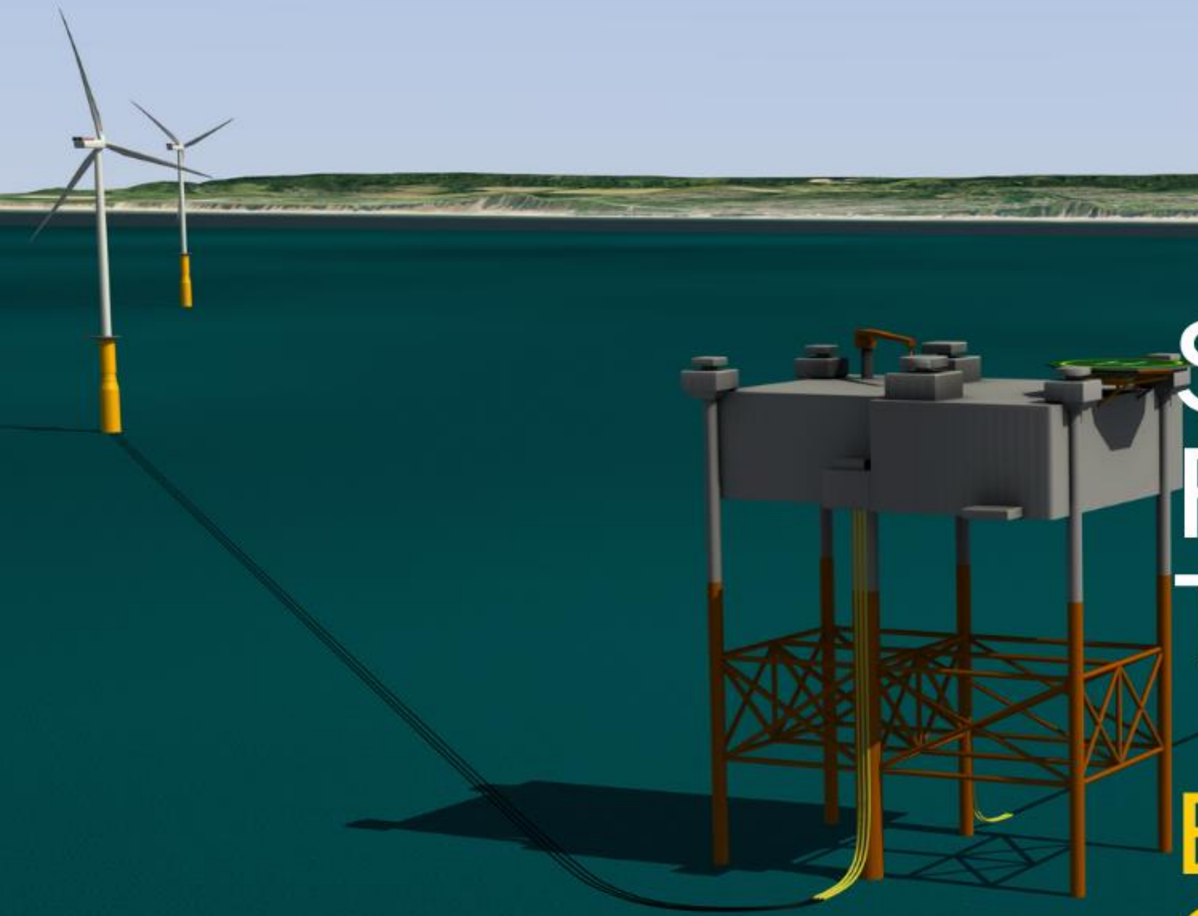
WEBINAR

CurrENT
Enabling Network Technology throughout Europe



SUPERCONDUCTORS FOR POWER TRANSMISSION

BEYOND THE AGE OF COPPER

7 JULY | 13.30–15:00 CEST

Agenda

Introduction and moderation by Layla Sawyer, Secretary General, currENT Europe

1. Eoin Hodge, SuperNode
2. Mathias Noe, KIT
3. Mike Ross, AMSC
4. Dag Willén, NKT
5. Norela Constantinescu, ENTSO-E
6. Mario Dionisio, DG ENER – European Commission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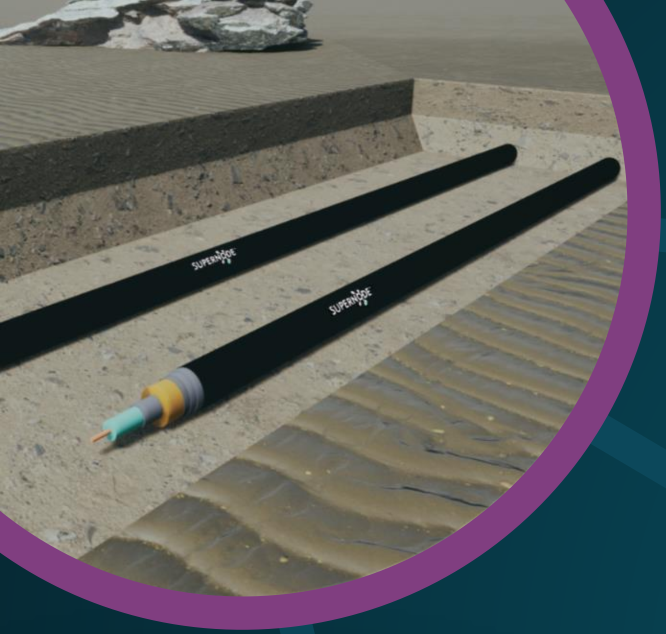
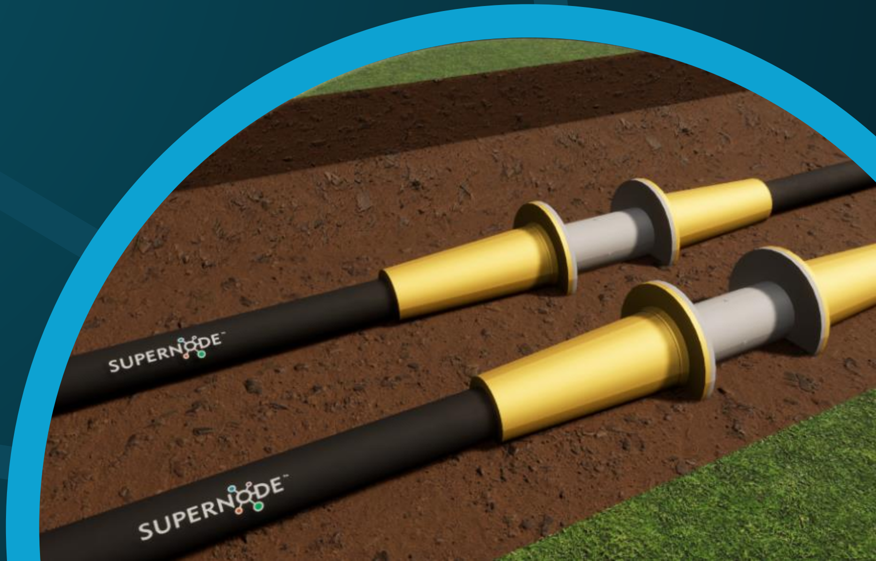
EOIN HODGE
Chief Engineer
Supernode



SUPERNODE™

SUPERCONDUCTORS FOR POWER TRANSMISSION – BEYOND COPPER



VISION AND MISSION

OUR VISION

People should have access to **secure**, **affordable** and **renewable** energy.

OUR MISSION

To develop and market innovative transmission technology based on **superconductors**, carrying vast amounts of energy over long distances in interconnected grids, requiring less infrastructure, materials and space.

WHY IS NEW TRANSMISSION TECHNOLOGY NEEDED IN EUROPE?

Electrical energy demand will **TRIPLE BY 2050** compared to today's demand

More than **800 GW** of new solar power will be required

More than **450 GW** of offshore wind power will be needed

The best renewable resources are found at the **PERIPHERIES** of Europe

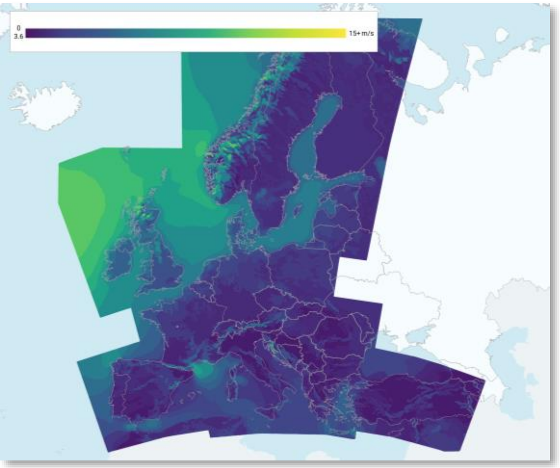
Current grid technology is **INEFFICIENT** for a renewables-based energy system

INSUFFICIENT TRANSMISSION CAPACITY to meet European climate and energy targets

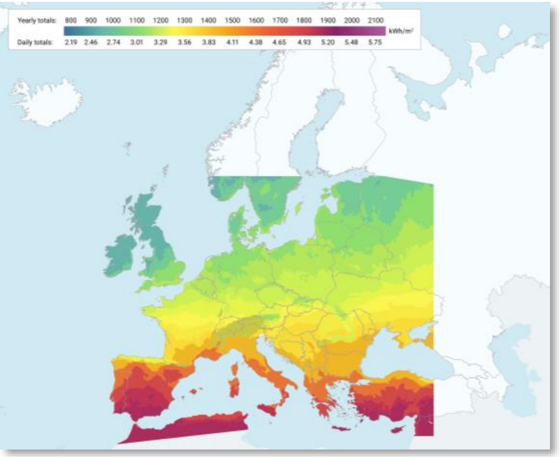
EUROPE’S GEOGRAPHY

- Best **renewables** are at the periphery.
- **Demand** centres are in Central Europe.
- **Current transmission technology** is not designed or sized for the job we need them for in a decarbonised Europe.

