators, consumers, prosumers, etc.

Dr. Jens C. Boemer
Member IEEE-SA, EPRI USA

Background: European Harmonization

entso-e Network Codes

Connection

- Demand Connection Code
- High Voltage Direct Current Connections
- **Requirements for Generators**

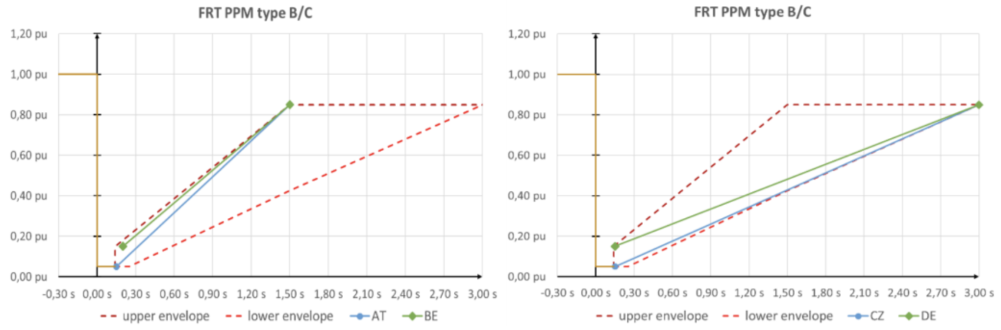
Operations

- Emergency and Restoration
- Cybersecurity
- Operations

Markets

- Forward Capacity Allocation
- Capacity Allocation & Congestion Management
- Electricity Balancing

Implementation Challenges



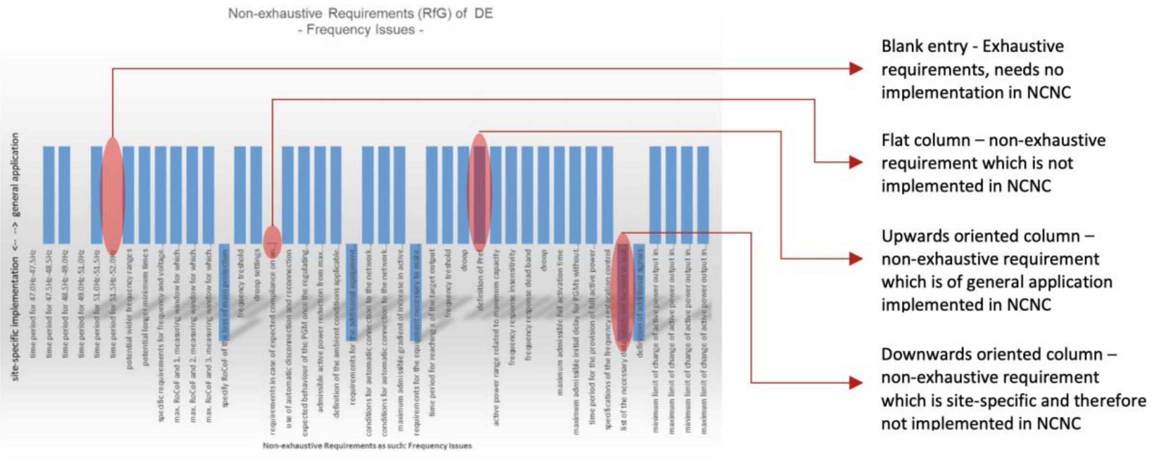


Figure 1: Example bar chart for demonstration and interpretation of binary coding approach

Source: own compilation based on

- https://www.entsoe.eu/network_codes/
- https://eepublicdownloads.azureedge.net/clean-documents/Network%20codes%20documents/CNC/201201_-_Implementation_Monitoring_Report_2020%20-%20Final%20Version.pdf

