Technopedia:

Grid Enhancing Technologies

29 June 2021

A webinar by:

entsoe

T&D europe

CurrENT

Enabling Network Technology throughout Europe

Ground rules

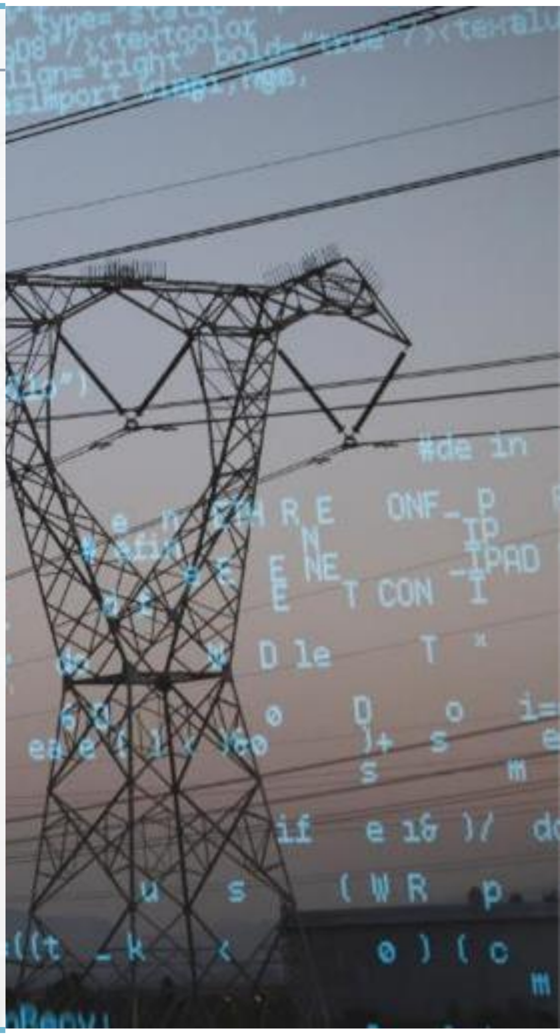
- Switch off the mic & camera
- During the panel discussion, write your question to the chat
- The webinar is recorded
- All the materials will be shared via the event website

A webinar by:

Technopedia webinar - agenda

29 June 2021 - 11.00-13.00

What?	When?	Who?
Welcome & Introduction	11.00-11.05	**Norela Constantinescu/Lorant Dekany** (ENTSO-E)
ENTSO-E Technopedia: The Assets, the Flexibility and the Digital technologies	11.05-11.20	**Bartosz Rusek, Christos Dikeakos, Karel Vinkler** (ENTSO-E RDI Committee)
Use cases from the Technopedia	11.20-11.55	
- HVDC		**Jochen Kreusel** (ABB Hitachi)
- FACTS		**Susanne Nies** (SmartWires)
- DLR		**Rena Kuwahata** (Ampacimon)
- Superconductors		**John Fitzgerald** (Supernode)
Competitiveness Progress Report	11.55-12.10	**Mark van Stiphout** (DG ENER)
Grid optimization & timely solutions	12.10-12.20	**Ivan Pineda** (WindEurope)
Panel discussion - trends of the grid enhancing technologies	12.20-12.45	**Susanne Nies** (CurrENT), **Jochen Kreusel** (T&D Europe), **Mark van Stiphout** (DG ENER), **Ivan Pineda** (WindEurope), **Uros Salobir** (ENTSO-E) **Christos Dikeakos** (ENTSO-E)
What's next for the Technopedia?	12.45-12.55	**Uros Salobir** (ENTSO-E RDI Committee)
Conclusions	12.55-13.00	**Norela Constantinescu** (ENTSO-E)



ENTSO-E Technopedia:
The Assets, the Flexibility and the Digital technologies

Bartosz Rusek
Convener of Working Group ‘Assets & Technologies’
ENTSO-E

Christos Dikeakos
Convener of Working Group ‘Flexibility & Markets’
ENTSO-E

Karel Vinkler
Convener of Working Group ‘Digitalization & Communication’
ENTSO-E

entsoe
Reliable Sustainable Connected

Technopedia

A new tool to guide through innovative & state-of-the-art technologies related to the world of TSOs

Factsheets provide:

- General description
- Info on advantages & field of application
- Technology Readiness Level (TRL)
- Current fields of research
- Selected best practices

Assets
34 Factsheets

Flexibility
23 Factsheets

Digital
8 Factsheets

Technopedia

The Report:
- Static document
- Graphically enhanced

ENTSO-E
Technology Factsheets

ASSETS

HVDC Mass Impregnated Cables

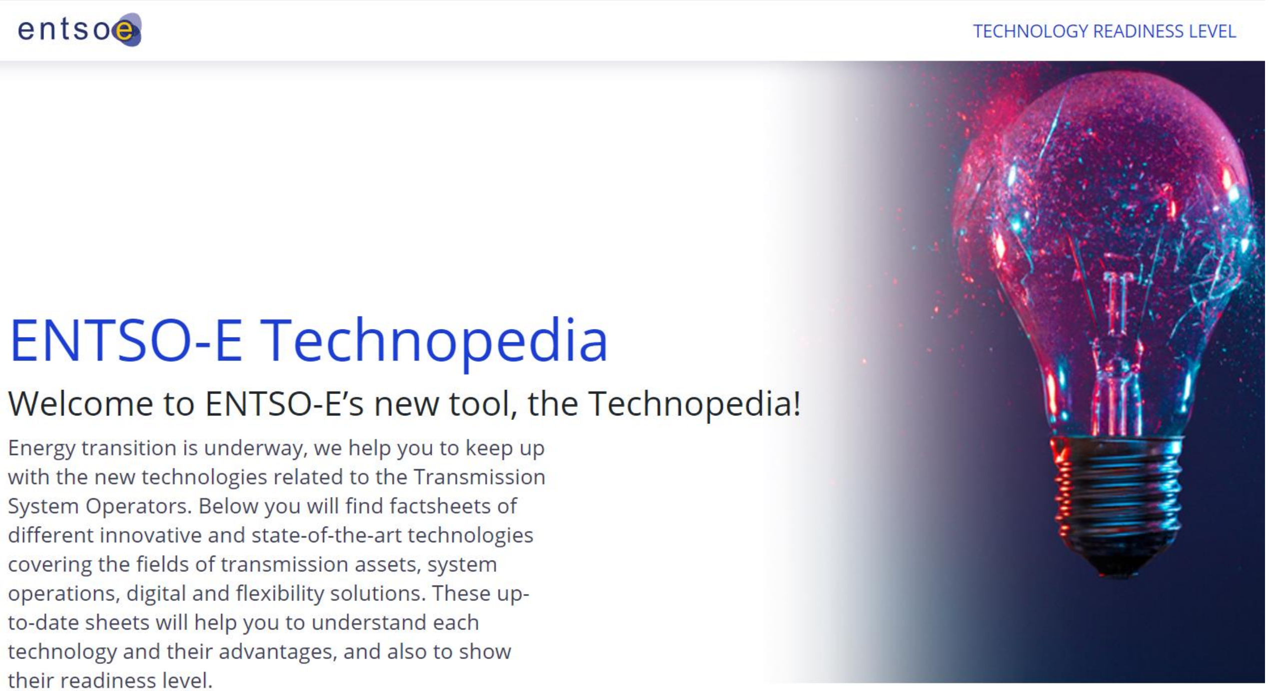
HVDC Mass Impregnated (MI) cables are a very consolidated and traditional technology mainly deployed for subsea applications. Initially, MI cables were used with LCCs. Currently, this technology is mainly deployed for Extra High Voltage (EHV) DC subsea applications. MI cables are composed of a very high viscosity impregnating compound which does not cause leakage in the event of cable damage or failure. The latest innovation allows voltages of up to 600 kV.

Technology Types

Advantages & Field of Application

Components & Enablers

The Tool:
- Regularly updated
- Easy to search



https://www.entsoe.eu/Technopedia/

Technopedia

Assets
34 Factsheets

The primary technologies related to the energy transmission system according to the current TRL

TRL 3: Experimental proof of concept
- HVDC XLPE (600 kV)
- EHV Fault Current Limiter (≥ 245)
- SF6-free: GIS (EHV switchgear)
- EHV SF6-free AIS & GIS circuit breaker
- EHV: HVDC Circuit Breakers

TRL 4: Technology validated in lab
- SF6-free: DC GIS
- High Temperature Low Sag Conductors
- SF6-free: GIL – DC
- New Tower Concepts (New ideas and studies)
- DC / DC VSC
- Probabilistic Asset Management
- Meshed MT Large-Scale DC Overlay Grid Concepts

TRL 5: Technology validated in relevant environment
- HVDC XLPE (525 kV)
- DC: HTS Cables
- SF6-free: Mixed Technology Substations (MTS)
- AI based Load Forecasting

TRL 6: Technology demonstrated in relevant environment
- DC GIS
- SF6-free: GIS (HV insulation and switchgear)
- SF6-free: GIS (EHV insulation purpose)
- HV: HVDC Circuit Breakers

TRL 7: System prototype demonstration in operational environment
- HVAC XLPE (≥ 420 kV)
- AC HTS Cables
- SF6-free: GIL – AC
- Hybrid AC / DC OHL Conversion from AC to DC
- New Tower Concepts (New designs)
- Voltage Uprating (≥ 245 kV)
- Super conducting Fault Current Limiter (SCFCL)
- HV SF6-free AIS & GIS circuit breaker
- Conventional SSSC
- Transformerless SSSC (> 110 kV)
- High inertia Synchronous Condensers with Flywheel
- IoT based Asset Management
- Drones and Robotics

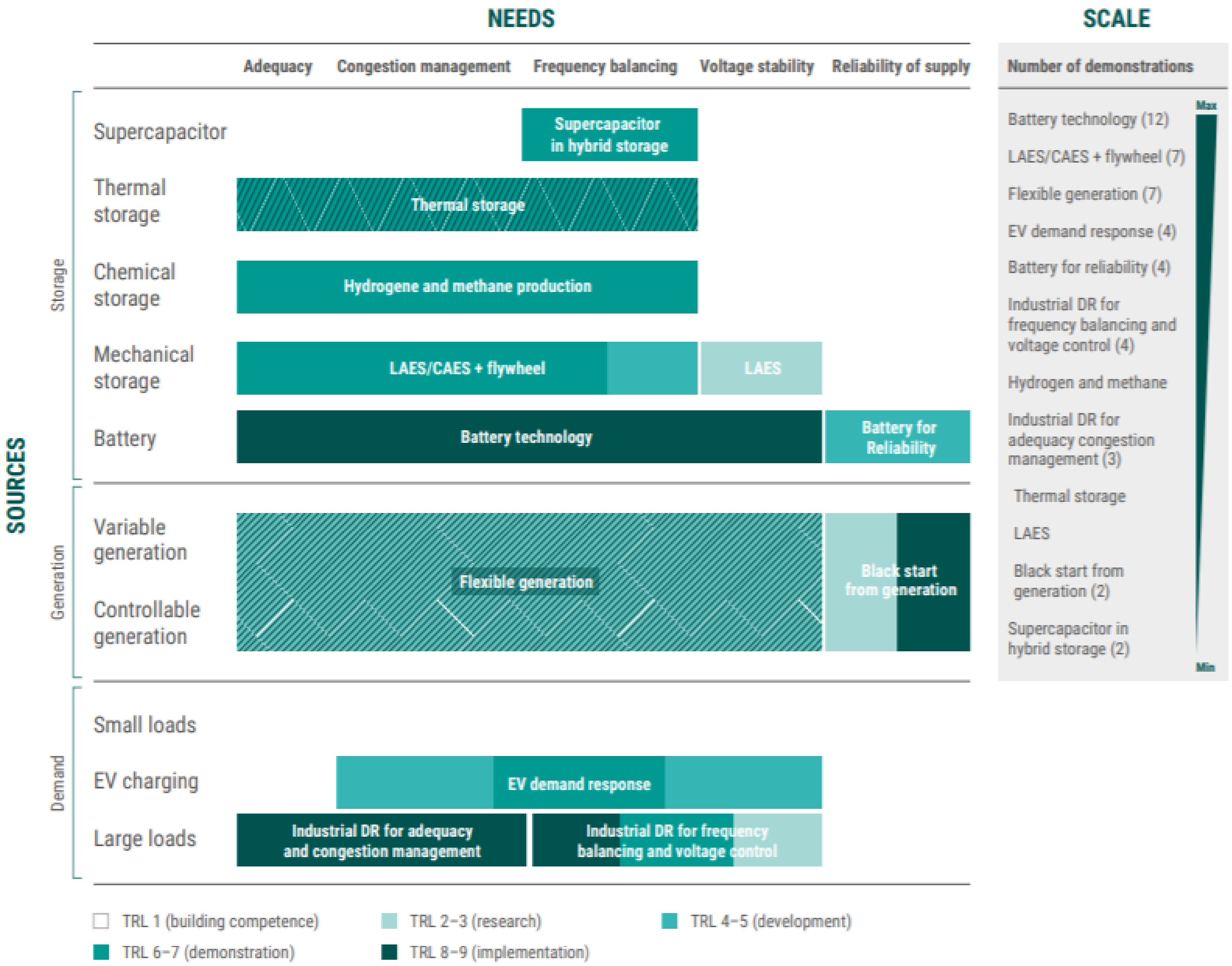
TRL 8: System complete and qualified
- Partial Undergrounding (EHV)
- Static Synchronous Compensator (STATCOM)
- Full bridge VSC