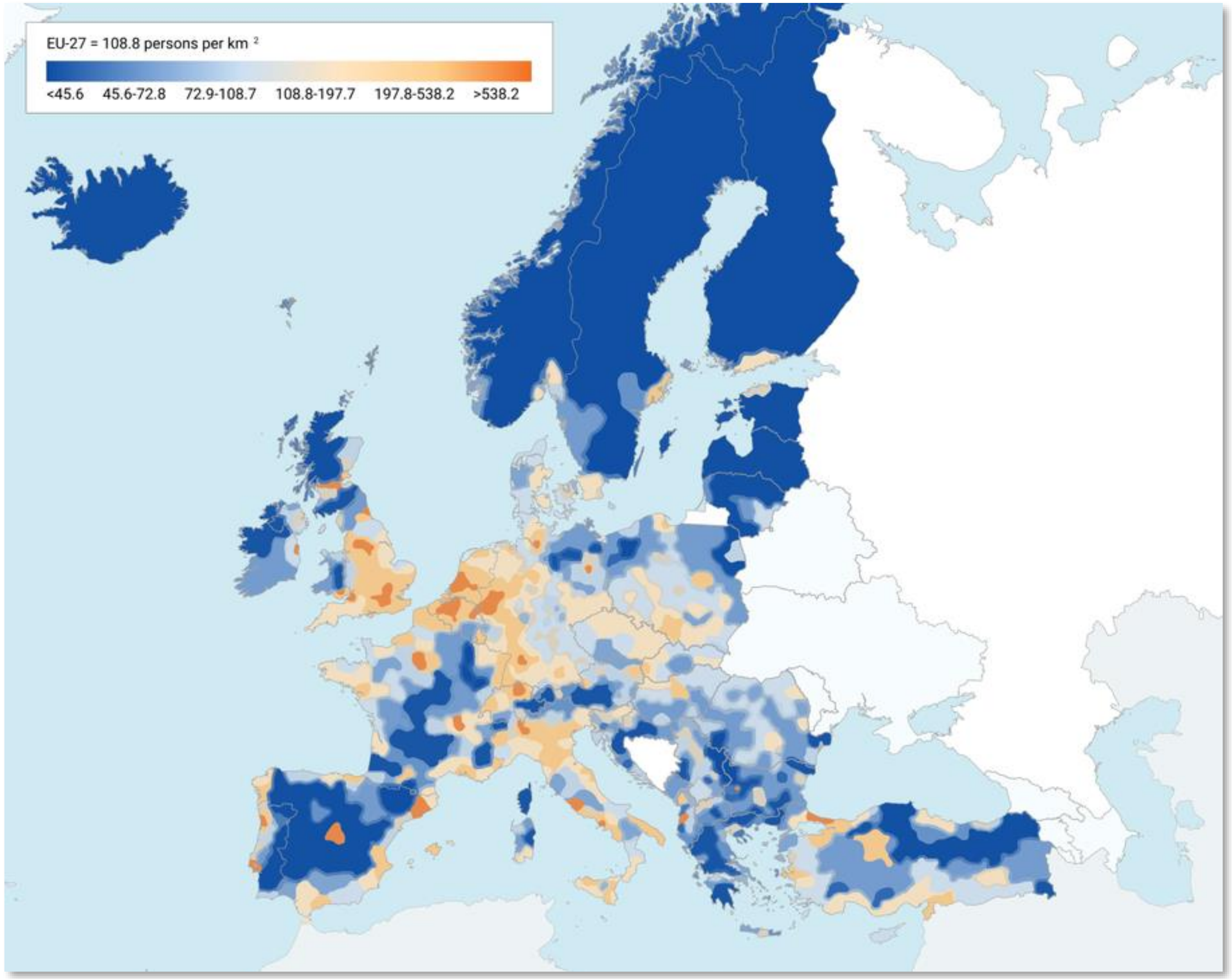
Wind speed



Solar Irradiance



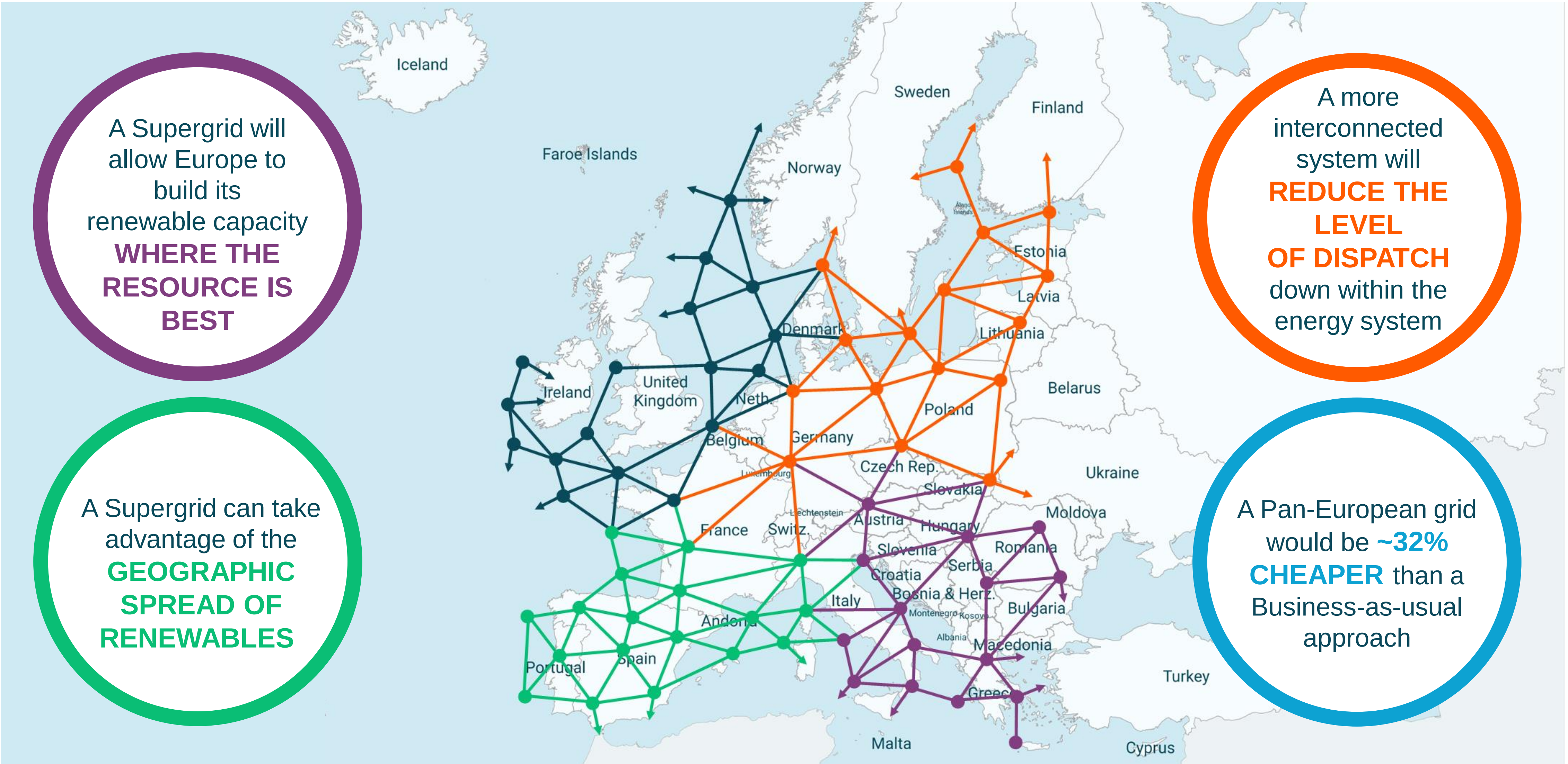
Population density



THE NEED FOR A PAN-EUROPEAN TRANSMISSION GRID

A Supergrid will allow Europe to build its renewable capacity **WHERE THE RESOURCE IS BEST**

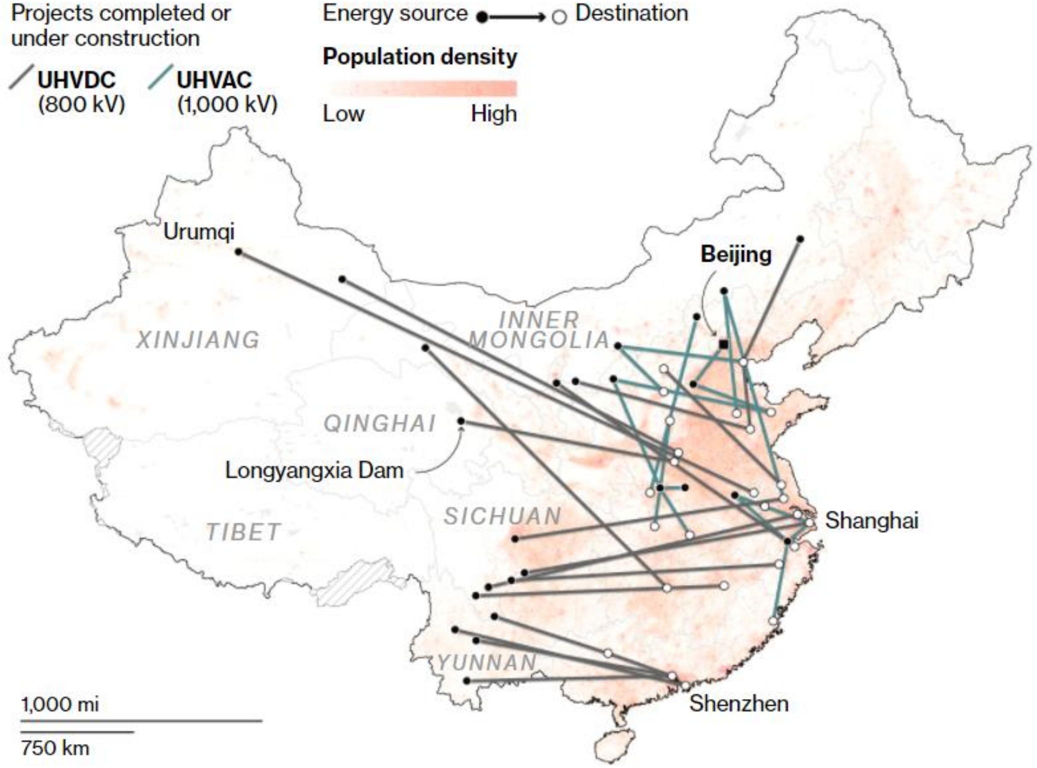
A Supergrid can take advantage of the **GEOGRAPHIC SPREAD OF RENEWABLES**



A more interconnected system will **REDUCE THE LEVEL OF DISPATCH** down within the energy system

A Pan-European grid would be **~32% CHEAPER** than a Business-as-usual approach

TRANSMISSION TECHNOLOGY - CHINA



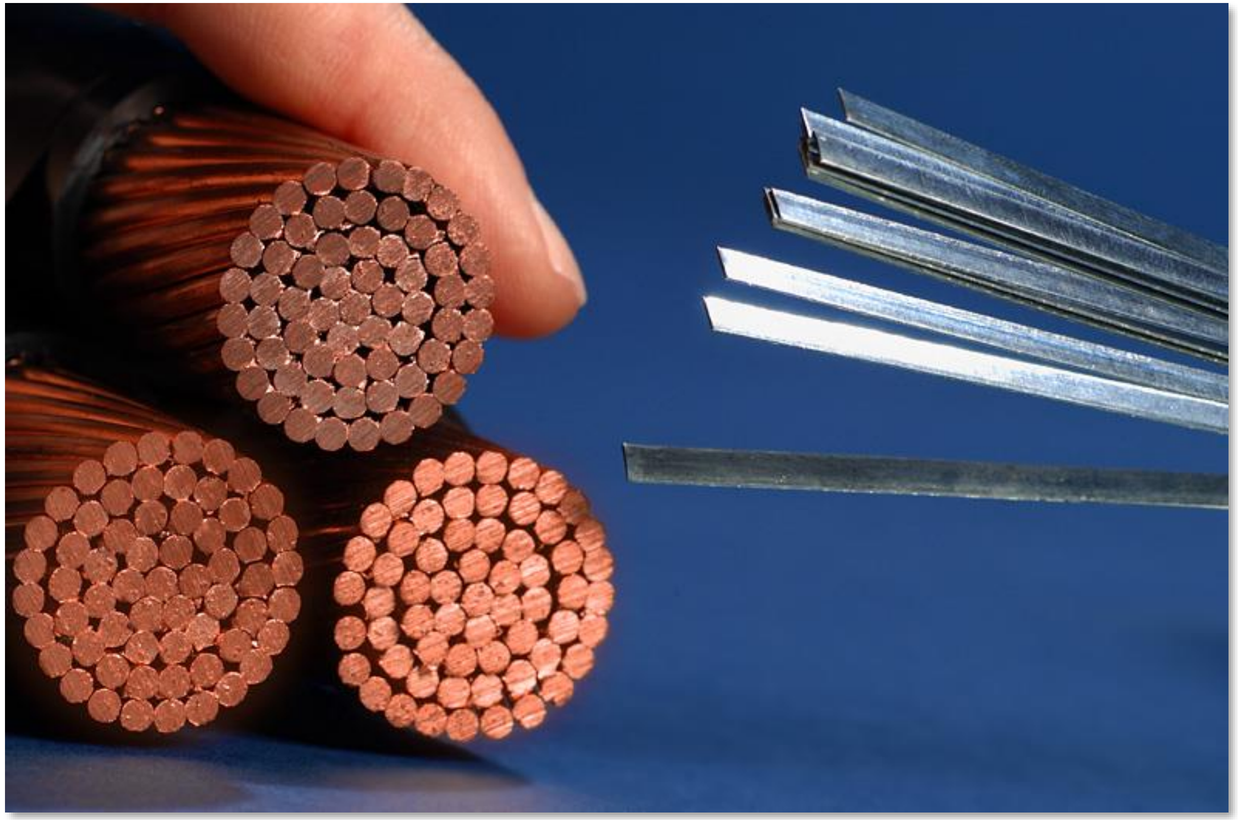
Sources: The Lantau Group, State Grid Corporation of China, WorldPop
Note: UHVDC lines perform better over longer distances. UHVAC lines are more efficient over shorter distances. UHV network data as of Jan. 21.