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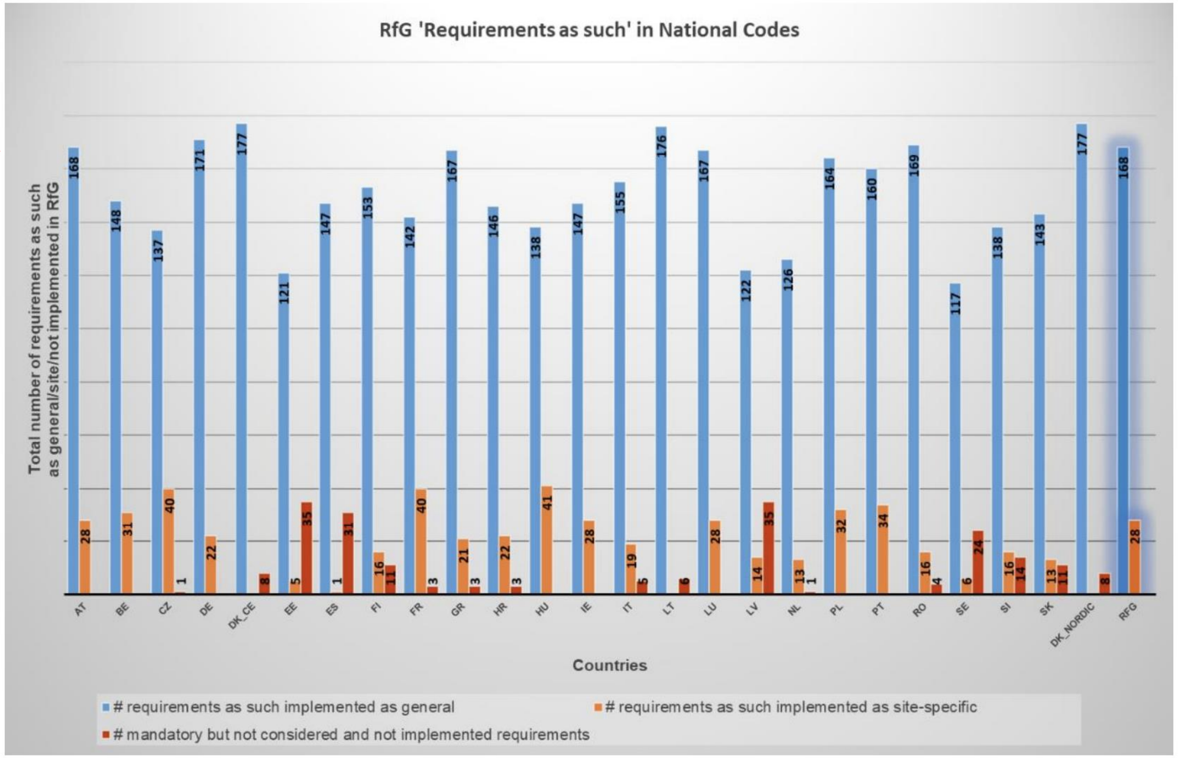

Figure 5: Reference total number of to be implemented RfG non-exhaustive requirements as such

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What to expect from IEEE SA Interconnection and Interoperability Standards?

May Provide Value

voluntary, widely-accepted, unified technical minimum capability requirements
possible simplification and speed-up of technical interconnection negotiations
flexibility for technology developers ➔ not an equipment design standard

May Specify

performance and functional capabilities, *not* utilization & services
functional parameters, default settings, and ranges of available settings
communication protocols and data models
performance monitoring and model validation
type of tests, plant-level evaluations, conformity assessment

Scope of Interconnection and Interoperability Standards

Transmission, sub-transmission, and distribution connected, large-scale and small-scale wind, solar, energy storage, and controllable loads

Mapping Standards of Different Standards Setting Organizations

IEEE

Scope	**Standard(s)** – *selection may be incomplete*
Interconnection and interoperability requirements	IEEE P2800 (Large IBR) IEEE 1547 (DER)
Test, Verification, and Conformity Assessment	IEEE P2800.2 (Large BR) IEEE 1547.1 (DER) IEEE ICAP
Communication and interoperability	IEEE 2030.5 (SEP2) IEEE 1815 (DNP3)

IEC/CENELEC

Scope	**IEC** – *selection may be incomplete*	**CENELEC** – *selection may be incomplete*
Interconnection and interoperability requirements	IEC 60034 (rot. machines) IEC 61400 (wind) IEC TS 62786-1 (DER) IEC TS 62786-2 (solar PV) IEC TS 62600 (wave & tidal)	CLC/TS 50549 (DER)
Test, Verification, and Conformity Assessment	IEC 61400-21 and -27 (wind) IEC 62116 & 63409 (solar PV) IEC IECRE	CLC/TS 50549-10 (DER)
Communication and interoperability	IEC 61968 (data model) IEC 61850 (communication protocol and data model)	CENELEC – EN IEC 61850-8-2 prTS 50XXX prTS 50568-4 (AMI)

Source: own compilation based on

- https://eepublicdownloads.entsoe.eu/clean-documents/Network%20codes%20documents/Implementation/stakeholder_committees/GSC/2016_08_09/160907%20CENELEC%20standards%20-%20brief%20status.pdf?Web=1
- https://storage-iecwebsite-prd-iec-ch.s3.eu-west-1.amazonaws.com/2021-08/content/media/files/iecre_2021_about_a4_en_lr_0.pdf
- https://www.cencenelec.eu/media/CEN-CENELEC/AreasOfWork/CEN-CENELEC_Topics/Smart%20Grids%20and%20Meters/Smart%20Grids/smartgrids_firstsetofstandards.pdf