TRL 9: Actual system proven in operational environment
- Conventional Conductors
- HVAC XLPE (< 245 kV)
- HVDC XLPE (320 kV)
- GIL – AC
- GIL – DC
- Dynamic Line Rating (DLR)
- HVDC Mass Impregnated (MI) Cables
- New Tower Concepts (Lattice towers)
- Voltage Uprating (< 270 kV)
- Digital Fault Recorders
- Non-superconducting Fault Current Limiter (FCL)
- Gas Insulated Substation (GIS)
- Mixed Technology Substations (MTS)
- AC Power Transformers (with Tap Changer)
- Circuit Breakers – AC
- Phase Shifting Transformers (PST)
- (Variable) Shunt Reactor – (V) SR
- Transformerless SSSC (< 110 kV)
- Conventional systems Synchronous Condensers
- Line Commutated Converters (LCC)
- Current Source Converters (CSC)
- Monopole and Bipole VSC
- Half bridge VSC
- Adaptive Protection Technology
- Asset Management
- Radial MT Large-Scale DC Overlay Grid Concepts
- Enhanced Load Forecasting
- Enhanced RES Infeed Forecasting – Wind

Technopedia

Mapping research on flexibility solutions – Technical

Flexibility
23 Factsheets



Technopedia

Digital
8 Factsheets

5G Digital Cellular Networks

Artificial Intelligence

Distributed Ledger Technology/Blockchain

Digital Twin

Cloud and Edge Computing

Internet of Things

Satellite Applications

Software-defined Security

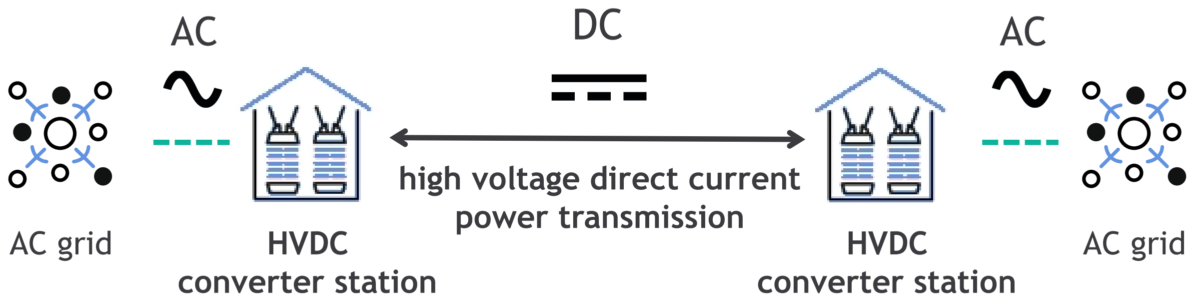
To be continued…

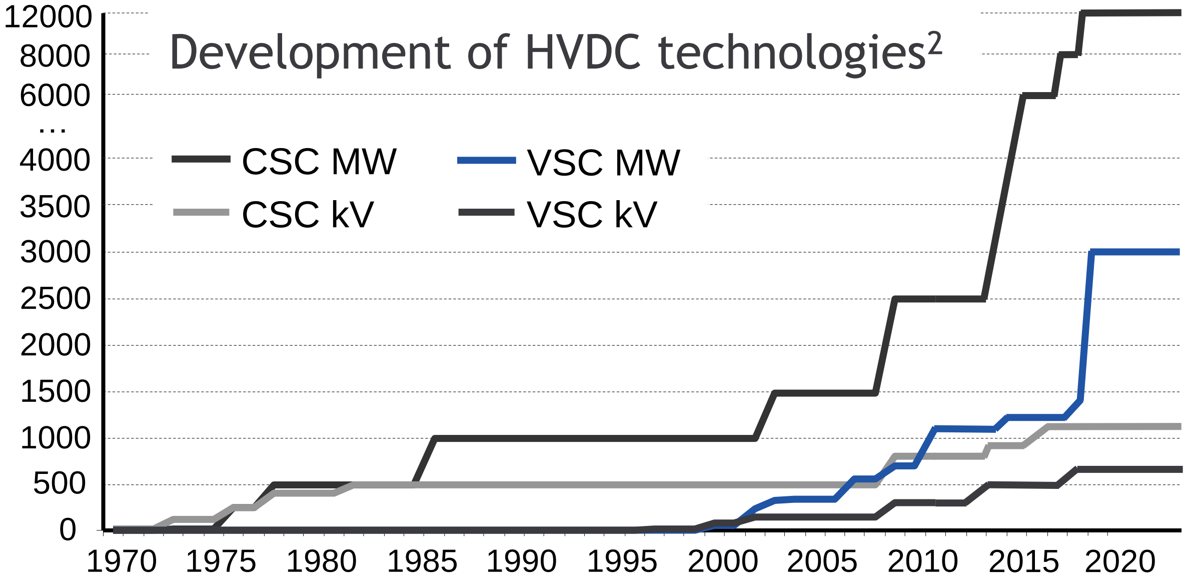
Use cases from Technopedia #1:
High-voltage Direct Current (HVDC)

Jochen Kreusel
Global Head of Market Innovation
Hitachi ABB Power Grids

A short introduction to HVDC[1] transmission

A technology with a long track-record and permanent evolution





Advantages

- Low losses (direct current)
- Small footprint
- No limitations in length
- Cables can be used over long distances as there is no reactive power consumption

Current source converters (CSC, LCC), ...12.000 MW

- Available since 1954
- Line-commutated thyristor valves
- Overhead lines or mass-impregnated cables
- Minimum short circuit capacity > 2x converter rating
- Bulk power long distance transmission, coupling of asynchronous power systems

Voltage source converters (VSC), ...3.000 MW

- Available since 1997
- Self-commutated IGBT valves
- Extruded cables or overhead lines
- No minimum short circuit capacity, black start capability
- Multiple areas of application

1 HVDC: high voltage direct current

2 Source: Hitachi ABB Power Grids

Why are we talking about HVDC today?

T&D europe

HVDC uses cases in the past and in future

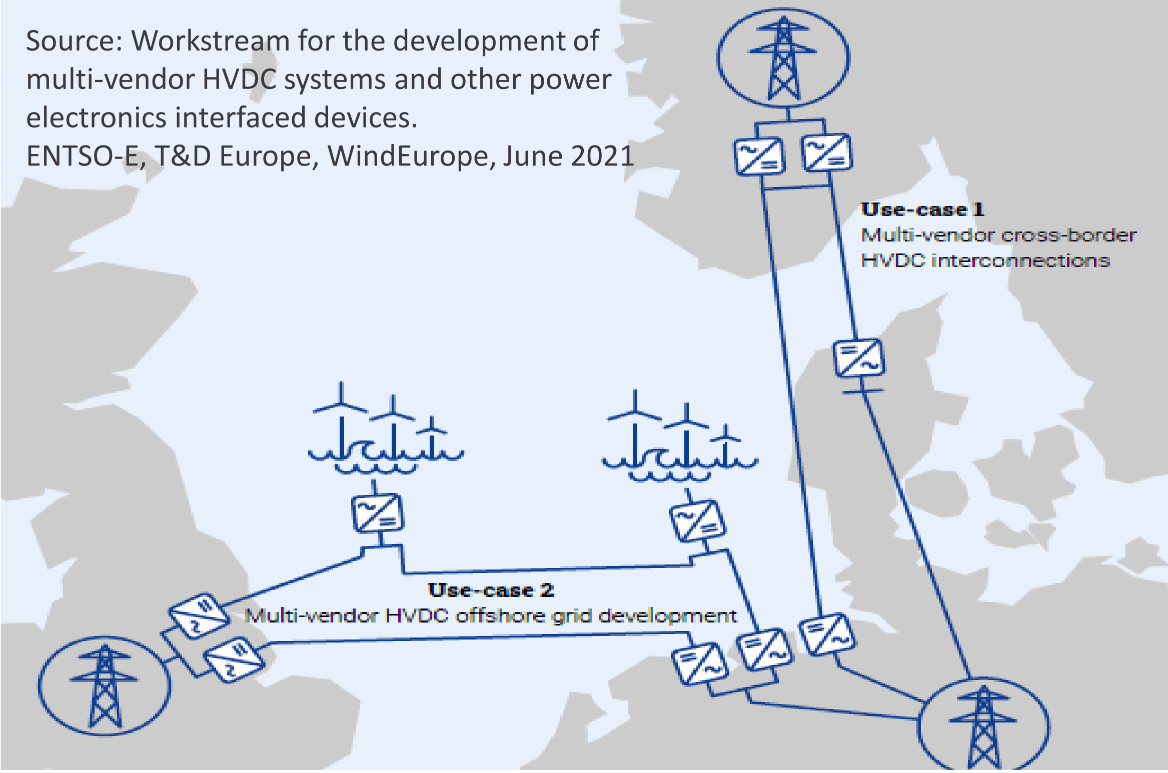
HVDC in an evolving environment

Power systems in the past	Power systems in the future
Primarily regionally balanced power systems Long-distance transmission was more the exception than the rule Few special challenges • Connecting remote power generation • Supplying remote loads • Subsea cables • Asynchronous systems	Local concentration of generation Long-distance transmission Strongly varying load-flow situations active control Offshore power • Need for cables • Need for redundant structures (a grid instead of individual lines)
HVDC was proven, for project-based, independent niche applications.	HVDC advantageous but requires further development.