SUPERCONDUCTORS FOR ENERGY TRANSFER

Analogous to how Fibre Optic transformed telecoms and replaced the twisted copper pair

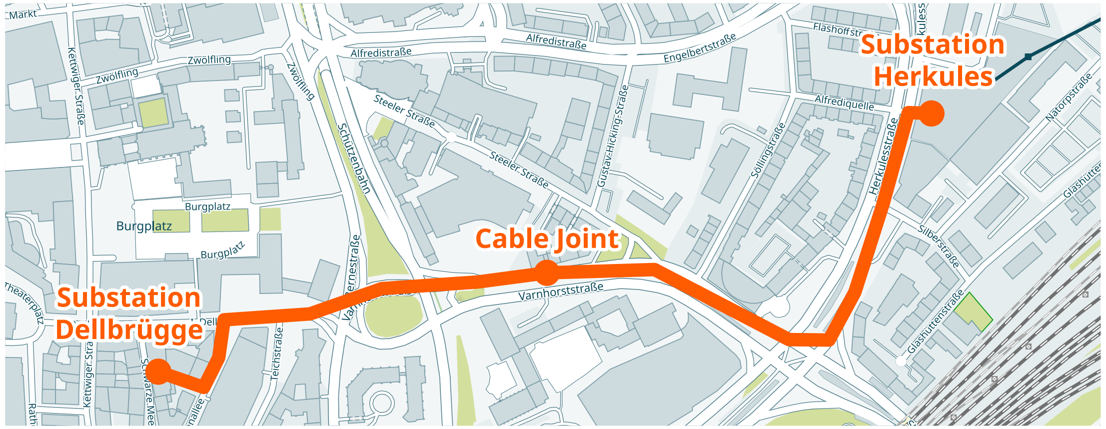
- Superconductor cables are much **more efficient** than conventional cables.
- They have a much **higher power density** which means a much smaller amount is needed to carry the same amount of energy as conventional cables.
- A **lower voltage** can be used to carry the same amount of power as a copper cable.
- Can carry **transmission levels of power** at distribution voltage.

1 kilo-Amp-meter: **1g YBCO tape : ~200g Copper**

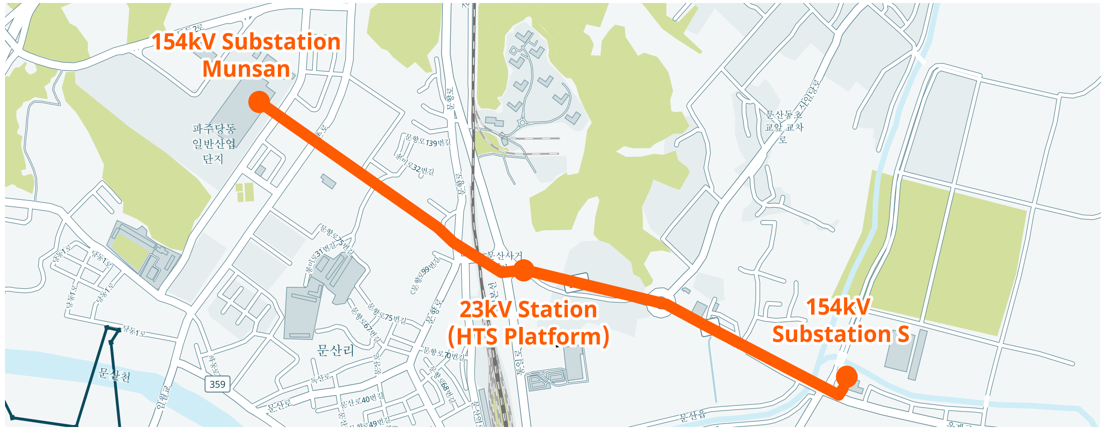


SUPERCONDUCTOR CABLE SYSTEMS IN PRACTICE

Ampacity Installation, Essen, Germany [1]



Shingal Project, Seoul, S. Korea [2]



Active Superconductor Projects		
2013	Operational	Ampacity, Essen [40MVA, 10kV]
2018	Demonstration	Horizon's 'Best Paths' Project [3.2GW, 320kV]
2019	Operational	Shingal, Seoul [50MVA, 23kV]
2021	Operational	REG, Chicago [62MVA, 12kV]
Planned	Feasibility study phase	Superlink, Munich (1st phase) [500MVA, 110kV]

1. https://ieeexplore.ieee.org/document/6683508
2. https://iopscience.iop.org/article/10.1088/1361-6668/ab6ec3/meta

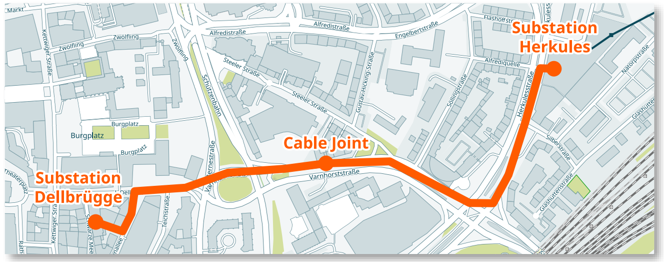
SUPERCONDUCTOR APPLICATIONS

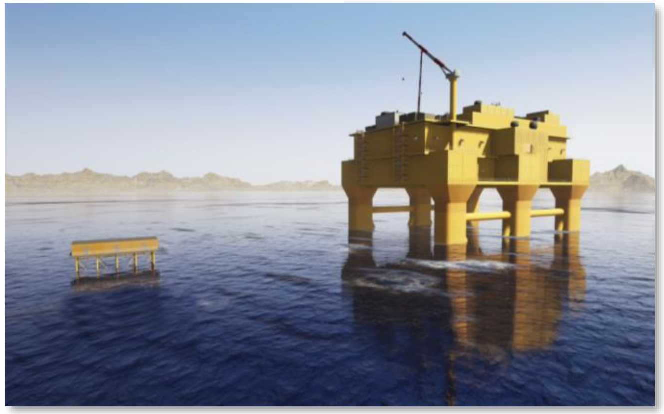
KEY ADVANTAGES

- **Most efficient** bulk power transfer
- **Underground Technology –** Greater Public Acceptability
- **Lower Voltages** – Reduces size, consent risk & cost.

APPLICATIONS

- Urban congestion
- Direct connections of large-scale offshore renewables
- Grid reinforcement at scale

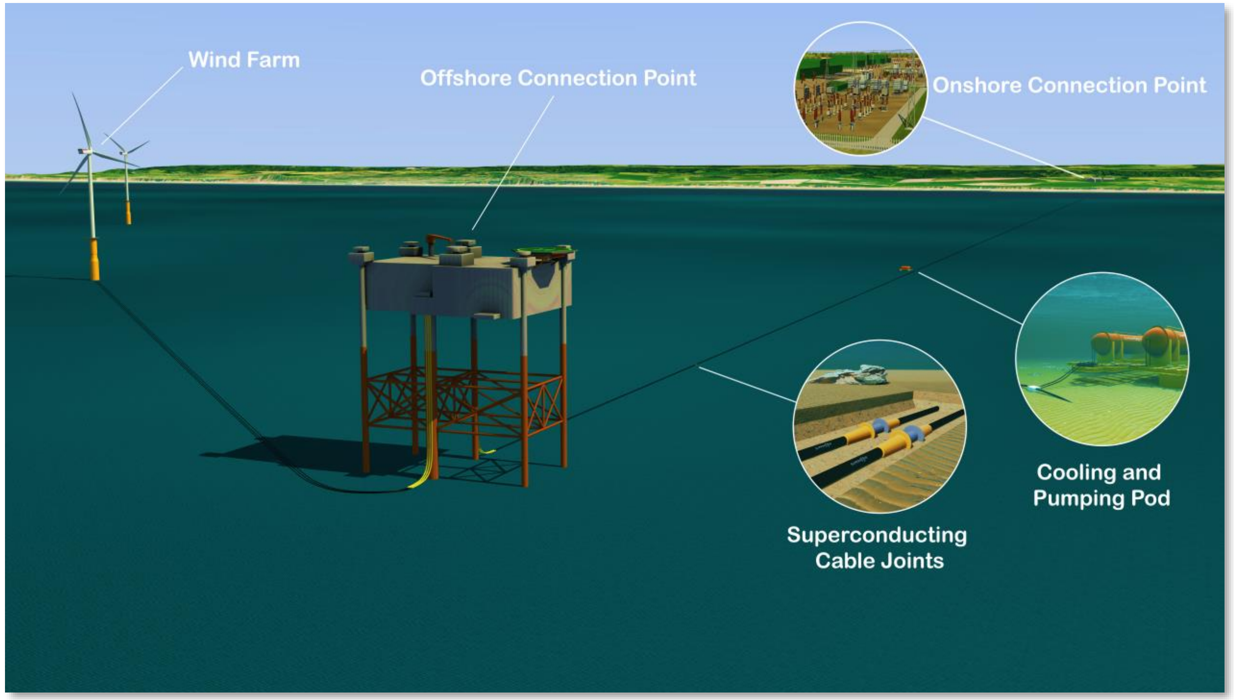




CABLE SYSTEM DEVELOPMENT

SUPERNODE'S R&D PROGRAM IS DEVELOPING SUPERCONDUCTING CABLE TECHNOLOGY:

- Offshore MVDC, 2GW+, long distance transmission
- Terrestrial MVDC, high-capacity, long distance transmission
- Specific focus of these applications is on deployment, operations & maintenance, optimal loss management, cooling and pumping stations and reliability & robustness
- Statement of Feasibility achieved for offshore transmission cable system



DNV·GL STATEMENT OF FEASIBILITY

SUPERNODE TECHNOLOGY DEVELOPMENT TIMELINE

2019

Market review & HTS Cable **Technology concept**

2020

Benchmark testing – Gen 01 Cryostat HTS

Statement of Feasibility from DNV

2021

Key patents, proof of concept testing for advanced cryostat & thermal systems

2022

SNL Technology Centre for subsystem prototype testing & high-tech manufacturing

2023

Design and manufacture of HTS Cable System Prototype

2025

Prototype validation of HTS Cable System Prototype – performance & reliability verified

FURTHER READING - DC FAULT STUDY

DC Fault Study of a Point-to-Point HVDC System Integrating Offshore Wind Farm using High-Temperature Superconductor DC Cables

Wang Xiang, *Member, IEEE*, Weijia Yuan, Lie Xu, *Senior Member, IEEE*, Eoin Hodge, John Fitzgerald, Paul McKeever, Keith Bell, *Member, IEEE*

***Abstract*—This paper presents a feasibility study of an offshore wind farm (OWF) HVDC integration system using high-temperature superconductor (HTS) DC cables. A representative ±100kV/2GW point-to-point OWF HVDC system is proposed including HTS DC cables and two converter stations using modular multilevel converters (MMCs). To be compatible with the high current rating of the HTS cables, each of the offshore and onshore converter stations consists of three MMCs in parallel. To study the interaction between HTS DC cables and MMCs, a multiple lumped π-section model of a HTS DC cable considering electrical and thermal functionality is developed. This paper provides a critical assessment of the proposed HVDC-HTS system, with emphasis on the performance under fast DC fault transients. Detailed simulations presented in this paper reveal that the HVDC-HTS system provides effective current limiting against DC cable short circuit faults.**

***Index Terms*—DC fault, HVDC transmission, high temperature superconducting, modular multilevel converter, renewable energy, wind energy.**

conductor (HTS) cables [6][7]. The HTS DC cables have the merits of a very high current capacity, smaller overall size, and higher efficiency. Several superconducting materials are now commercially available at an increasingly affordable price for HTS applications and industrial manufacture [8]-[13].