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- https://storage-iecwebsite-prd-iec-ch.s3.eu-west-1.amazonaws.com/2021-08/content/media/files/iecre_2021_about_a4_en_lr_0.pdf
- https://www.cencenelec.eu/media/CEN-CENELEC/AreasOfWork/CEN-CENELEC_Topics/Smart%20Grids%20and%20Meters/Smart%20Grids/smartgrids_firstsetofstandards.pdf

Conclusions & Recommendations

IEEE SA	ANSI
IEC	CEN
UL	CSA

I. Close gaps in existing European guidelines and standards
   - Review of IEEE Standards
   - Update ENTSO-E Network Codes
   - Update IEC and CENELEC Standards

II. Promote global harmonization by coordination on international SSO activities
   - Consideration of joint IEEE/IEC/ CENELEC Standards
   - Development of globally harmonized Conformity Assessment

Ms. Norela Constantinescu
Head of Section Innovation, ENTSO-E

Stability Management in Power Electronic Dominated Systems

RDI Roadmap, Flagship 5 AC/DC hybrid systems

Massive introduction of power electronics impacts today's stability (e.g. inertia), creates new phenomena, but bring also opportunities (grid forming)

A strongly interconnected and hybrid AC/DC power system requires new solutions

Change of characteristics in generation and demand require new methods for planning, design and operation concepts and tools

- Develop, test and implement **a new wide-area system stability management approach**.
- Coordinated response from Inverter Based Resources
- **A wide-area monitoring, protection and control system (WAMPAC)** to coordinate regional frequency response and maintain the system stability
- **System services** are critical, **access to flexible resources is a fundamental parameter**
- **Procedures** for long- mid and short-term planning and real-time operation and **tools** for the **simulation of dynamic behavior**
- **Significant RDI efforts** to foster digitalisation, develop technological options, new planning and operational tools and models

WP1: Long term planning, development and design

WP2: Mid to short term resource planning

WP3: Sources for system services

WP4: Real time planning and operation

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DC Technologies in the energy system

Mario Dionisio

Unit B5 - DG Energy
European Commission

Key challenges

- The business as usual grid planning and development can not cope with many aspects of the energy transition (wide offshore development prospected by the ORES, fit for 55% and other energy policy initiatives and instruments): need of a modern energy system
- The increase of Power Electronic Interfaced Devices (PEID) due to the growing increase of RES contributes to make the grid more unstable
- ➔ DC technologies as part of the solution

Overarching goals

- **Prove the grounds to decision-makers and investors** to make better-informed decisions regarding the DC systems as an important grid development option.
- **Increase interest and acceptance** of DC Technologies systems among professional engineers, investors and decision-makers.
- **Support** the development of DC Technologies and Systems (HVDC, MVDC, LVDC) within the AC grid to make both the offshore and onshore grid fit-for-purpose in 2050.
- **Stimulate R&D** to increase the efficiency, controllability, security and dynamic stability of the electricity grid.

Key actions

- DG ENER – DG CNECT Expert round table on the impact of electronic components and systems in the energy domain, in 2017
- DG ENER DC – AC/DC hybrid grid workshop, in 2018
- DG ENER – ENTSO-E Horizon 2050 power system and the role of HVDC technologies in a highly decentralised RES generation, in 2020
- DG ENER Low voltage direct current and direct current technologies: potential applications for a clean energy transition, on 8, 9 and 10.11.2021

Outcomes

- Horizon 2020 calls on MVDC. Two projects ongoing: TIGON and HYPERRIDE
- Horizon Europe calls open on HVDC, Power Electronics, SCTL
- New SET-PLAN Working Group on HVDC

Objectives of the HVDC WG

- **Align ongoing research**, development and innovation actions at national and EU level and focus new actions.
- **Raise interest in DC systems** and related Power Electronics at national and EU level to support this key technology for the energy transition.
- **Increase the collaboration and coordination** with SET Plan countries and to ensure their active involvement in the technology development.
- **Set targets** for HVDC technology development to make the energy systems fit for the future with the need to transport and integrate large scale renewable electricity in the EU energy system.