Vision for the future of HVDC/potential fields of development

The building blocks of an evolved HVDC eco-system

HVDC in an evolving environment



Higher VSC[1] ratings

Large-scale DC overlay grid concepts, including
- Multi-terminal capability and interoperability
- Control and protection schemes

DC gas insulated switchgear and substation

HVDC circuit-breakers

HVDC cables and lines
- Mass impregnated (MI)
- XLPE (cross-linked Polyethylene)
- Gas insulated lines (GIL) for DC
- Hybrid AC/DC overhead lines

1 VSC: Voltage source converter

Use cases from Technopedia #2:
Flexible Alternating Current Transmission Systems (FACTS)

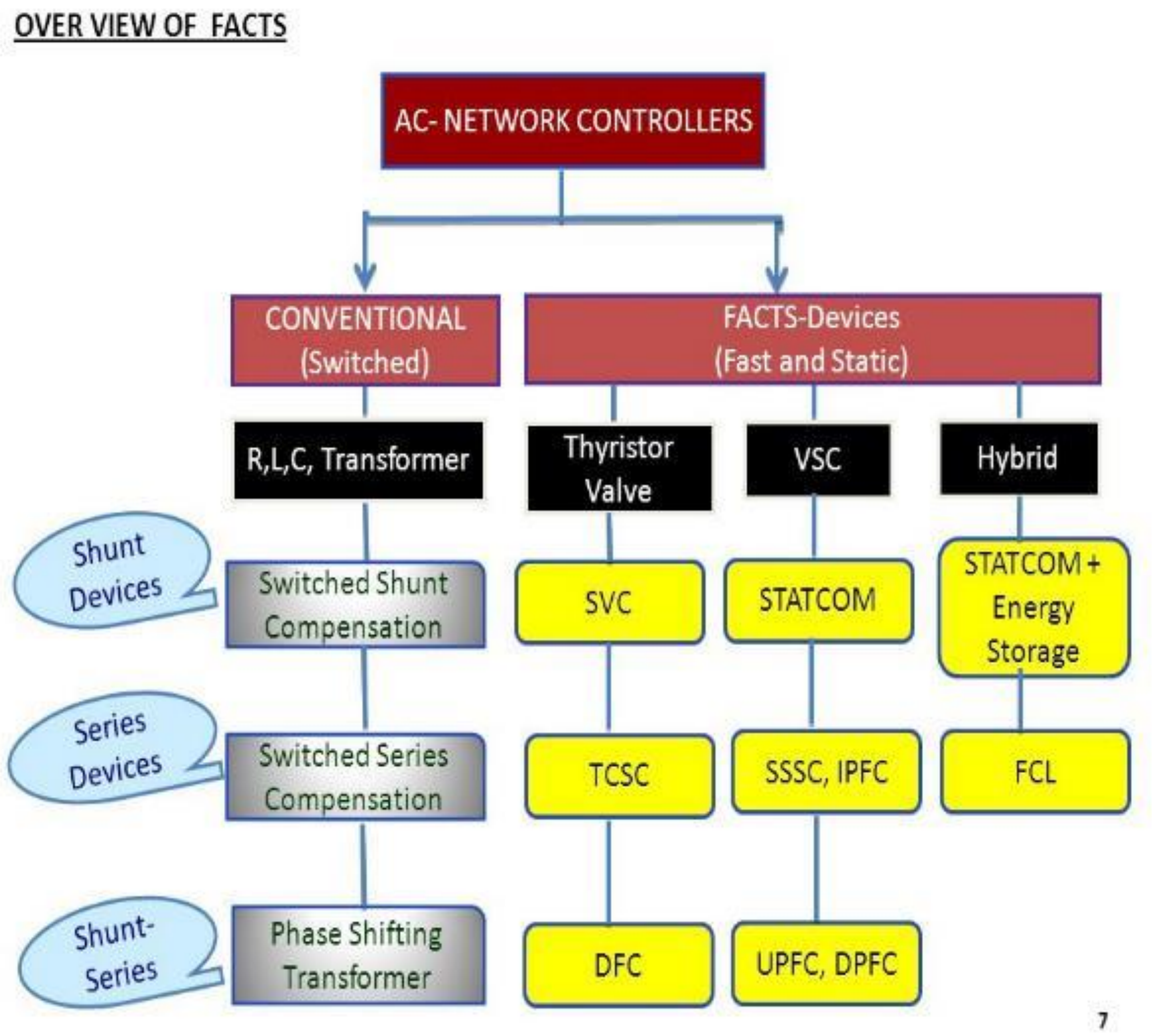
Susanne Nies
General Manager - Germany
Smart Wires

Short introduction of the technology

FACTS devices and the case of the mSSSC

Where does modular SSSC sit?

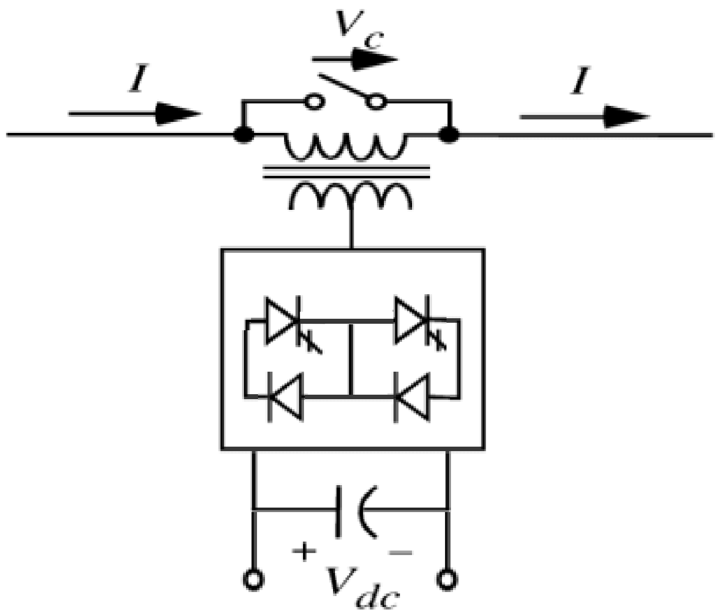
- FACTS devices improve the security and flexibility of the existing transmission system
- FACTS devices are typically categorized into shunt-connected devices, series-connected devices or combinations of the two.
- Shunt-connected devices are typically used for voltage-regulation
- Series-connected devices are typically used for power flow control
- Shunt/Series combinations include the Unified Power Flow Controller (UPFC)
- **Smart Wires existing products are series-connected devices that use power electronics for control and protection**



Modular Static Synchronous Series Compensators

Origin of Smart Valve

Smart Wires existing products are series-connected devices that use power electronics for control and protection

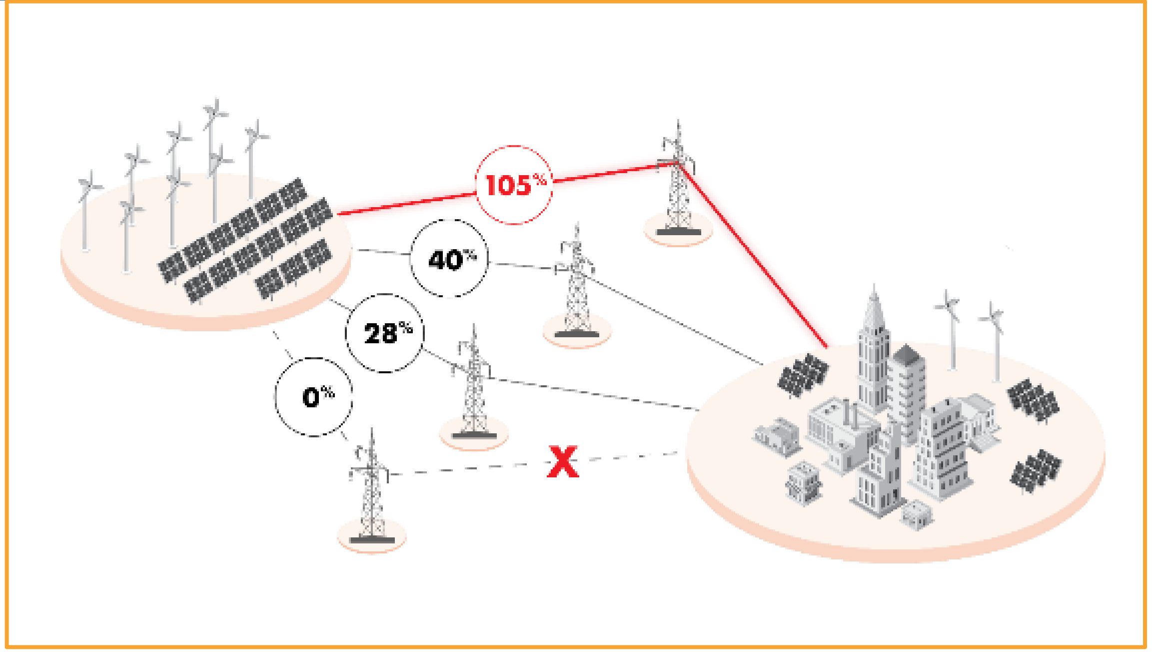


SSSC Schematic

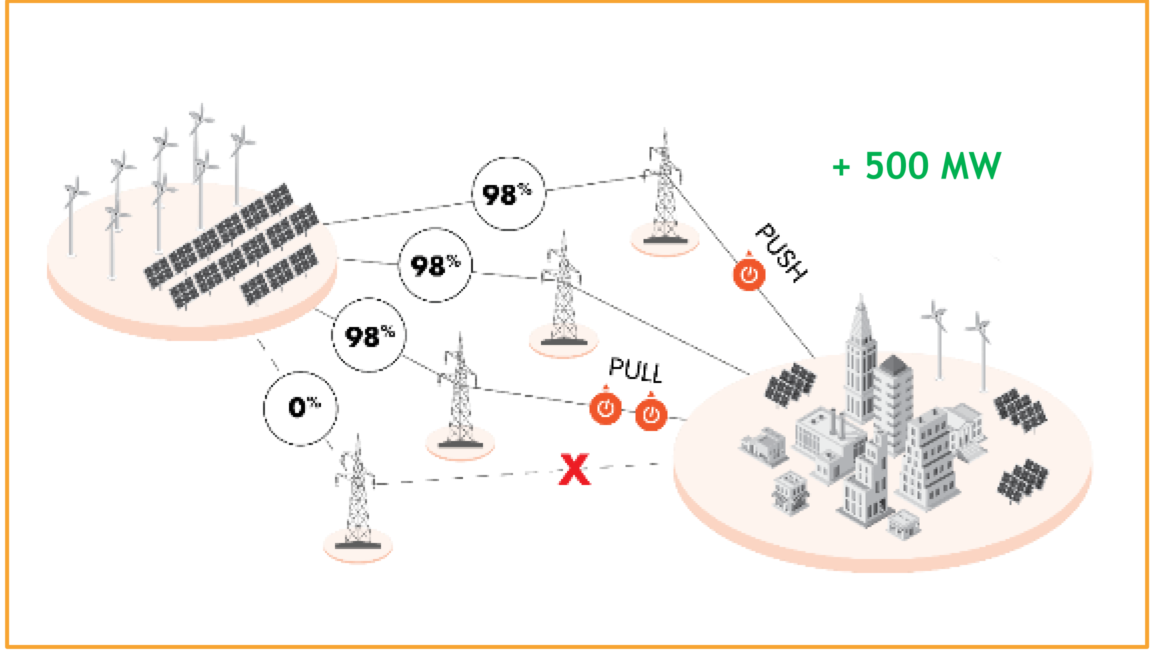
- The SmartValve uses a modular single-phase Static Synchronous Series Compensator (SSSC) that employs VSC technology
- SSSCs were first operated on the grid for power flow control applications in 1998 at American Electric Power (AEP) as part of a UPFC installation
- In 2001, another installation was completed within New York Power Authority (NYPA)'s system. The NYPA VSCs are still in operation.
- **The power electronics in the SmartValve uses Insulated-Gate Bipolar Transistors (IGBTs) that have been widely used for utility-scale VSCs, including STATCOMs and HVDC systems**

Use case of the technology -1- Grids Run at 20-40% Utilisation in average

Before Smart Wires



After Smart Wires



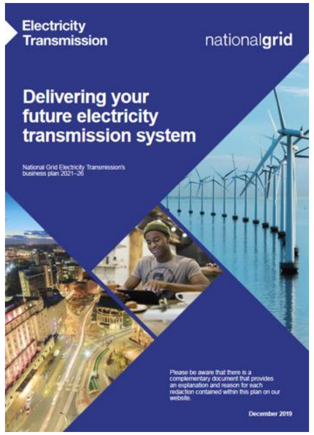
Smart Wires modular technology balances flows on the grid to maximize transfer capacity