In reference [9], 1 km of HTS DC power cable is installed in the 80 kV/60MW *Hanlim* line commutation converter (LCC) based HVDC system. Steady-state and DC fault transient studies were carried out on the system. Owing to the current control and the voltage-dependent current limiter (VDCOL) of the LCC rectifier and the unidirectional conduction of the LCC inverter, it was found that the peak value of DC overcurrent was lower than the critical current of the HTS DC cable. Thus, quenching did not occur and the HTS DC power cable was safe during DC faults. A prototype of 100m/3.25 kA/80kV HTS DC cable was further developed in *South Korea* and successfully passed the qualification tests [10]. Reference [11] simulated an LCC-HVDC transmission system incorporating a 300km HTS

Fault Transient Study of a Meshed DC Grid with High-Temperature Superconducting DC Cables

Wang Xiang, *Member, IEEE*, Weijia Yuan, Lie Xu, *Senior Member, IEEE*, Eoin Hodge, John Fitzgerald, Paul McKeever

***Abstract*- This paper presents the DC fault transient study of a meshed DC grid with high-temperature superconducting (HTS) HVDC cables to integrate offshore wind power. A four-terminal meshed DC grid model with a ±100 kV DC voltage rating is developed. DC circuit breakers (DCCBs) are implemented in the DC grid to deal with DC cable faults. To conduct the fault transient study, the fault scenarios with different fault locations and protection delays are studied. The sensitivity study versus different DC fault locations reveals that the faults on the faulted cable will not cause the quenching of healthy cables. The sensitivity study considering different DC fault protection delays demonstrates that the HTS cables have a current-limiting effect and the long delay of DC fault protection does not result in large fault current and the quenching of healthy cables. Extensive simulations in PSCAD/EMTDC validate the founding.**

***Index Terms*- DC fault, DC grid, DC circuit breaker, modular multilevel converter, superconducting HVDC cable, offshore wind power.**

I. Introduction

Driven by the carbon-neutral electricity supply, more than 300 GW offshore wind power is expected to be installed in Europe by 2050. The modular multilevel converter (MMC) based high-voltage direct current (HVDC) transmission technology is considered to be one of the most effective technical solutions to realize this target. Existing offshore wind farm (OWF) HVDC systems implemented in Europe are should be increased, e.g., the ultra-high voltage (above 600 kV). But the ultra-high voltages impose high insulation requirements and increase the footprint and weight of offshore platforms, which in turn increases the cost. On the other hand, to integrate 300 GW OWF, more cable corridors and associated onshore substation space need to be accommodated, which is difficult for some countries, such as the limitation of the Frisian Islands in Germany.

The other one is the constraint of the large interruption current of DC circuit breakers (DCCBs). Under DC cable faults, the fault current will rise very fast and the voltage of the entire system may collapse within a few milliseconds. Hence, a high-power DCCB is required to interrupt the faults with ultra-fast speed and dissipate the inductive energy stored in the grid. Substantial research on DCCB technologies has been carried out and different topologies and concepts have been proposed to deal with the DC faults, such as the mechanical DCCB, the hybrid DCCB, the magnetic coupling DCCB [5]-[7]. But the cost and reliability of high power DCCB is still a problem. Taking the world's first meshed HVDC grid project (*Zhangbei* HVDC grid project in China) as an example, it adopts 14 hybrid DCCBs and 2 mechanical DCCBs to deal with overhead line fault. The total cost of DCCBs exceeds 60% of that of the converters [8], which is a big investment in the construction of the HVDC grid.

THANK YOU


CURRENT
Enabling Network Technology
throughout Europe
MATTHIAS
NOE
Professor
KIT

Opportunities for high voltage superconducting fault current limiters

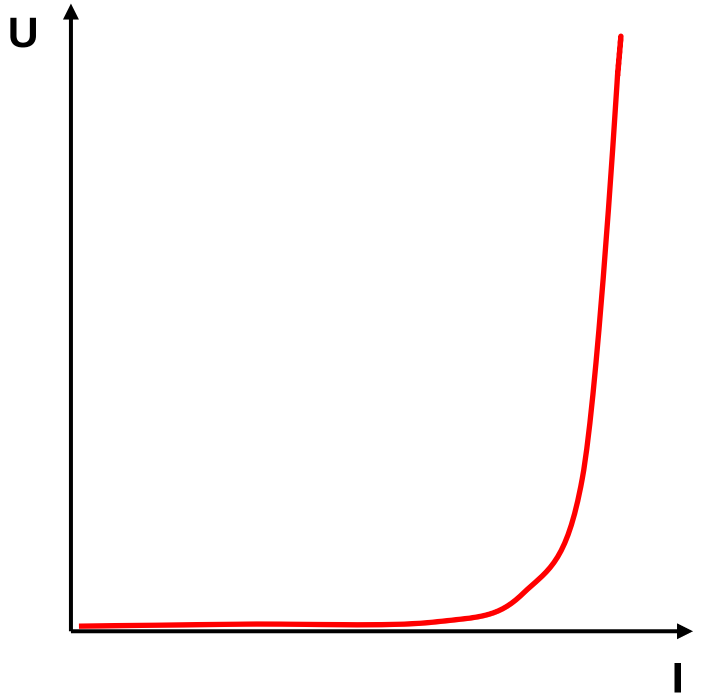
Prof. Dr.-Ing. Mathias Noe, Karlsruhe Institute of Technology, Institute for Technical Physics
currENT‘s Webinar, Superconductors for Power Transmission: Beyond the age of copper, July 7th 2022

KIT-ZENTRUM ENERGIE

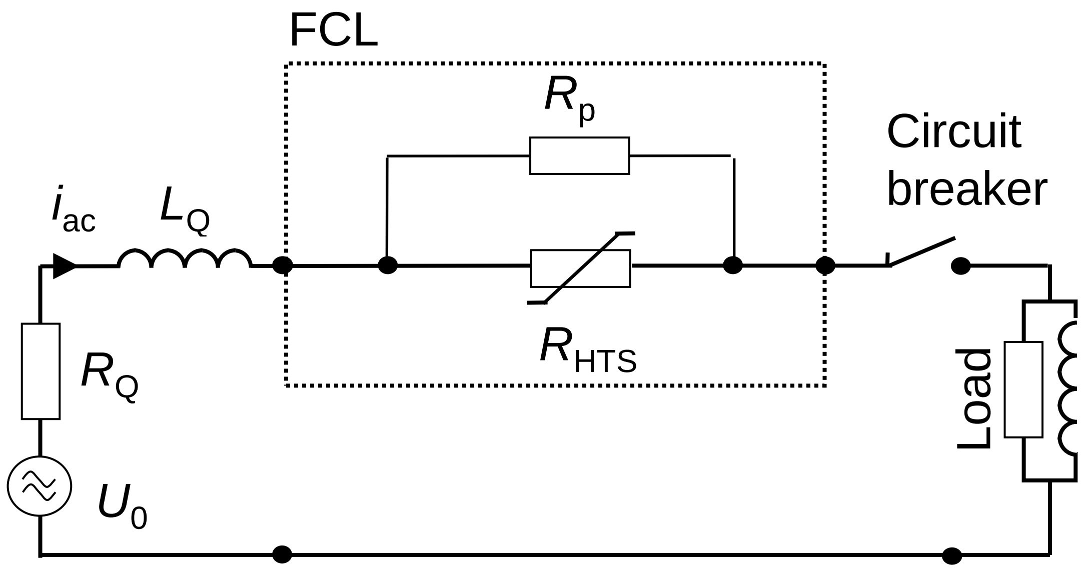
Working principle resistive type fault current limiter

- Non-linear current-voltage curve of superconductors

Current-voltage curve



Electric equivalent circuit

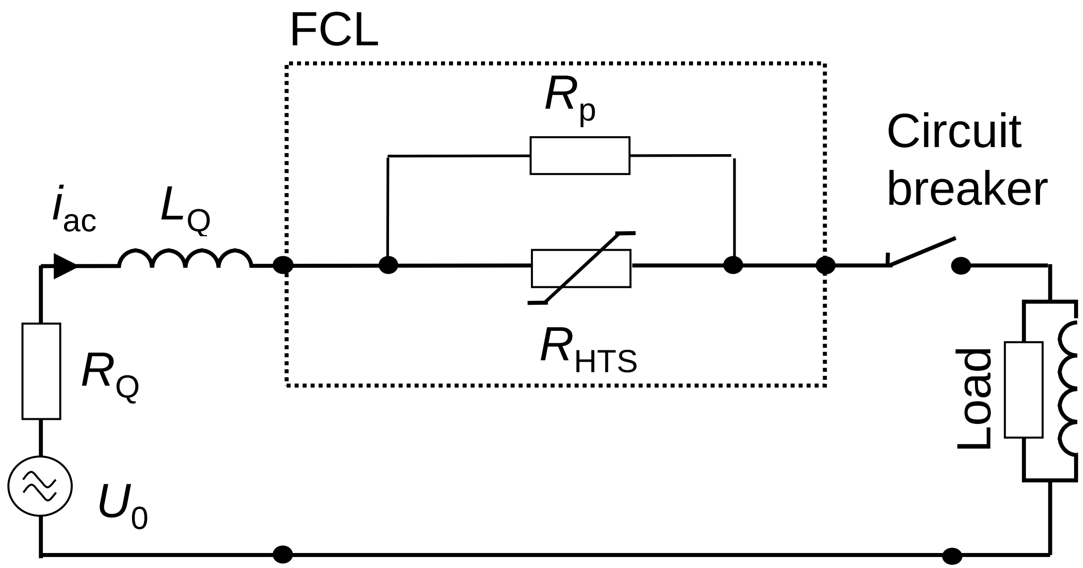


Intrinsic increase in resistance if current exceeds the critical current

Working principle resistive type fault current limiter

- Main features
  - Fast short-circuit limitation
  - No or small impedance at normal operation
  - Fast and automatic recovery
  - Fail safe
  - Applicable at high voltages
  - Cost effective