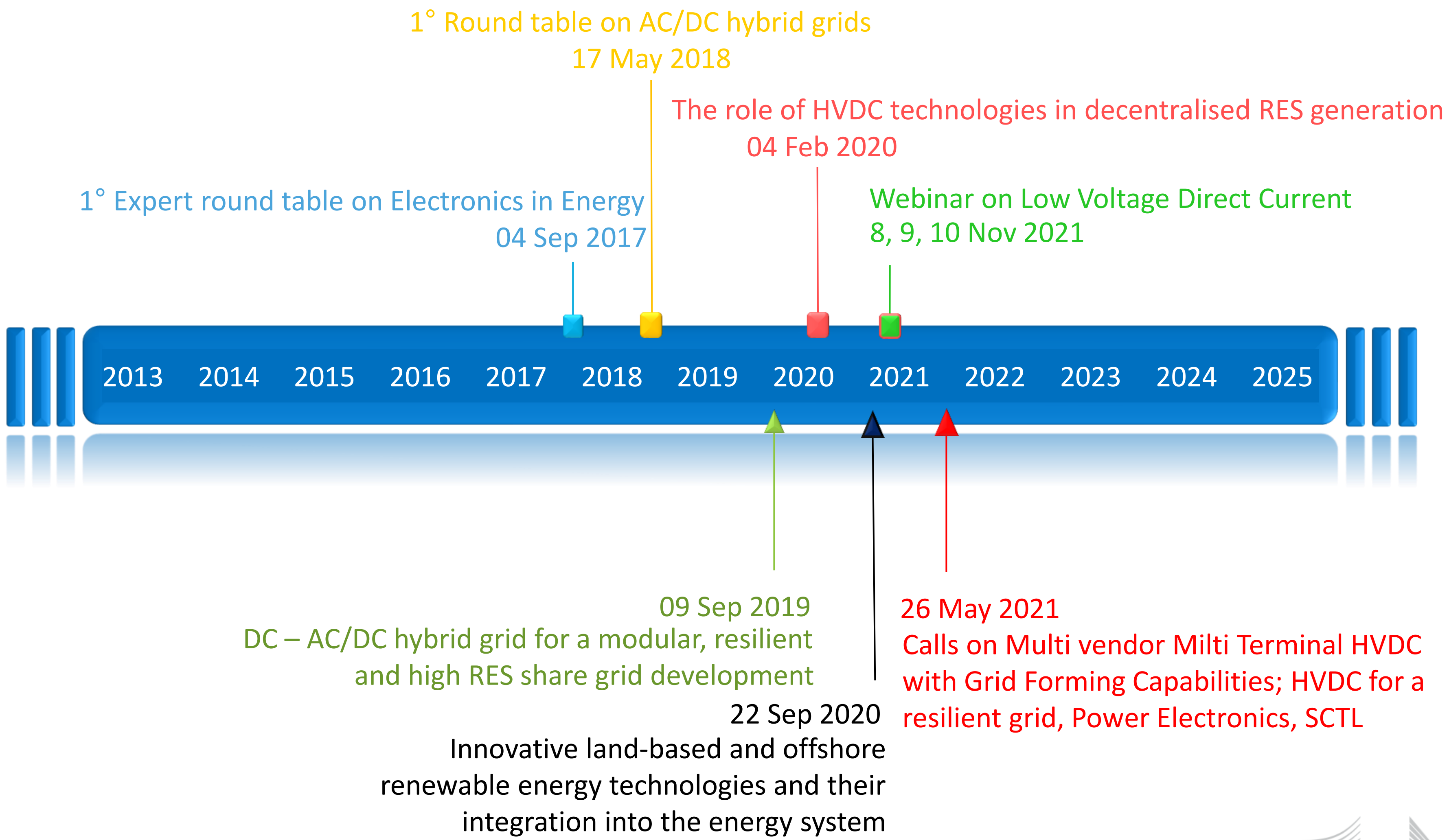
HVDC solution (2 birds with one stone)

- Short-term
  - Commissioned first European full-scale implementation of Multi-Vendor Multi Terminal VSC HVDC with Grid Forming Capabilities (by 2026 - 2027)
  - Studies and knowledge of complex DC and AC / DC hybrid systems to anticipate the grid behavior and address the related challenges
- Mid to Long-term
  - Stability management concepts (e.g. Grid Forming capabilities)

LVDC solution

- Optimisation of the overall grid:
  - AC/DC/AC double conversion avoided, use of less copper
  - Converters can bring services to the AC grid
  - Decongesting AC grid through local DC microgrids
  - Wide range of application: distribution grid, industry, data centres, buildings, EV charging stations
- Challenges:
  - Standardisation and certification
  - Regulation
  - Education & training
  - More R&I&D

EC support to innovative technologies



Conclusions

- The end goal is reducing the global warming of our planet ➔ **decarbonisation of the energy system and our economy.**
- **DC systems are not replacing, but are complementary to AC. T**hey can work in symbiosis for a more efficient grid.
- **DC systems** can bring benefits, but there are challenges to be addressed. **AC – DC hybrid solutions** need to be developed. More R&D&I is needed to obtain solutions applicable and competitive.
- Horizon 2020 and Horizon Europe support the transformation of the energy system through large demonstration projects to **de-risk technologies** and enable the energy transition.

Thank you!

Mario Dionisio

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Mr. Jakub Fijalkowski, Policy Officer, DG Energy, European Commission