Use case of the technology -2- Large scale deployment in the UK 2021

INSTALLS QUICKLY
Deploys in less than 12 months with minimal site disruption or outages

COST-COMPETITIVE
Provides more than £387 M in cost savings compared to new circuits or PSTs while delivering the same system benefits

FLEXIBLE
Can easily be expanded or relocated if network conditions change



Circuit	Voltage	Solution
Penwortham -Washway Farm - Kirkby 1	275kV	2 valves per phase
Penwortham -Washway Farm - Kirkby 2	275kV	5 valves per phase
Lackby - Norton	400kV	2 valves per phase
Harker - Fourstones	275kV	2 valves per phase
Ha	75k	

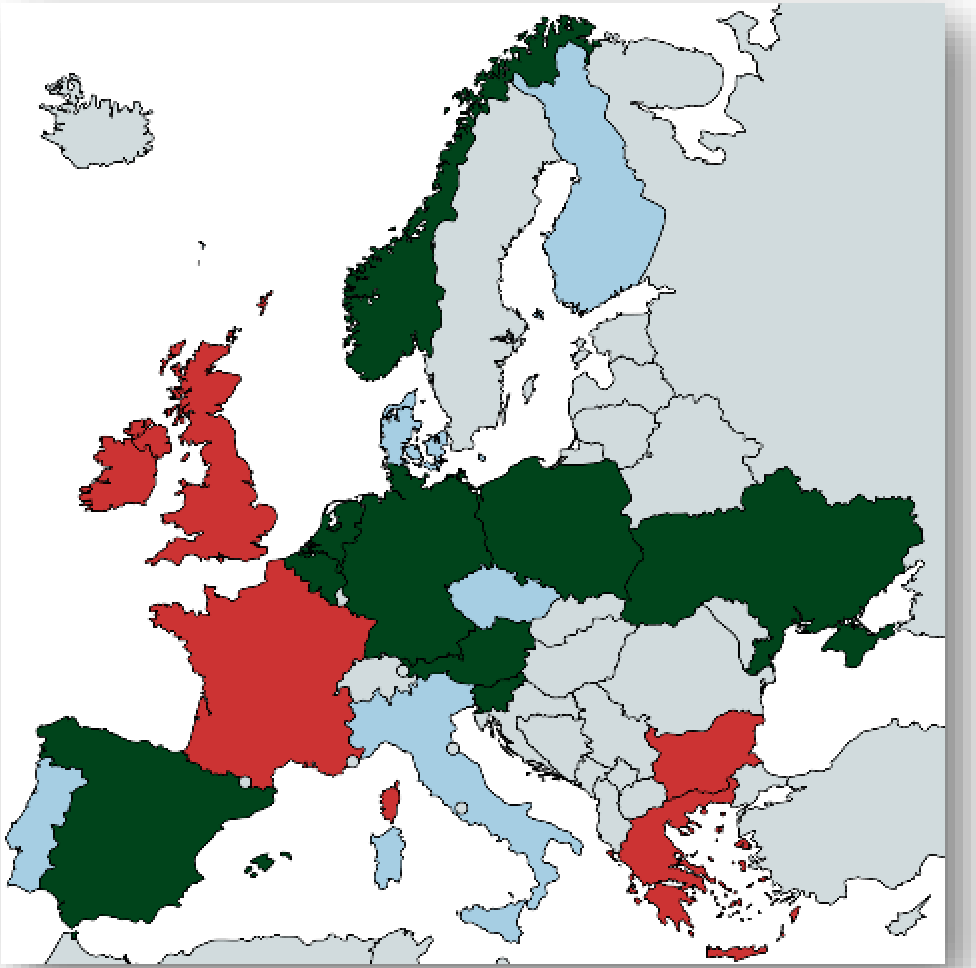
David Wright, Director of Transmission & Chief Engineer

> *"I can see a world very soon where power grids everywhere become more intelligent, digital and controllable. NGET will be a leader in this transition and it's inevitable that technology like Smart Wires will be a big part of this future."*

Vision for the future of the technology/potential fields of development

Massive deployment of technology with extended services

- Smart Wires is working with TSOs across Europe to free up capacity on their existing grids
- Interest by DSOs in several countries
- Technology has been deployed in Ireland, UK, France, Greece and Bulgaria.
- We see combined benefits with other innovative Grid technologies such as DLR, superconductors
- We are working currently with a number of system operators collaboratively on:
    - Increasing available interconnection capacity
    - Phase Oscillation dampening
    - Piloting mobile technology
    - Phase balancing
    - Curative (post N-1) response
    - System Separation avoidance



SMART WIRES
REIMAGINE THE GRID

Use cases from Technopedia #3: Dynamic Line Rating (DLR)

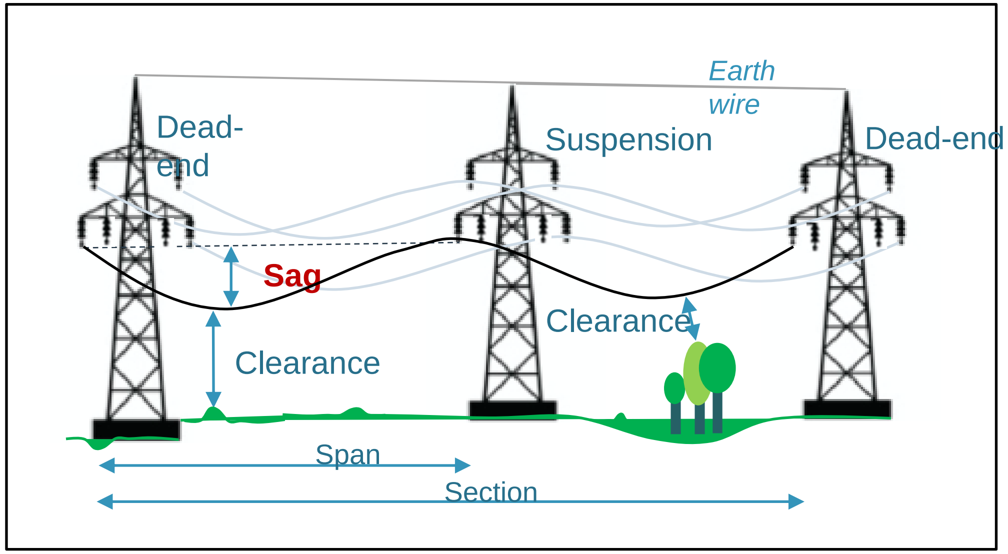
Rena Kuwahata
Business Developer for Power Grid Optimization Services
Ampacimon

Short introduction of the technology

What is Dynamic Line Rating?

Overhead power line **monitoring system** → Increases visibility of **asset condition** → Enables the **safe use of extra line capacity**

Line Capacity is limited by **sag** and **conductor temperature**
sensitive to weather: **wind speed** and **air temperature** have most impact



Thermal limits

- Maximum ***Conductor Temperature***
- Maximum ***Sag***

Rating (maximum load current)

Static based on fixed/seasonal, conservative ambient conditions, no *field* information

Dynamic based on variable, real-time ambient conditions, with *field* information

Heat-balance equation
IEEE 738 or CIGRE TB207

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Use case of the technology – 1.

① Reduce congestion management costs

- Congestion management **costs range from 20-500EUR/MWh**
- Expensive measures used to address moderate (~10%) overloads.

Saved 500 kEUR redispatch costs in a day

elia

② Accelerate renewables integration

- Generally **high loaded line** carrying **volatile infeed** from renewables.
- If forecast is wrong, it can very quickly deviate from expected loading.
- This needs remedial actions (actions to avoid (N-1) security issues).

50% increase in hosting capacity

Rte

③ Increase cross-border trade capacity

ELES

- **Short-term solution to boost market coupling capacity**.
- Small capacity increase in **high price split reap enormous returns in short time** frame.
- Cross border capacity benefits all citizens.

Saved 247 kEUR in 4 hours

Use case of the technology – 2.

④ **Reduce the need for remedial actions**	• **Increasing need for remedial actions** to prevent overloading of lines (congestion) **in day-ahead and intraday timeframes** like topology change, PST tapping, redispatch, curtailment, load shedding. • **DLR alleviates congestion thereby reducing this need.**	No need to reschedule maintenance outage
⑤ **Economic dispatch cost reduction**	• Making full use of **ambient cooling** effect, transmission lines can be used to **transport energy more efficiently** • Maximum sag and conductor temperature for **safety** never exceeded	10-20% increase in acceptable infeed
⑥ **Improve controllability of risk**	• Visibility of real-time and forecast line capacity and flow allows grid operator to **manage more precisely overload risks**. • Data statistics-based decisions can be made to inform asset management like outage planning and maintenance intervals.	Alerted overload risk in recent heat waves
⑦ **Defer grid investment**	• Increase in line capacity and visibility of use can be combined with power flow control. • Such **grid operation-based solutions to tackle increased power flows can be counter-balanced with investment projects.** • This gives flexibility in investment portfolio management.	Up to 15% saving on new CAPEX projects

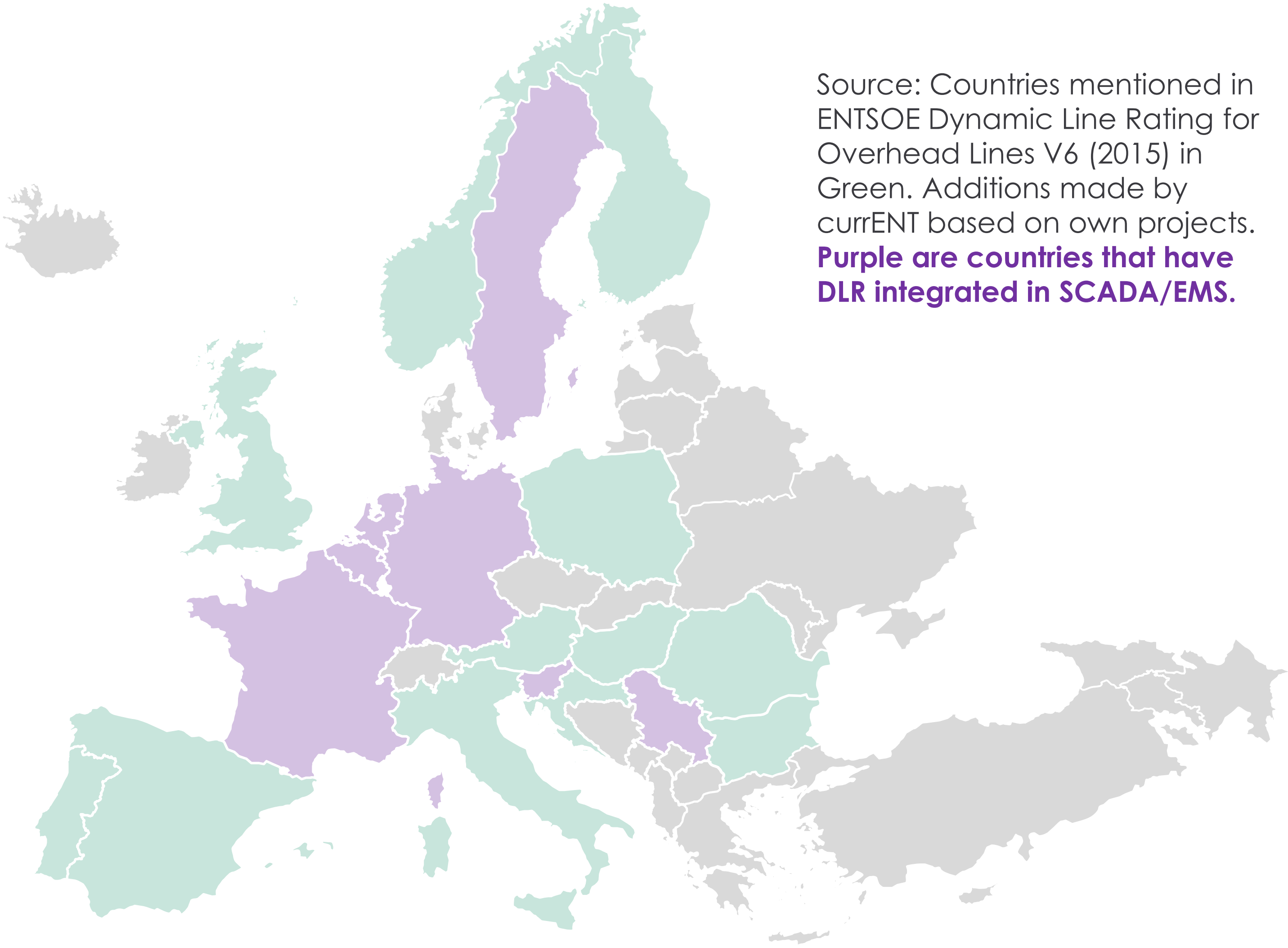
Vision for the future of the technology/potential fields of development