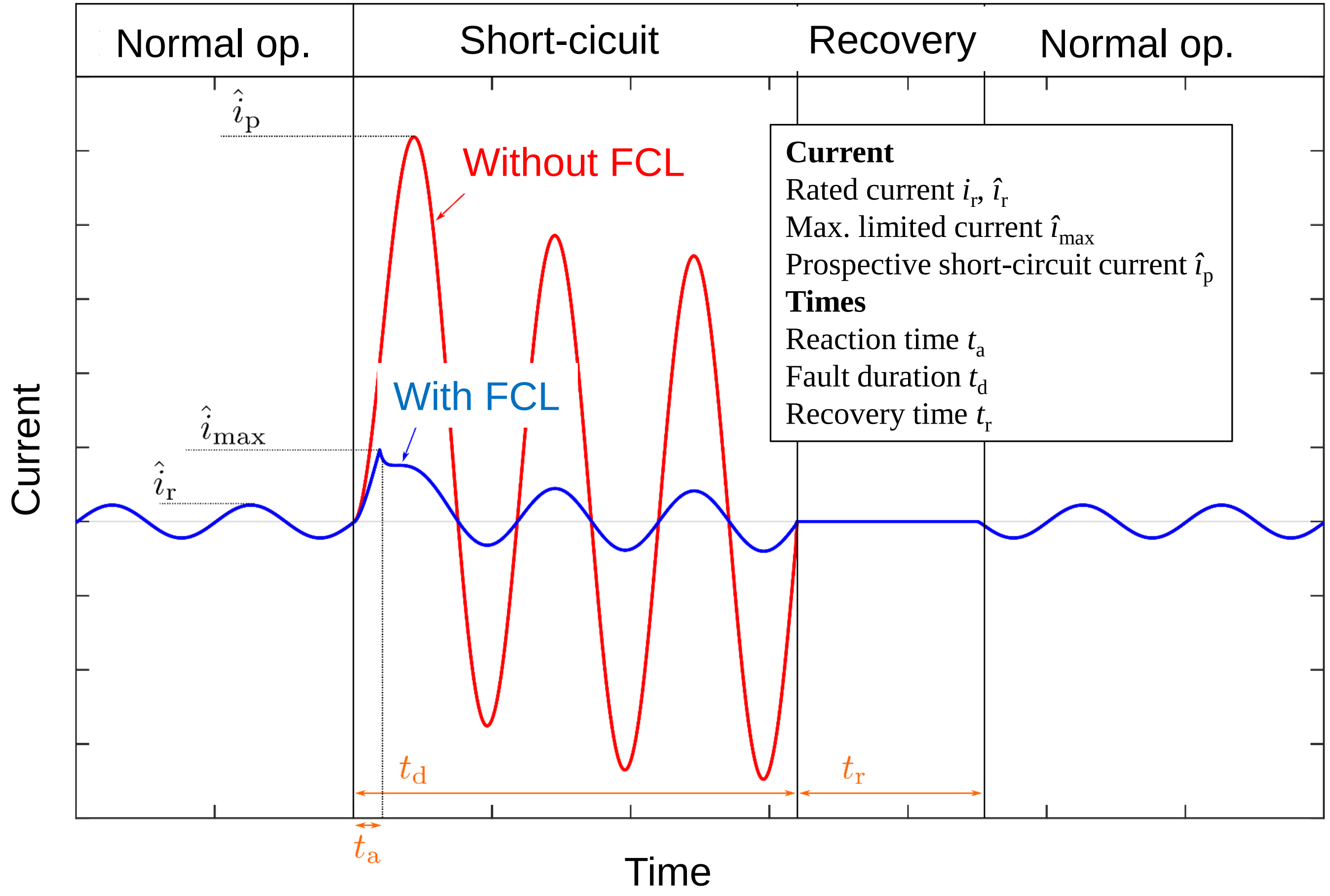
Electric equivalent circuit



Intrinsic increase in resistance if current exceeds the critical current

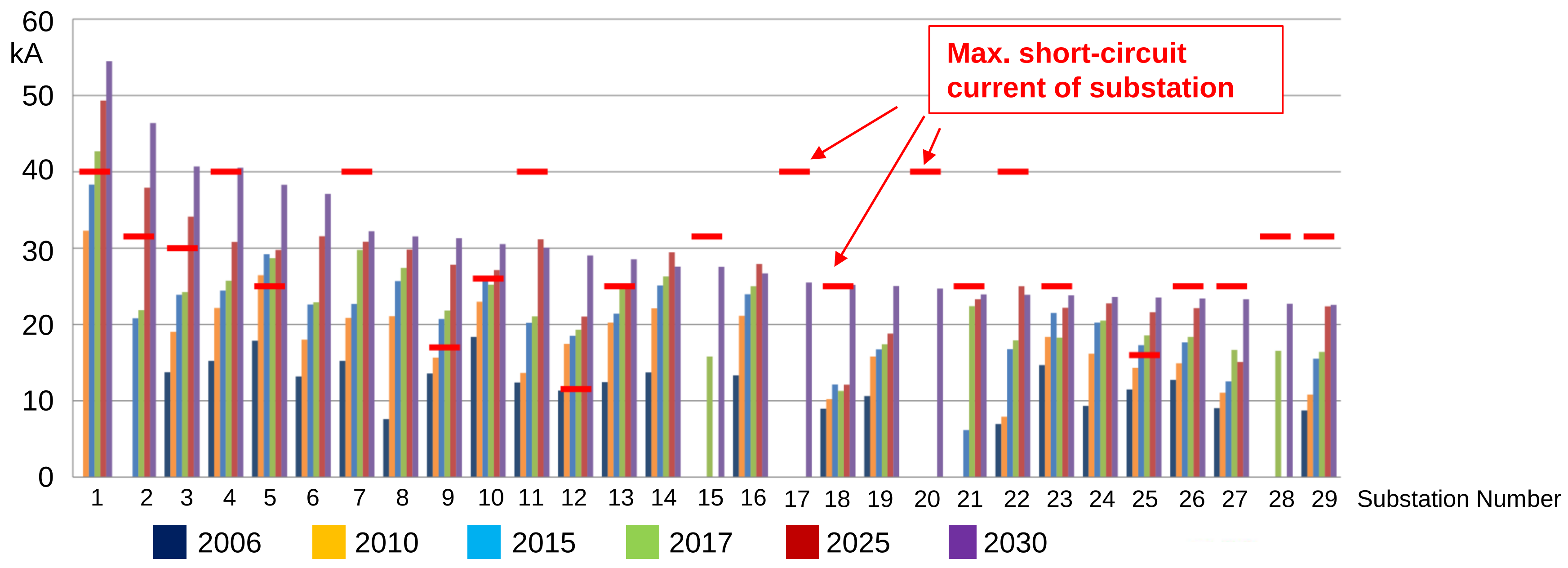
Working principle fault current limiter

- Typical short-circuit limitation



Opportunities for fault current limiters

- Development of highest short-circuit current of high-voltage to medium voltage substations of a German distribution system operator

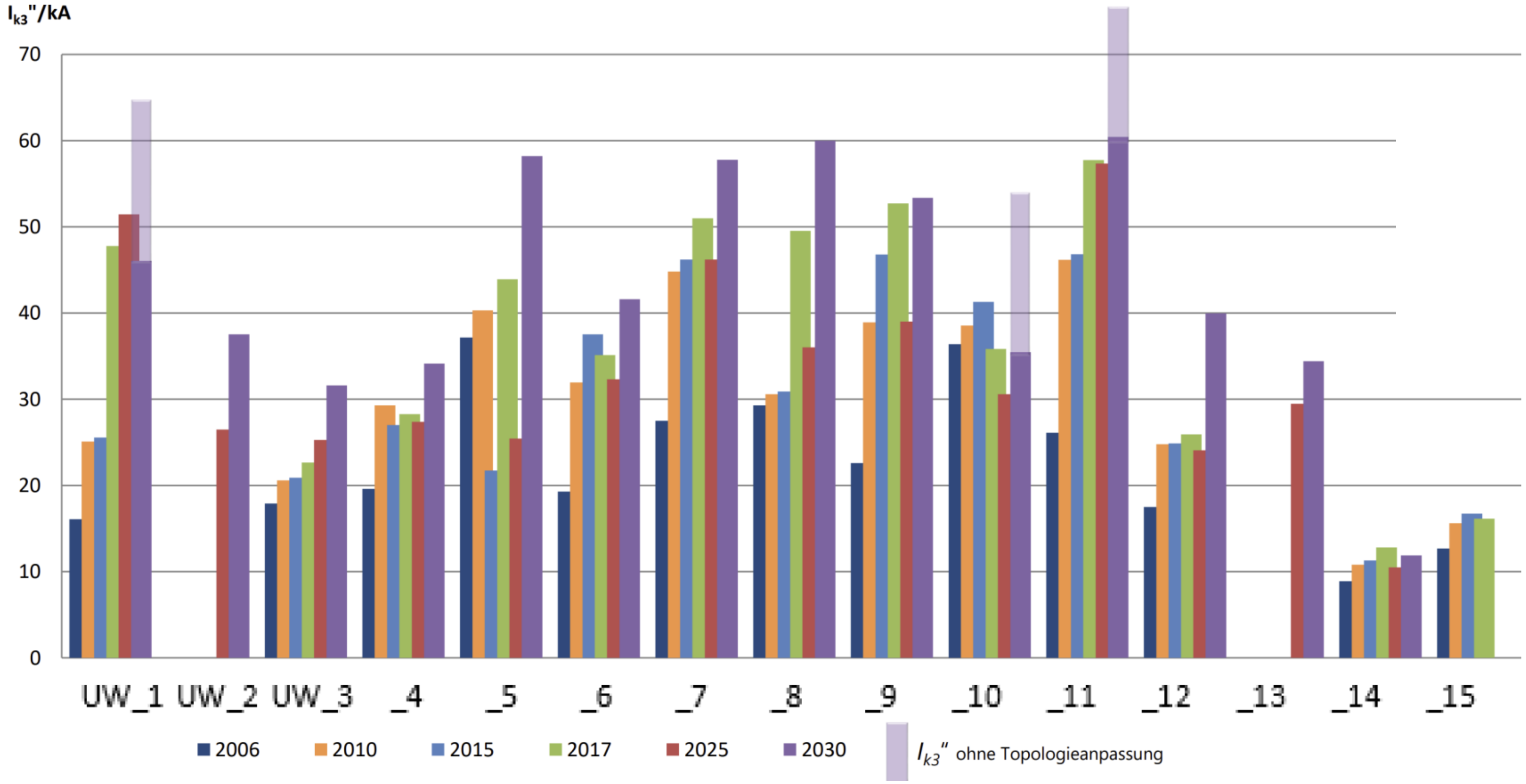


Source; R. Steinhorst, presentation ZIEHL Workshop 2022, Berlin, https://ivsupra.de/wp-content/uploads/2022/04/3-2-ZIEHL-VIII-Steinhorst.pdf.

In some locations a new substation has to be built with higher short-circuit ratings

Opportunities for fault current limiters

- Development of highest short-circuit currents for German TSO



Source; R. Steinhorst, presentation ZIEHL Workshop 2022, Berlin, https://ivsupra.de/wp-content/uploads/2022/04/3-2-ZIEHL-VIII-Steinhorst.pdf.

Grid extension overcompensates de-activation of coal and gas power stations

Opportunities for fault current limiters

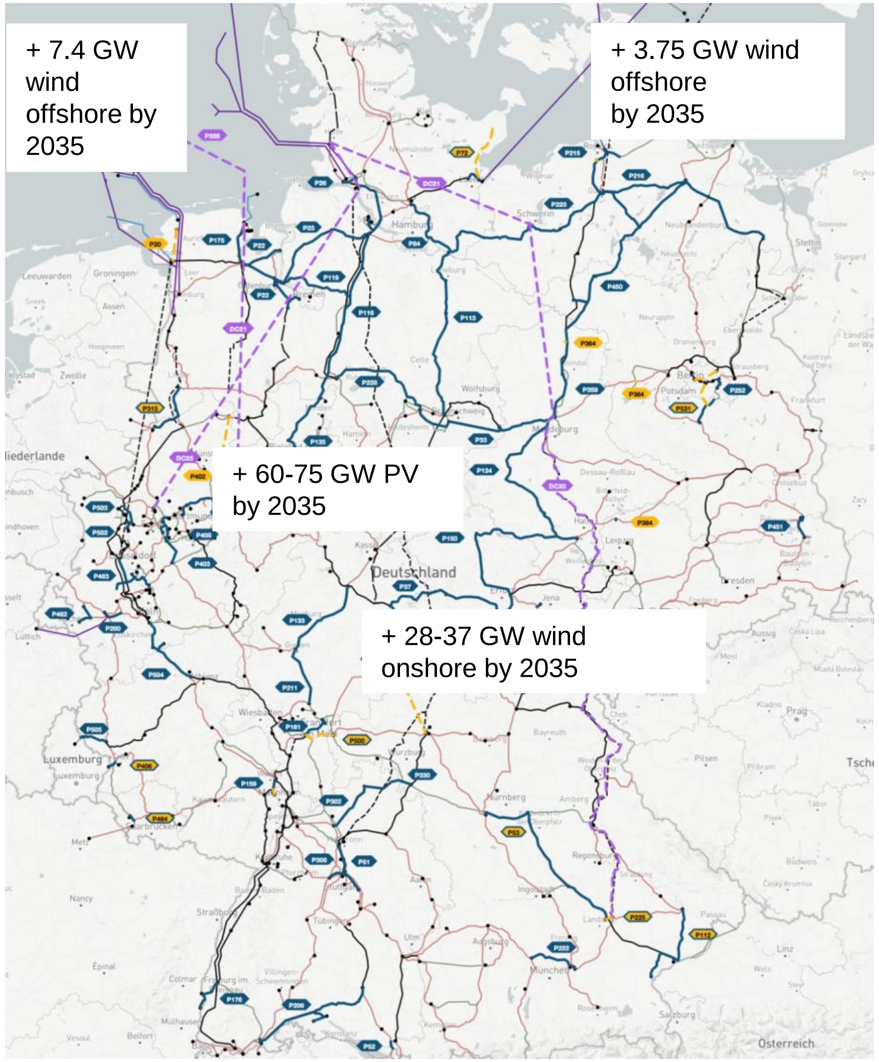
- Installation of many new transmission and distribution lines

Scenario	AC upgrade	DC upgrade	AC New	DC New
A	3365	540	380	1310
B	3365	540	380	1310
C	3490	540	380	1835
D	3775	540	520	1835

All values in km

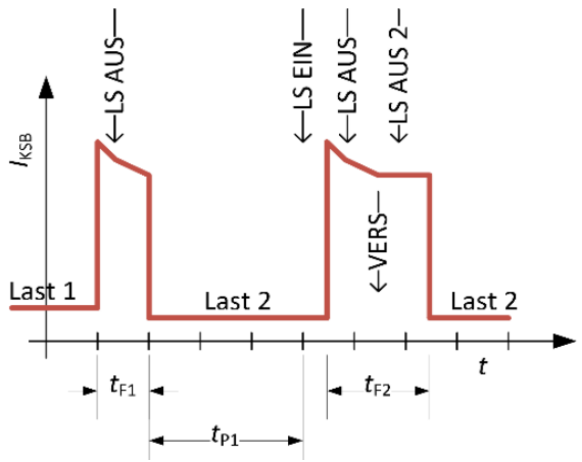
Source and picture: Netzentwicklungsplan Strom 2035, Version 2021

By 2035 an investment of up to 80 Mrd. Euro is expected for the high voltage transmission grid only in Germany



Example specification

	Transformer feeder	Bus Section Coupling
Nominal Voltage, U_n	110 kV	380 kV
Nominal Current, I_n	2.1 kA	5.0 kA
Max. short-circuit current without limiter, I_k''	13 kA	63 kA
Max. limited current with FCL	4.5 kA	30 kA
Fault duration t_d	0.30 s 0.2 s	0.25 s