Achievements so far:

- Most countries in Europe have tested DLR in the past decade
- Some have integration in SCADA/EMS
- Some use DLR (with wind cooling) for CACM and SCA processes
- We see transition from pilots to Tenders

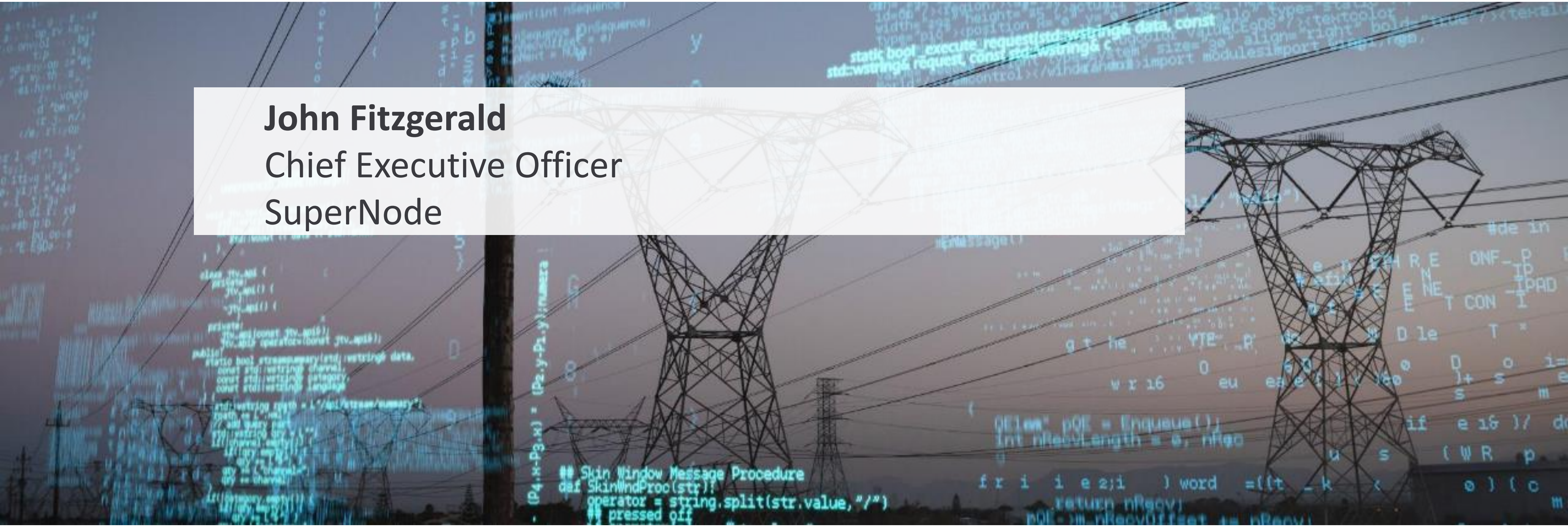
Outlook:

- 70% CB rule & RES growth -> rising congestion management costs
- What would help to accelerate tech adoption:
  - Output based regulation to enable TSO to reap benefit of reduced OPEX.
  - Knowledge sharing between TSOs on overcoming challenges.
  - Leverage from what has been achieved so far and avoid reinventing the wheel (especially on forecasting).



Source: Countries mentioned in ENTSOE Dynamic Line Rating for Overhead Lines V6 (2015) in Green. Additions made by currENT based on own projects. **Purple are countries that have DLR integrated in SCADA/EMS.**

Use cases from Technopedia #4: Superconductors



John Fitzgerald
Chief Executive Officer
SuperNode

What is Superconductivity and what does it offer?

Superconductivity is a phenomenon that occurs in some materials that, when cooled below a certain temperature, display unique characteristics.

A state of Superconductivity is reached when a material is cooled to below its ‘*critical temperature*’.

Zero Electrical Resistance - When a superconducting material is cooled below its critical temperature, its electrical resistance reduces to zero.

High Power Density – Superconductors can carry significantly higher levels of current and thus are capable of the transmission of higher power levels than copper.

Smaller Right of Way – Superconducting cables have a smaller cross-section and thus the right of way required for their installation is much smaller than comparable copper cables.

Lower Cost – The cost of the individual cables is higher but the cost of a superconducting project can be significantly lower.

State of the Art

AC SC cable (Ampacity)

HVDC SC cable 3.2GW
(Horizons Project)

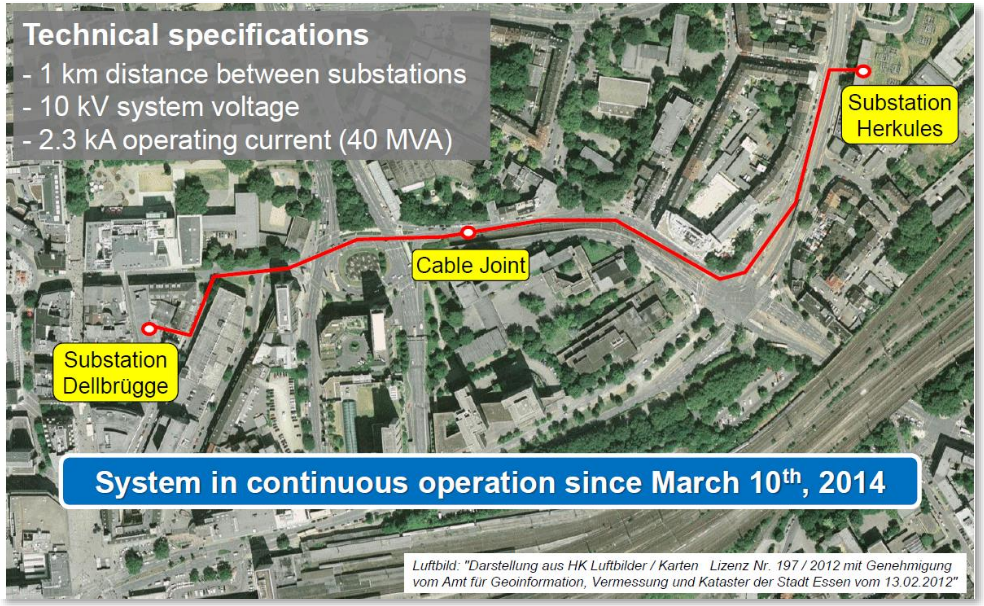
Novel Cryostat to
extend range

Superconductors in the Grid Today

Ampacity Project, Essen

The Ampacity project was designed to solve an urban density problem, with the substation Dellbrugge requiring more power.

To solve this problem, a new transformer was built out in the suburbs where there was available space and a new HTS line was installed to connect them which is 1km long.



Shingal Project, Seoul

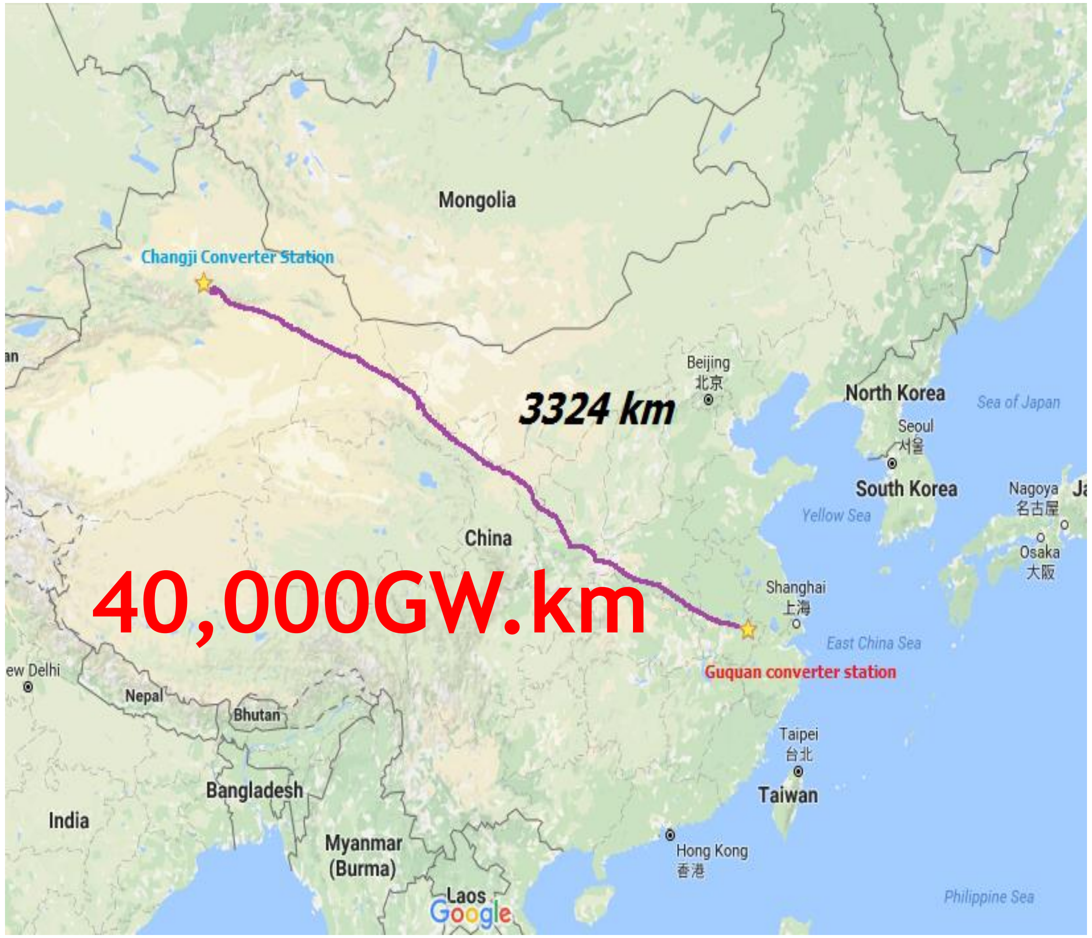
Shingal substation needed a higher capacity but had no room for another transformer.

HTS cables were installed to connect to Heungdeok substation with a 1km, 23kV HTS cable.

HTS was found to be 15% cheaper than the alternative method of building 154kV underground cables.

Chinese Approach to New Grids

Developing UHVDC overhead lines, carrying 10GW+



Superconducting Connection Scheme

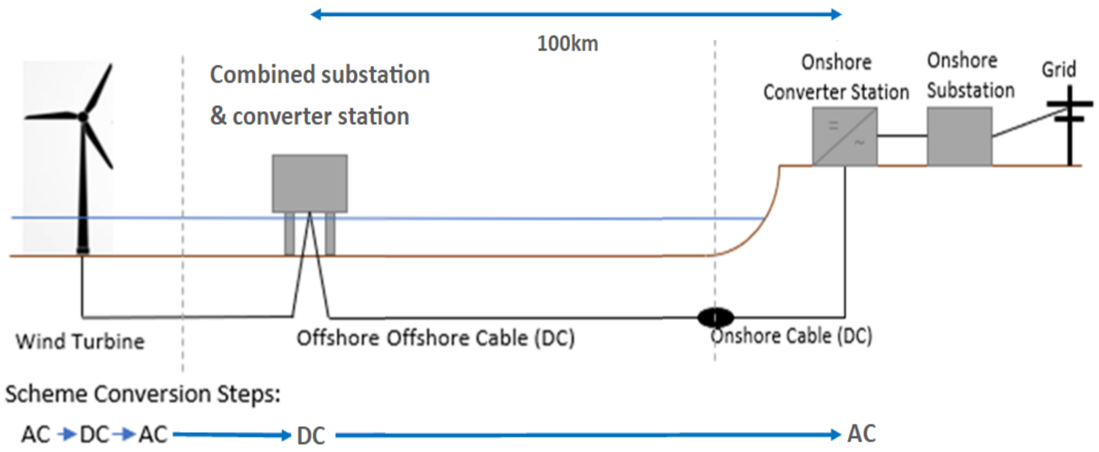
Facilitating the cost effective integration of increasing offshore wind capacity

525kV HVDC and 100kV HTS MVDC systems compared at 100km cable length.

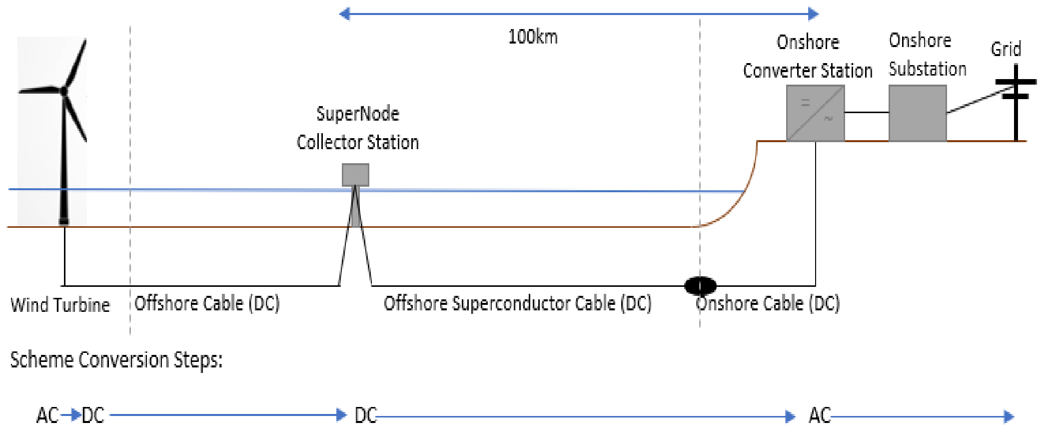
HTS System comes in over 35% cheaper than HVDC System cost.

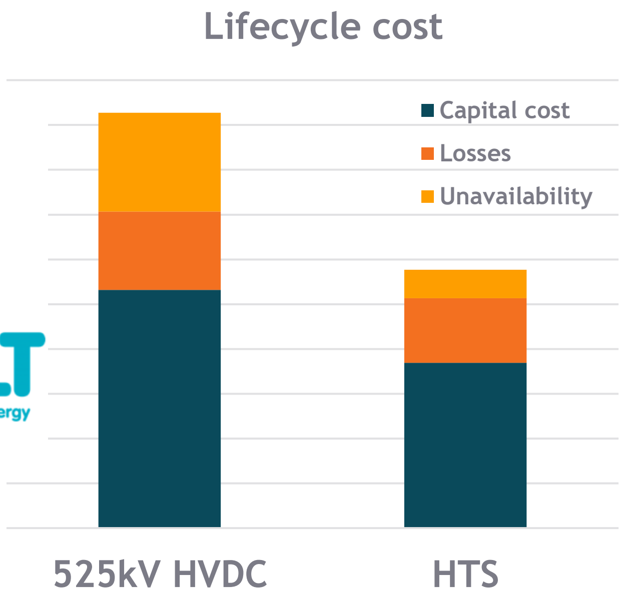
Competitiveness of superconductors improves further as capacity increases.

Conventional 2GW HVDC Scheme



Superconducting 2GW MVDC scheme





University of Strathclyde Glasgow

SUPERNODE

CATAPULT Offshore Renewable Energy

Areas for further development

Bringing the most cost competitive solution to the market

Superconducting cable system development & qualification program

Deployment / Demonstration projects

Industry Collaboration

Establishing a secure and reliable supply chain

Competitiveness Progress Report

Mark van Stiphout
Deputy Head of unit
DG ENER

Technopedia Webinar

Competitiveness Progress Report

29.06.21

Mark van Stiphout, ENER.B5

Background & timeline

- <u>Legal basis</u>

  - Article 35 (m) of the **Governance Regulation of the Energy Union and Climate Action**: *The State of the Energy Union report shall include the following elements: […] a progress report on competitiveness;*

  - Annex to the State of the Energy Union Report.

- <u>Format:</u> main report and underpinning annex with data

1st draft (End June)	2nd Interservice meeting (feedback on draft)	ISC	Adoption of the report
June	**July**	**September**	**October**

Outline of the report (1/2)

1. Introduction

2. Overall competitiveness of the EU clean energy sector

2.1 Boosting competitiveness tools within the EU framework: mechanisms and instruments – **new**

- Mapping tools (legal, funding, other) based on impact on pre-selected indicators

Macro-economic analysis	Technology analysis – Current situation and outlook	Value chain analysis of the energy technology sector	Global market and analysis
Energy intensity, share of RES, import dependency, industrial electricity and gas prices	Capacity installed, generation/production	Turnover	Trade (imports, exports)
Turnover of the EU	Cost/Levelised Cost of Electricity	Gross value added growth	Global market leaders vs. EU market leaders
Gross value added	Public R&I funding (EU and MS)	Number of companies in the supply chain	Resource efficiency and dependence
Employment figures	Private R&I funding	Employment in value chain segment	
Covid-19 disruption	Patenting trends	Energy intensity, labour productivity	
	Scientific Publications	Community production	

Examples: Horizon Europe, Batteries Alliance, State-Aid Framework for Energy or R&D&I

Offshore wind

Technology Analysis – Current situation and Outlook	Value chain analysis of the energy technology sector	Global market analysis
Capacity Installed	Turnover	Trade (imports, exports)
Cost/Levelised Cost of Energy	GVA growth	Global market leaders vs EU leaders
Public R&I Funding (MS & EU)	Number of EU companies	Resource efficiency and dependence
Private R&I Funding	Employment in selected value chain	
Patenting Trends	Energy intensity, labour productivity	
Level of Scientific Publications	Community Production	

European Commission

Onshore wind

Technology Analysis – Current situation and Outlook	Value chain analysis of the energy technology sector	Global market analysis
Capacity Installed	Turnover	Trade (imports, exports)
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Private R&I Funding	Employment in selected value chain	
Patenting Trends	Energy intensity, labour productivity	
Level of Scientific Publications	Community Production	

European Commission

Solar photovoltaics

Technology Analysis – Current situation and Outlook	Value chain analysis of the energy technology sector	Global market analysis
Capacity Installed	Turnover	Trade (imports, exports)
Cost/Levelised Cost of Energy	GVA growth	Global market leaders vs EU leaders
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Patenting Trends	Energy intensity, labour productivity	
Level of Scientific Publications	Community Production	

European Commission

Batteries

Technology Analysis – Current situation and Outlook	Value chain analysis of the energy technology sector	Global market analysis
Capacity Installed	Turnover	Trade (imports, exports)
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European Commission

Electrolysis for production of renewable hydrogen

Technology Analysis – Current situation and Outlook	Value chain analysis of the energy technology sector	Global market analysis
Capacity Installed	Turnover	Trade (imports, exports)
Cost/Levelised Cost of Energy	GVA growth	Global market leaders vs EU leaders
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Private R&I Funding	Employment in selected value chain	
Patenting Trends	Energy intensity, labour productivity	
Level of Scientific Publications	Community Production	

European Commission

Smart distribution, metering and charging

(working title)

- Focus: smart metering, home energy management systems (HEMS), low-voltage (LV) power distribution

- Why:

→ **"Smart grids" are the electricity network of the energy transition:** i) more efficient & effective operations & maintenance of the grid, ii) integration of distributed renewable energy into the electricity system, iii) demand-side flexibility (and energy services offered by third parties).

→ **widest possible deployment of smart meters and energy management systems** (at grid and consumer side), smart energy equipment and appliances in an interoperable ecosystem.

→ to be complemented with **the digitalisation** (or simply automation sometimes**) of the distribution grids**, meaning (mostly) the rollout of modernised cabling and sensors, as well as advanced distribution management systems.

European Commission

Heat pumps

Technology Analysis – Current situation and Outlook	Value chain analysis of the energy technology sector	Global market analysis
Capacity Installed	Turnover	Trade (imports, exports)
Cost/Levelised Cost of Energy	GVA growth	Global market leaders vs EU leaders
Public R&I Funding (MS & EU)	Number of EU companies	Resource efficiency and dependence
Private R&I Funding	Employment in selected value chain	
Patenting Trends	Energy intensity, labour productivity	
Level of Scientific Publications	Community Production	

European Commission

Renewable fuels: aviation and shipping

Technology Analysis – Current situation and Outlook	Value chain analysis of the energy technology sector	Global market analysis
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European Commission

Thank you!

Outline of the report (1/4)

2.2 Energy and resource trends

- Primary & final energy intensity, renewable energy share in gross final energy consumption, net import dependency, industrial electricity and gas prices.
- Share of EU energy sector in EU GDP (turnover), value added of the clean energy sector (incl for RES and EE), labour productivity (GVA per employee).

2.3 Human capital

- Jobs in clean energy technologies in EU vs RoW

2.4 Research and Innovation trends

- Public R&I spending (absolute and % of GDP)
- Private R&I spending (absolute and % of GDP)
- (High value) patents

The analysis for the above 3 sub-sections will be done at MS level where possible.

Outline of the report (2/4)

2.5 Innovation ecosystems – **new**

- **EU Clean Tech Innovation Ecosystem** | current status, future expectations, gaps, comparison with major economies
  - Novel Technologies, start-ups, scale-ups: their disruptive potential in the short, medium and long term | How to shape a clean tech Innovation Ecosystem contributing to the twin transition

- **Clean Tech: a challenging domain for EU VC funding** | trends, challenges, new opportunities, comparison with major economies

- **Supplementing solutions to VC funding**
  - **e.g.:** Deeper and wider engagement between start-ups, scale-ups and large corporations, Blended Finance, Patient Capital, Special Purpose Acquisition Companies (SPACs), Multifaceted financing
  - **Q:** Do we have successful examples?