Example specification and some data

	Transformer feeder	Bus Section Coupling
Nominal Voltage, U_n	110 kV	380 kV
Nominal Current, I_n	2.1 kA	5.0 kA
Max. short-circuit current without limiter, I_k''	13 kA	63 kA
Max. limited current with FCL	4.5 kA	30 kA
Fault duration t_d	0.30 s 0.2 s	0.25 s
Amount of HTS tapes	24.5 km*	240 km**
Cryostat dimensions (D, L)	2 m, 5.4 m	3.4 m, 13.5 m
Cryostat pressure	3 bar	5 bar

* I_c = 600 A at 77 K, self field, 12 mm width
** I_c = 700 A at 77 K, self field, 12 mm width

State of the art

- 2019 – First 220 kV resistive type SCFCL in grid operation in Russia

  Voltage 220 kV

  Current 1200 A

  Limited Current 7 kA

  Fault duration 400 ms

  25.2 km, 12mm wide YBCO

  Max. Cryostat press. 15 bar

  Weight one phase 27 tons with LN_2

Source: Mikhail Moyzykh et.al, First Russian 220 kV Superconducting Fault Current Limiter (SFCL) For Application in City Grid, IEEE TRANSACTIONS ON APPLIED SUPERCONDUCTIVITY, VOL. 31, NO. 5, AUGUST 2021

Installation of worldwide first high voltage resistive type superconducting fault current limiter

State of the art – List of field tests of resistive type SFCLs

Lead Company	Country	Year	Data	Superconductor
ACCEL/NexansSC	Germany	2004	12 kV, 600 A	Bi 2212 bulk
Toshiba	Japan	2008	6.6 kV, 72 A	YBCO tape
Nexans SC	Germany	2009	12 kV, 100 A	Bi 2212 bulk
Nexans SC	Germany	2009	12 kV, 800 A	Bi 2212 bulk
ERSE	Italy	2011	9 kV, 250 A	Bi 2223 tape
ERSE	Italy	2012	9 kV, 1 kA	YBCO tape
KEPRI	Korea	2011	22.9 kV, 3 kA	YBCO tape
Nexans SC	Germany	2011	12 kV, 800 A	YBCO tape
AMSC / Siemens	USA / Germany	2012	115 kV, 1.2 kA	YBCO tape
Nexans SC	Germany	2013	10 kV, 2.4 kA	YBCO tape
Nexans SC	UK	2015	12 kV, 1.6 kA	YBCO tape
Siemens	Germany	2016	12 kV, 815 A	YBCO tape
Superox	Russia	2019	220 kV, 1.2 kA	YBCO tape
LS Industrial Systems	Korea	2020	25.8 kV, 2 kA	YBCO tape
China Southern Pow. Gr.	China	2022	160 kV, 2 kA	YBCO tape

*list not complete

More than 10 successful field tests and a few companies offering commercial systems

Summary

- Superconducting high voltage current limiters are technically feasible
- Voltages of up to 380 kV and currents up to 5 kA seem possible
- Economic feasibility needs more detailed design studies

Many thanks for your attention!


CurrENT
Enabling Network Technology throughout Europe
MIKE ROSS
Managing Director
Superconductor Power Systems
AMSC

RESILIENT ELECTRIC GRID NETWORKS: ACHIEVING ENHANCED RESILIENCY IN TODAY'S GRID

ComEd Application

Resilient Electric Grid (REG) Networks

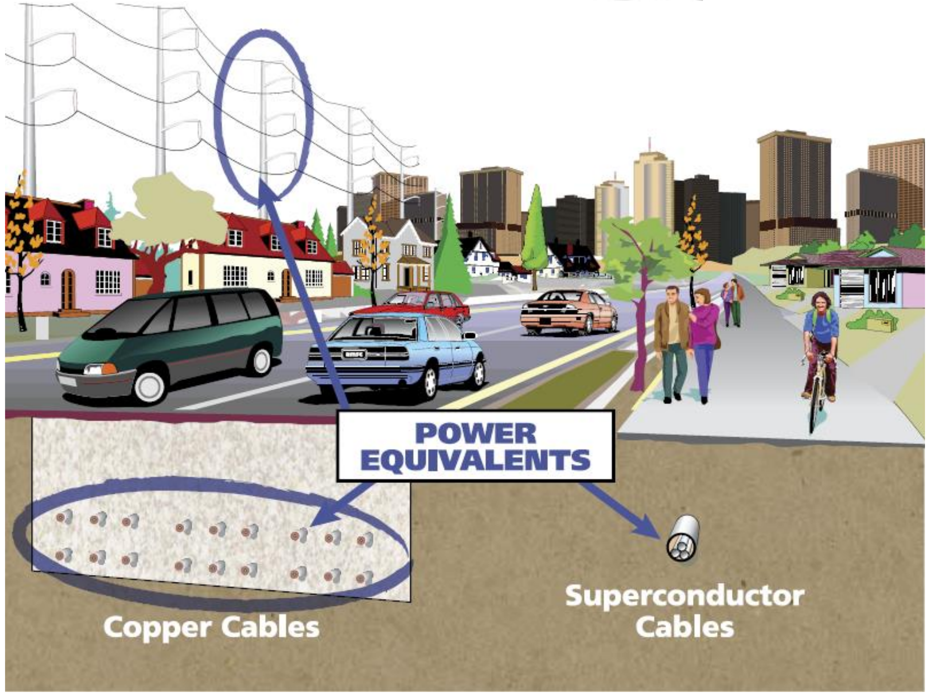
Achieve Major Increases in Reliability

AND

- Avoid land acquisition for new or expanded substations
- Avoid construction of new transmission circuits
- Minimize public disruption during construction
- Enable new options for installation in congested ROW
- Avoid the delay and risk of transmission siting and permitting
- Avoid public debate of new sources of EMF
- Avoid oil and SF6

REG Networks’ Unique Value

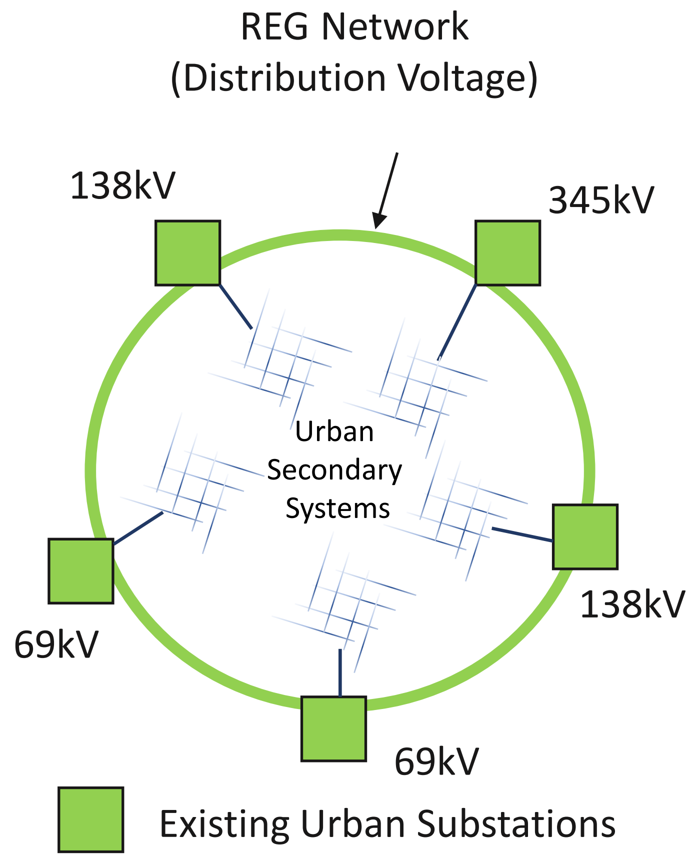
- ✓ Fault current management
- ✓ Power transfer equivalency at a smaller footprint and lower voltage equipment
- ✓ Simpler permitting, siting, and installation in smaller Rights-of-Way, due to near zero thermal and EMF signature
- ✓ Provides an option to improve resiliency that is effective even in areas served by multiple Transmission Voltage levels



REG Networks' Unique Value

Creating a higher-level network above the existing Urban Secondary System

- ✓ REG Networks provide **resiliency** by creating grid **redundancy**
- ✓ REG Networks **connect** urban substations on the **distribution side**, effectively **reinforcing** the transmission system
- ✓ REG Networks provide **high capacity, distribution voltage connections** with minimal footprint, civil work and permitting
- ✓ Approach is independent of **transmission voltage levels,** but compliments the existing transmission system



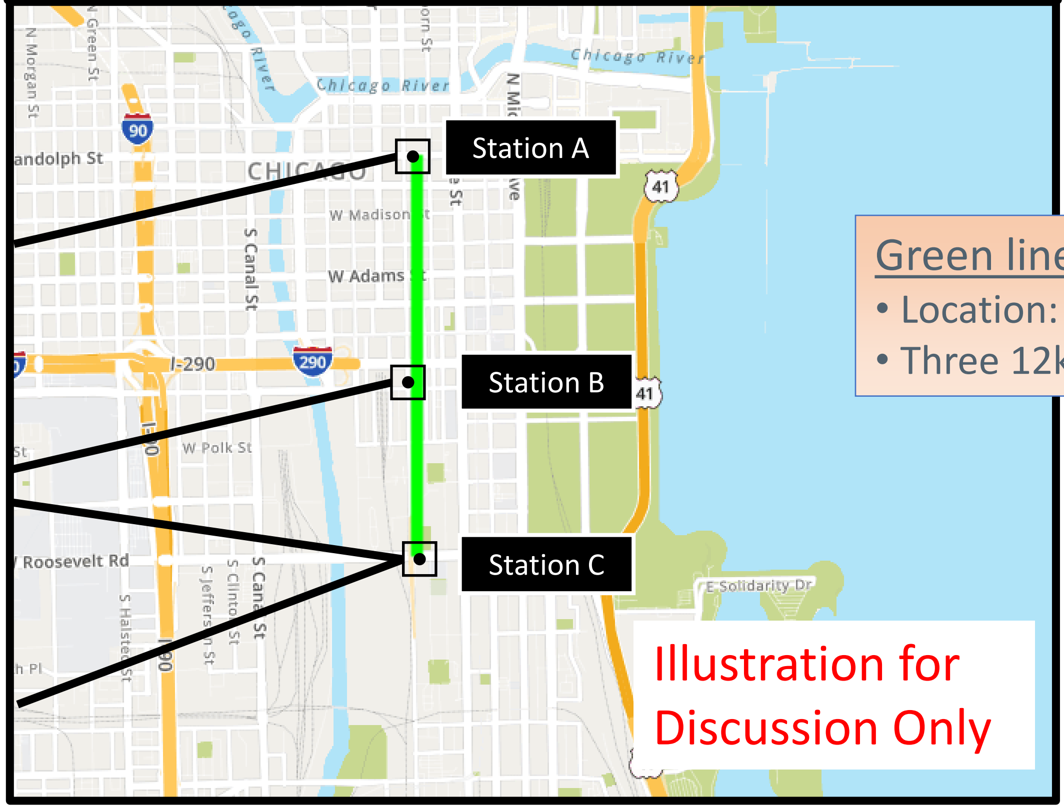
REG Benefits for Chicago

Intended to Provide Greater Resilience with Lower Cost and Less Disruption

- **Expected to increase reliability in the heart of the Chicago**
- **Project intended to loop together multiple substations into a network, increasing reliability and resiliency for all to N-3**
- **Project will connect multiple substation including two** radial substations, served from <u>69kV</u> sources, and **one station** looped at <u>138kV</u>
- **Expected to be far less disruptive** to the downtown core area than conventional transmission upgrades and not to:
  - Require **additional high voltage transformation**
  - Require **significant infrastructure construction**
  - Require **land acquisition for substation expansion**

Possible Second REG Project in Chicago

Chicago's Central Business District (CBD)



<u>Green line indicates superconducting cables:</u>

- Location: Chicago's Central Business District (CBD)
- Three 12kV, 62MVA superconductor cables

Initial REG Project

Smaller scale initial phase with similar benefits

- As a prelude to the possible CBD project, ComEd will implement a REG Network at different Chicago substation to increase the reliability level from N-1 to N-2
- Project will serve to increase the reliability within the substation by providing a high-capacity link between two terminals in the substation
- Effort will provide experience and lessons learned to be incorporated into the possible CBD project