- **Digitalisation of Energy: how the integration of digital solutions in the energy system will impact the EU Innovation Ecosystem?**

- **Covid-19 impact and Recovery** | Examples from MSs supporting start-ups and scale-ups in their RRPs

Outline of the report (3/4)

<u>2.6 Covid-19 impact and recovery – **new**</u>

- Impact of pandemic on clean energy transition
- How Recovery and Resilience Plans respond to this impact

<u>2.7 Innovative business/cooperation models – **new**</u>

- **Virtual Power Plants (VPPs) and peer-to-peer trading** → link with tech section on "Smart distribution, metering and charging"
- **Energy communities**
- **Integrated service packages**
  - **E.g. Retrofit packages** that combine energy-efficient and smart-ready/ demand response-enabled technologies
- **Innovative financing models**

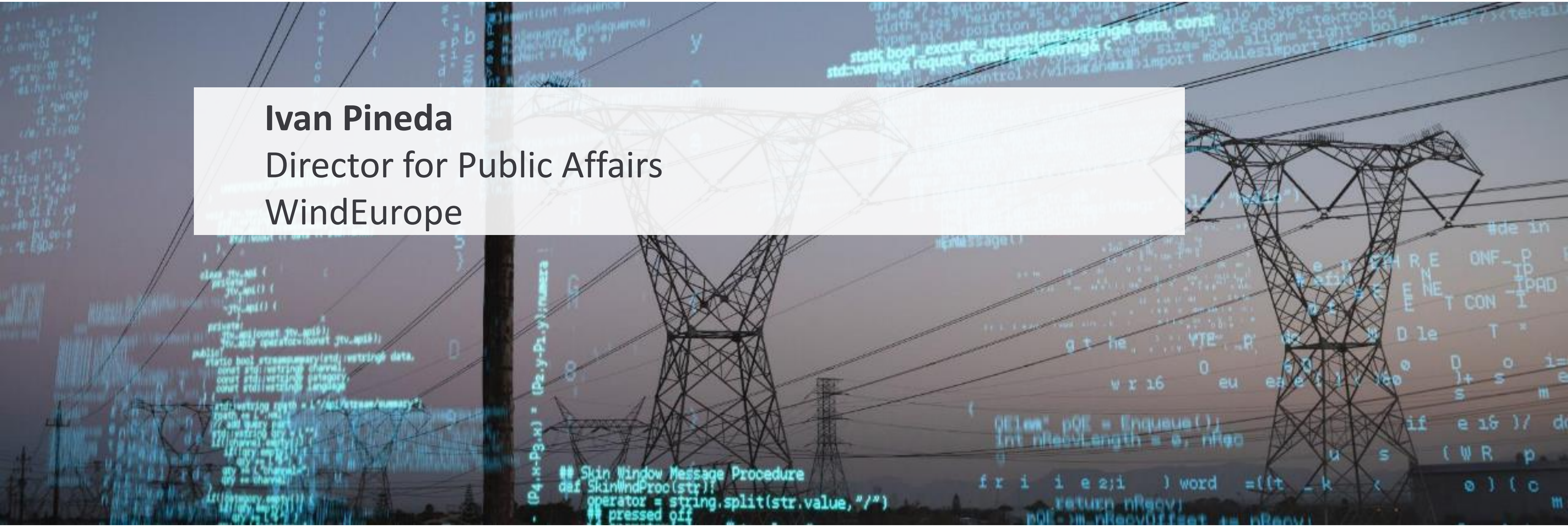
European Commission

Outline of the report (4/4)

3. Focus on key clean energy technologies and solutions

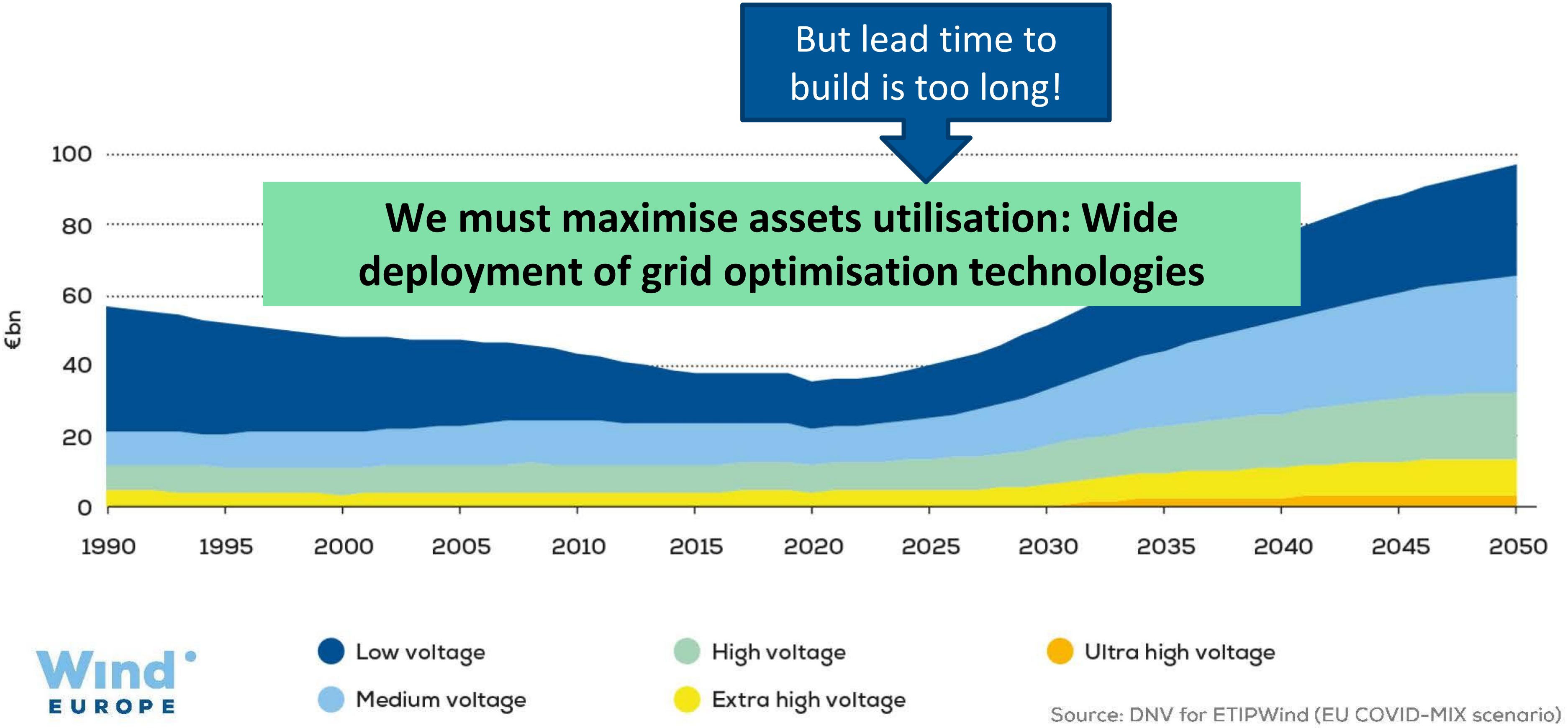
1. Wind (offshore and onshore)
2. Solar photovoltaics
3. Batteries
4. Electrolysis technology to produce renewable hydrogen
5. Smart distribution, metering and charging
6. Heat Pumps
7. Renewable fuels: aviation and shipping

Grid optimization & timely solutions



Ivan Pineda
Director for Public Affairs
WindEurope

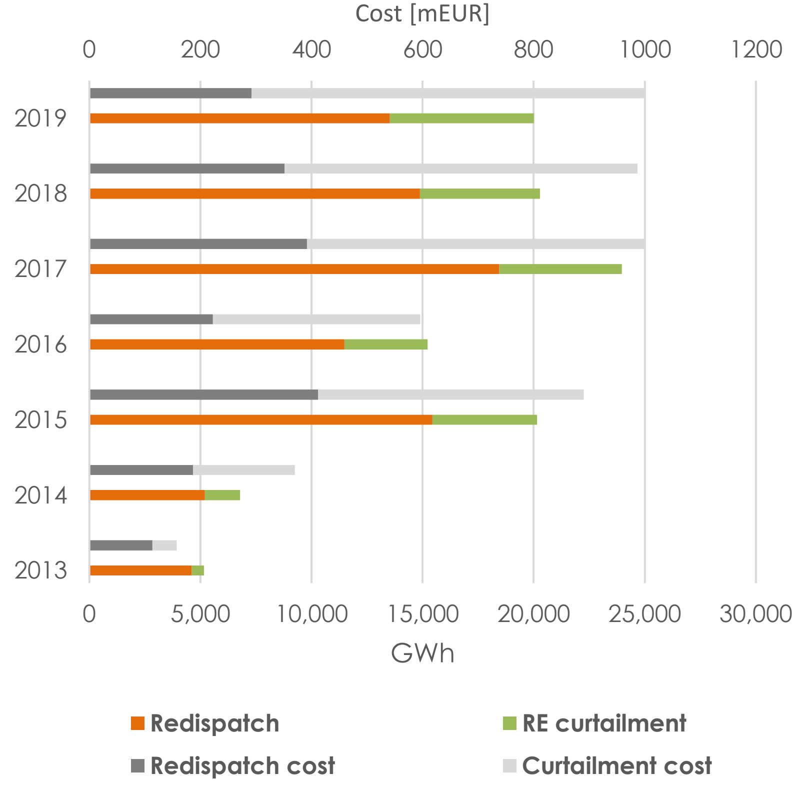
Europe needs to more than double its annual grid infrastructure investments to deliver climate neutrality



German situation today

1BillionEur/Year congestion costs!

Redispatch and RE curtailment measures and costs



Insufficient grid capacity to accommodate power flows from Energy Transition

Source: Monitoring Reports by Bundesnetzargentur

Elektrizität: Dauer von strombedingten Redispatch Einzelüberlastungsmaßnahmen auf den am stärksten betroffenen Netzelementen im Gesamtjahr 2018

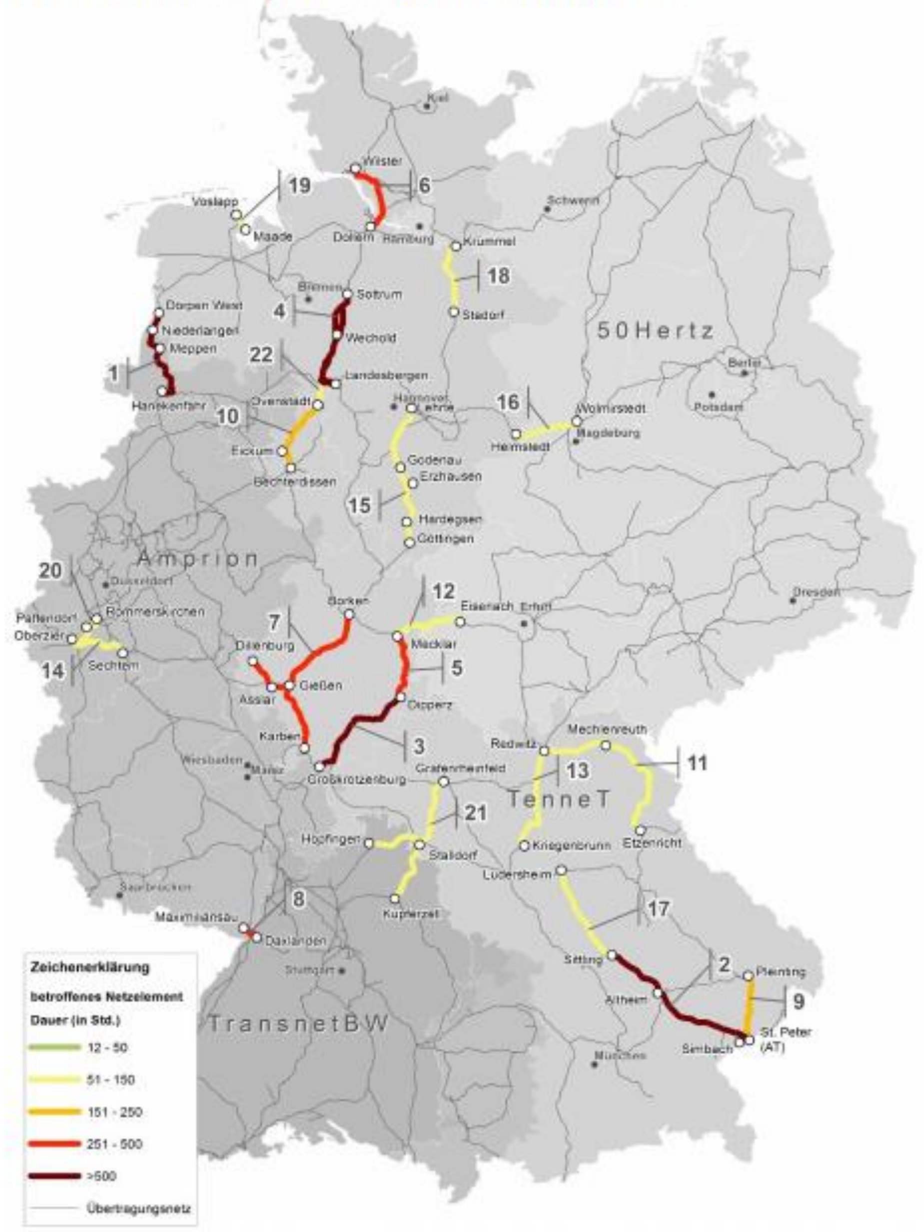


Abbildung 53: Dauer von strombedingten Redispatch Einzelüberlastungsmaßnahmen auf den am stärksten betroffenen Netzelementen im Gesamtjahr 2018 gemäß Meldungen der ÜNB