REG System – Initial Project

Legend

- Superconductor Cable
- Refrigeration Building
- Underground Cable
- Terminations

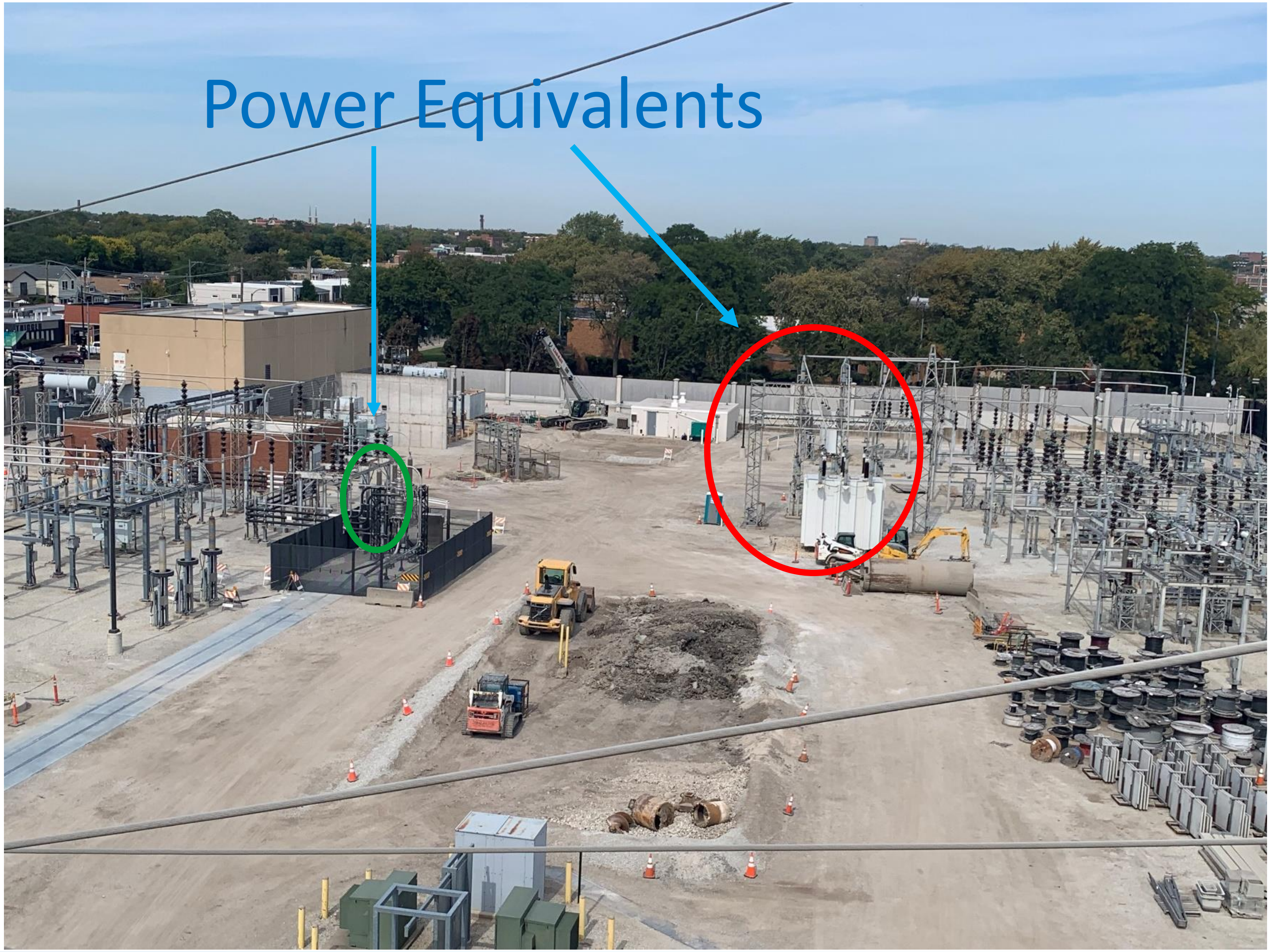
← North

REG Cable Installation

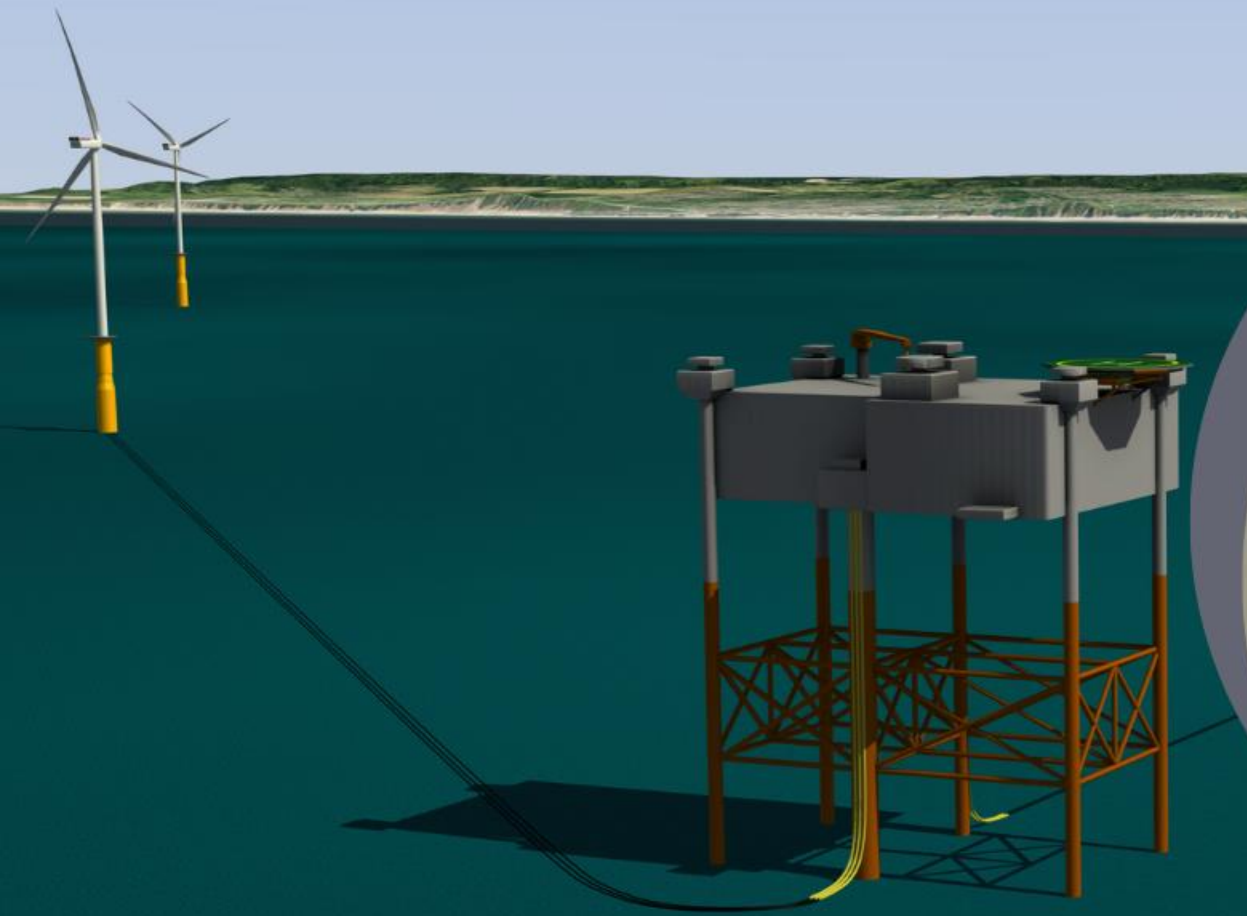
REG Termination

REG Termination 2

REG Footprint Comparison



CURRENT
Enabling Network Technology throughout Europe



DAG WILLEN

Principal R&D Engineer
NKT

7/12/2022

HTS Cable Technology

Dag Willén
NKT Group A/S, Technology R&D

Introduction
Urbanization

Increasing use of electricity

Heating

e-mobility

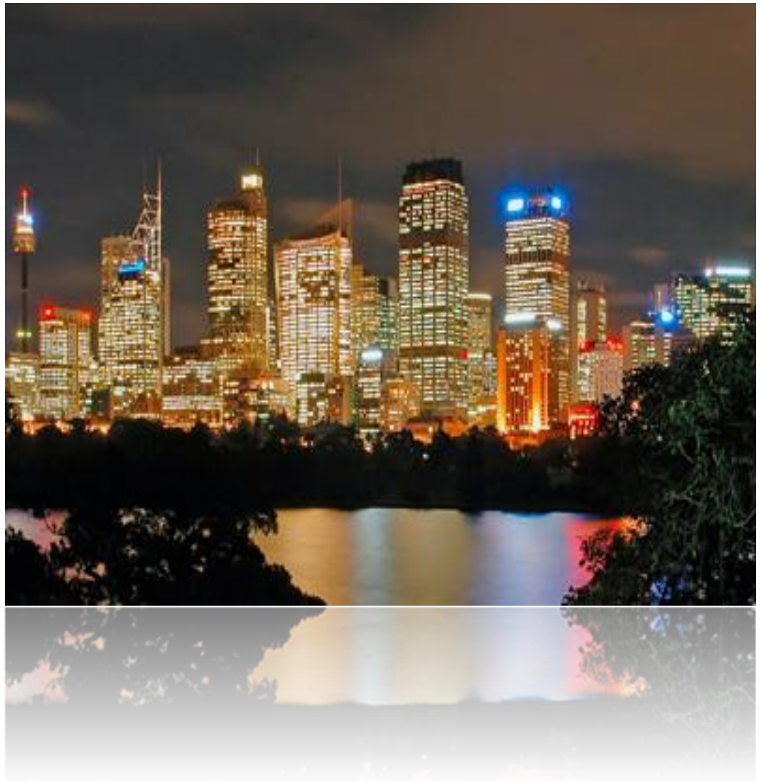
Higher energy density

Replacing old cables

No footprint left

Geometrically (space)

Thermally (heat)



EPRI Conference Albany NY, 2005

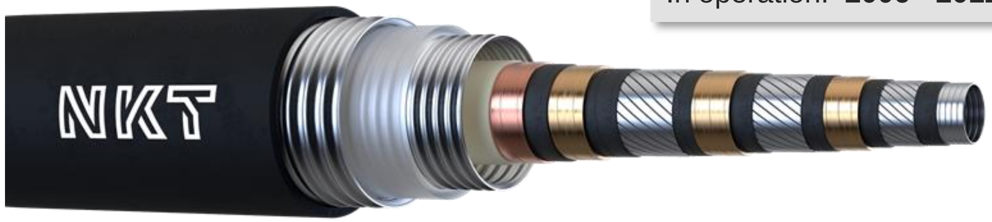
HTS Cable Designs

MV and HV

HTS Triax® Energy & FCL Cables

- 10-72 kV
- 1000-5000 Aac, 3000-10000 Adc
- 25 MVA-500 MVA

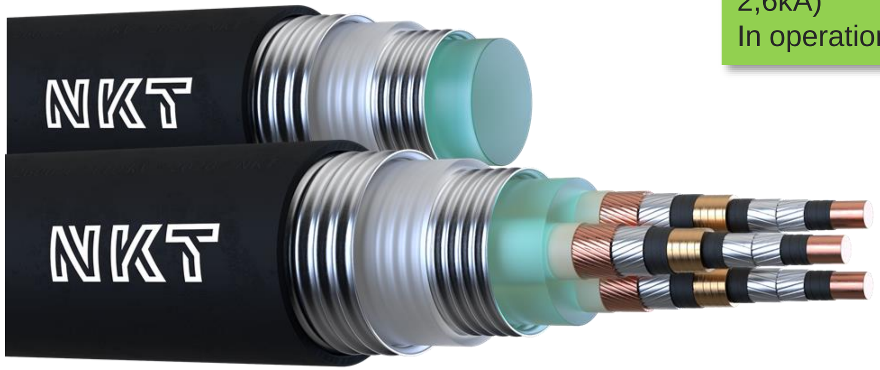
Bixby, USA
Cable length: 200 m
Rating: 69 MVA AC (13,2kV, 3kA)
In operation: **2006 - 2012**