Grid optimisation technologies can accelerate wind energy integration

By:

- ➢ enabling **closer to limits** system operation and **maximising grid use**
- ➢ contributing to **mitigate RES variability and reduce curtailment**

GRID OPTIMISATION TECHNOLOGIES		
Advanced monitoring		• Dynamic Line Rating • Substation Fleet Digitalisation • Asset Performance Management
Advanced system operation control devices		• Phase-Shifting Transformer • Solid-State Transformer • Static Synchronous Series Compensator • Modular Power Flow Control Technology • Thyristor-controlled Series Compensator • Static Synchronous Compensator • Static VAR Compensator • Adaptive Protection Scheme • Synchronous Condensers
Advanced converter technologies		• Grid-forming capabilities • Black-start
Line and voltage upgrades		• High Temperature Low Sag conductors • Voltage uprate
DC transmission		• HVDC technology • AC TO DC line upgrade • Superconductor

Source: ETIPWind, WindEurope, Getting fit for 55 and set for 2050, June 2021

Our recommendations

1. **Incentivise TOTEX-saving investments, move away from only CAPEX-based ones**
   - Re-visit CBA to factor short and long-term grid optimisation
   - Include grid optimisation in system planning

2. **Align system planning with the EU Green Deal objectives**
   - continuous, open, flexible
   - Incentivise grid-optimisation in cross-border infrastructure planning

3. **Apply grid smartness indicators**
   - to planning, operation, asset management, and innovation

Wind EUROPE

THANK YOU

GRID OPTIMISATION TECHNOLOGIES PAPER:

https://windeurope.org/wp-content/uploads/files/policy/position-papers/20200922-windeurope-grid-optimisation-technologies-to-build-a-greener-europe.pdf

windeurope.org

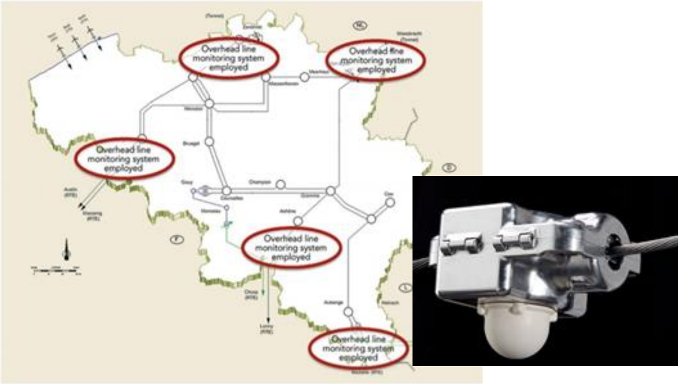
WindEurope, Rue Belliard 40
1040 Brussels, Belgium

BACK-UP

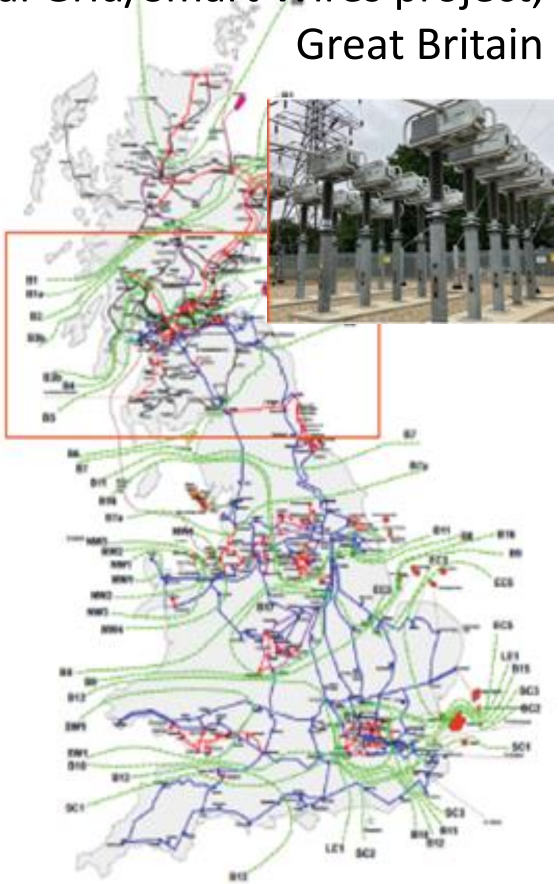
Grid optimisation project examples

Hybrid STATCOM
Tennet/Hitachi ABB project, Germany

Dynamic Line Rating
Elia/Ampacimon, Belgium



Modular power flow control with SmartValve devices
National Grid/Smart Wires project, Great Britain



The technologies are there and proven; still not widely deployed

RWTH Aachen University/Orsted study

- **On the further integration of offshore capacities in the North Sea**
  - 3GW more than the current 2030 target with network optimization measures
  - Dynamic Line Rating alone can reduce congestion management costs by reducing redispatch by 6,8TWh/a and renewables curtailment by 2,5TWh/a in the German grid development scenarios
  - Significant similar conclusions also for Phase-Shifting Transformers and HVDC


IAEW Institut für Elektrische Anlagen und Energiewirtschaft | RWTH AACHEN UNIVERSITY

INSTITUT FÜR ELEKTRISCHE ANLAGEN UND ENERGIEWIRTSCHAFT

STUDIE FÜR

ØRSTED Wind Power Germany GmbH

Aachen, 29. Mai 2020

UNTERSUCHUNG DER WEITEREN INTEGRATION VON OFFSHORE-KAPAZITÄTEN IN DEUTSCHLAND

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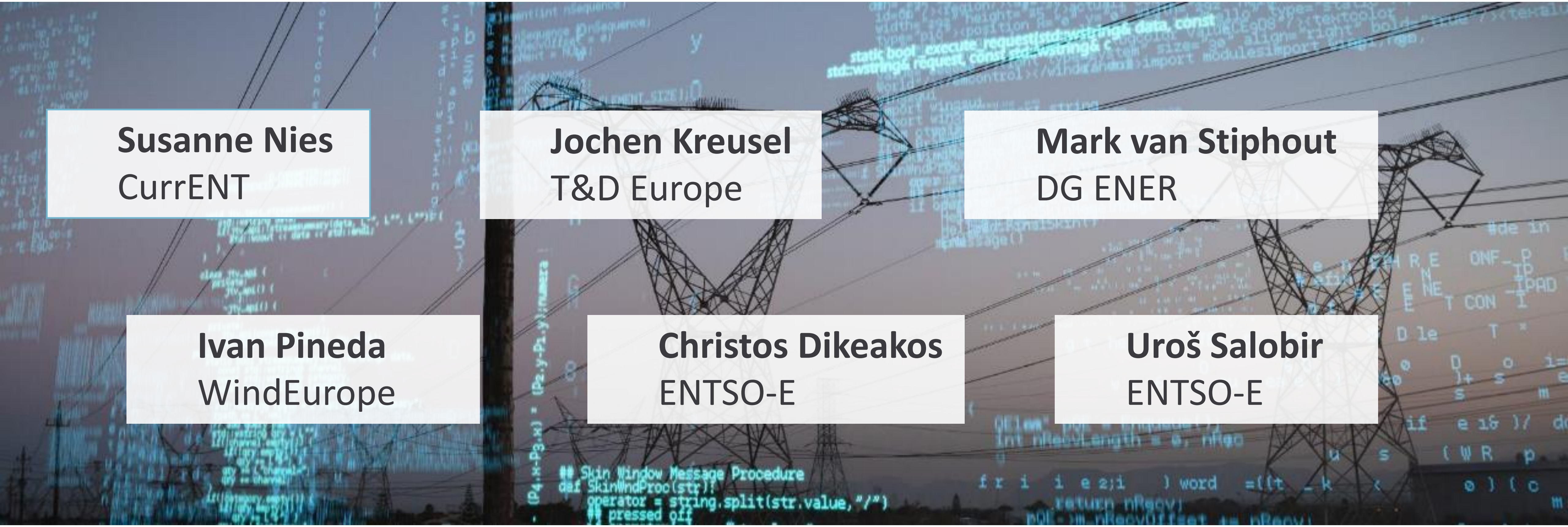
WindEurope

Trends of the grid enhancing technologies
Panel discussion



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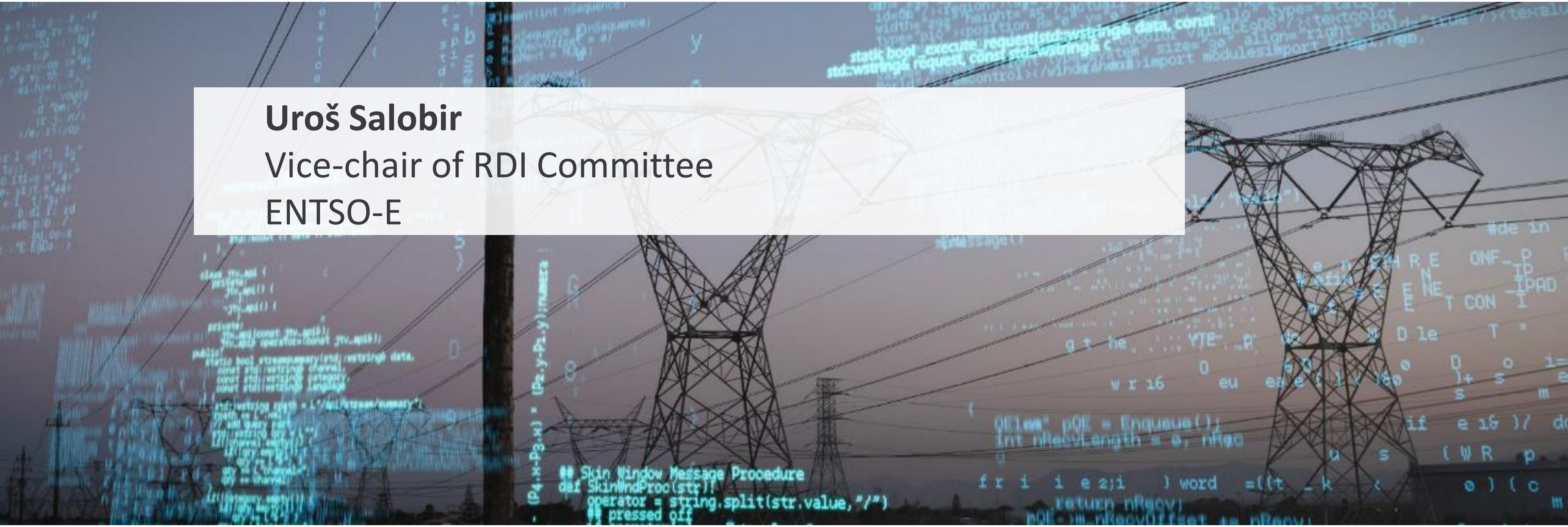
What’s next for the Technopedia?



Uroš Salobir
Vice-chair of RDI Committee
ENTSO-E

Thank you for joining us!

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