HTS Coax Cables

- 110-400 kV
- 1000-5000 Aac, 3000-10000 Adc
- 150 MW – 3 GVA

SuperLink, Munich, DE
Cable length: 200 m
Rating: 500 MVA AC (110kV, 2,6kA)
In operation: **2023**



The same materials, machines and processes are used for both product groups

Project SWM SuperLink
Partners

Gefördert durch:

Bundesministerium
für Wirtschaft
und Energie

aufgrund eines Beschlusses
des Deutschen Bundestages

SWM

NKT

THEVA

Linde

Fachhochschule
Südwestfalen
University of Applied Sciences

KIT
Karlsruher Institut für Technologie

Task Description

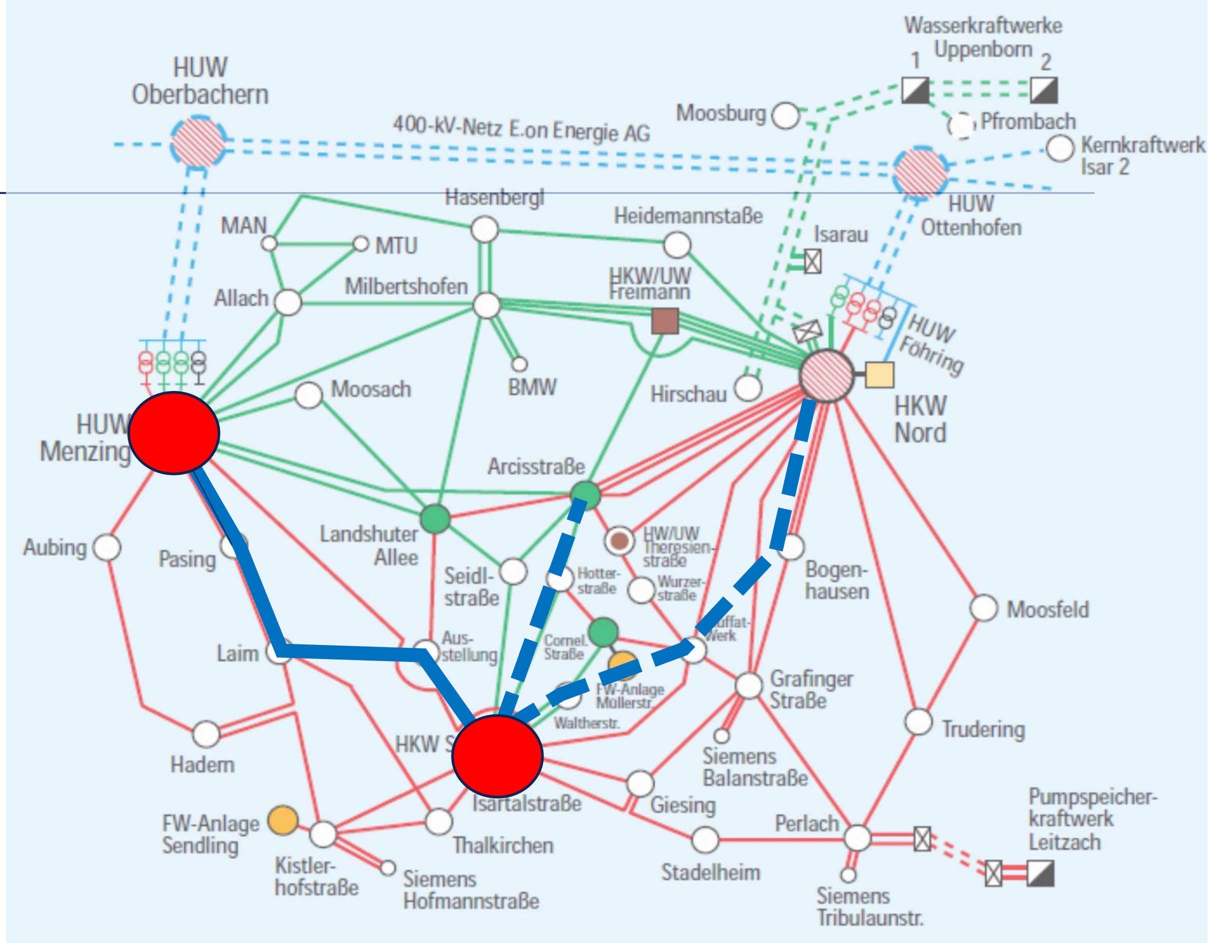
High-density load area Munich

- Connect Kraftwerk Süd to the OH lines north of Munich
- Power rating 500 MVA
- Operation voltage 110 kV
- Length ~12 km
- Routed through the center og Munich

Gefördert durch:

Bundesministerium
für Wirtschaft
und Energie

aufgrund eines Beschlusses
des Deutschen Bundestages



Werkstatt Kabel 2020

Most Important requirements - Overview

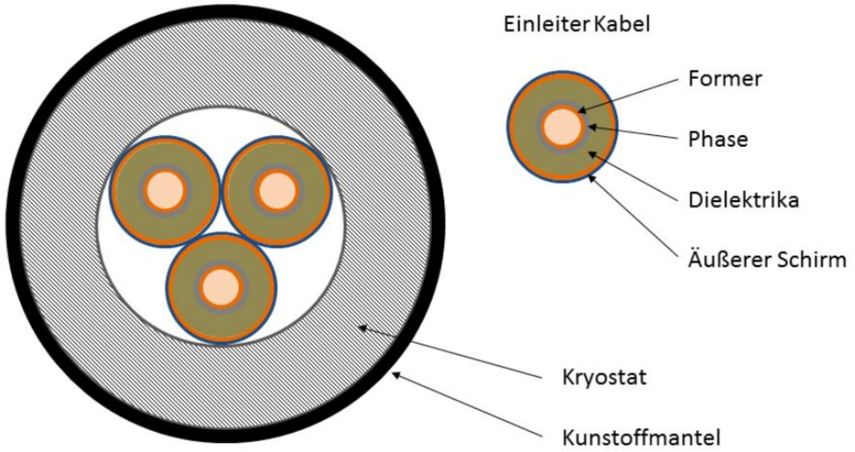
The SuperLink must provide these advantages:

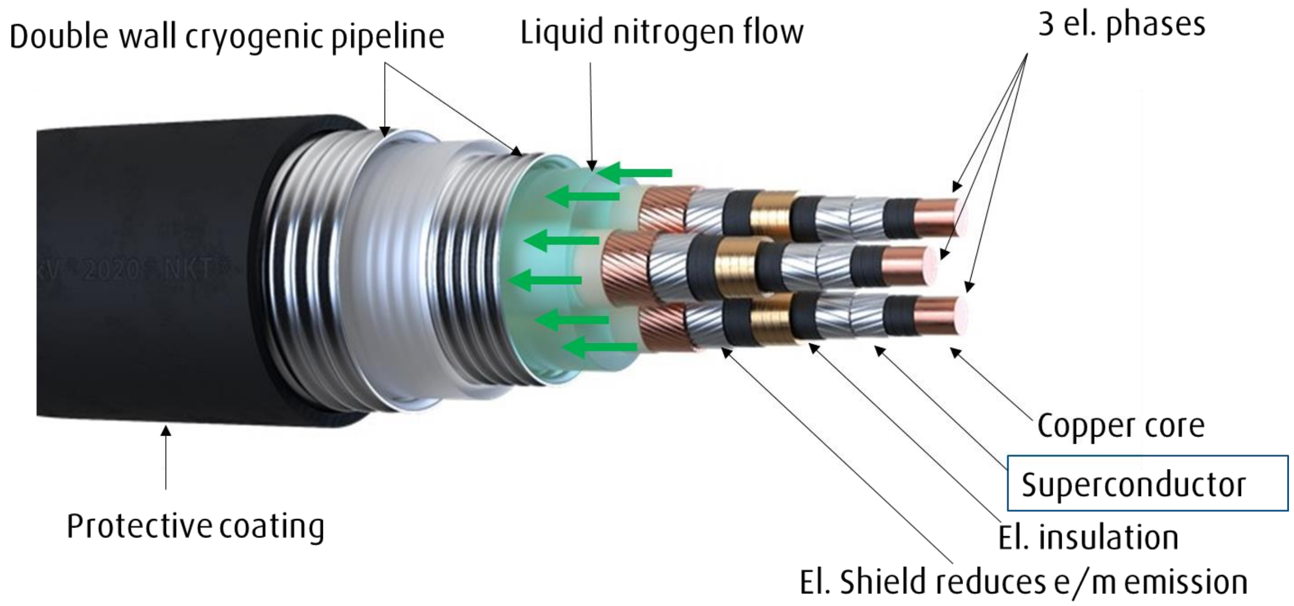
Criteria	Background
Save space	Very limited room for construction, Influence of other services, Routes and Right-of-way
Acceptance	Electromagnetic fields, Ground heating, Building sites
Economic	Cost of building and operating
Technically mature	Electric networks are critical infrastructure
Power Rating	Deliver 500 MVA or more in smallest space
Energy efficient	Reducing CO_2 Emissions

Werkstatt Kabel 2020

Development of the Cable System

- Three single-phase cables
- Terminations and joints
- Common Cryostat
- Ultra compact
  (Option to Retrofit)



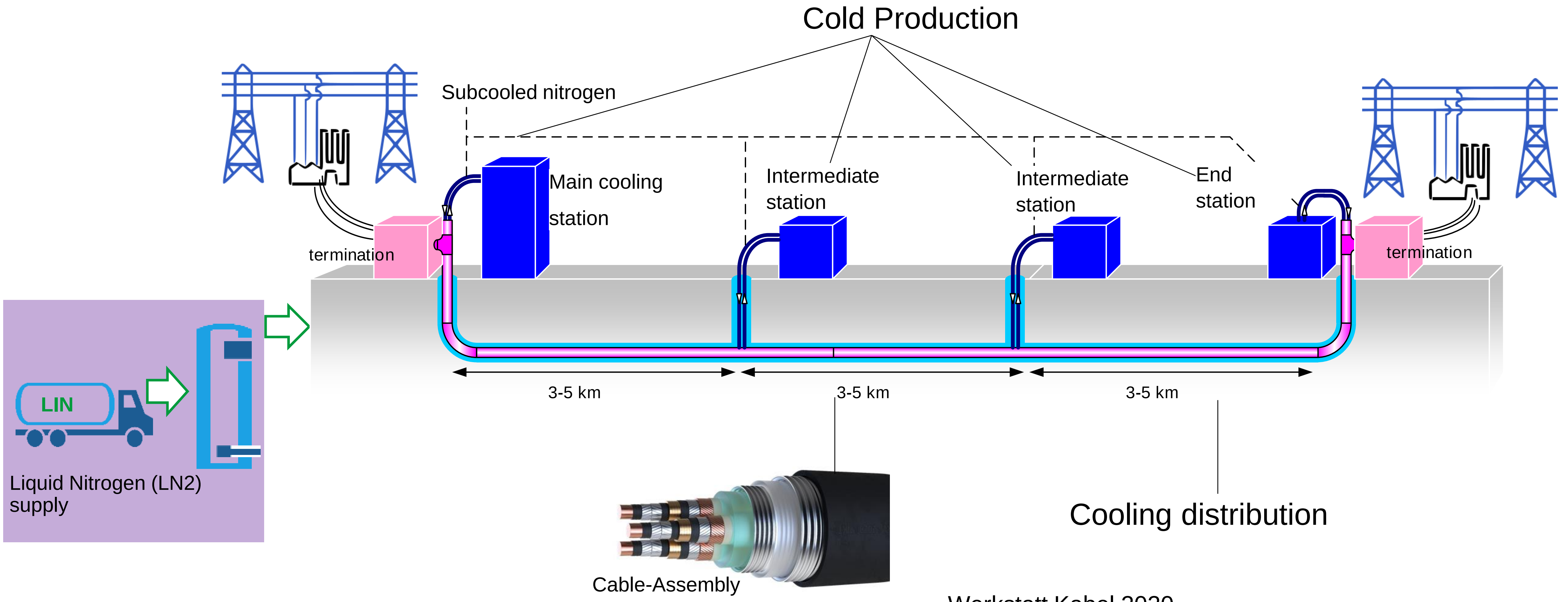


110 kV SuperLink Kabel

- Three-phase cable with High-Temperature Superconductor (HTS)
- One cable in one trench replaces 5 conventional 110 kV cables in separate trenches

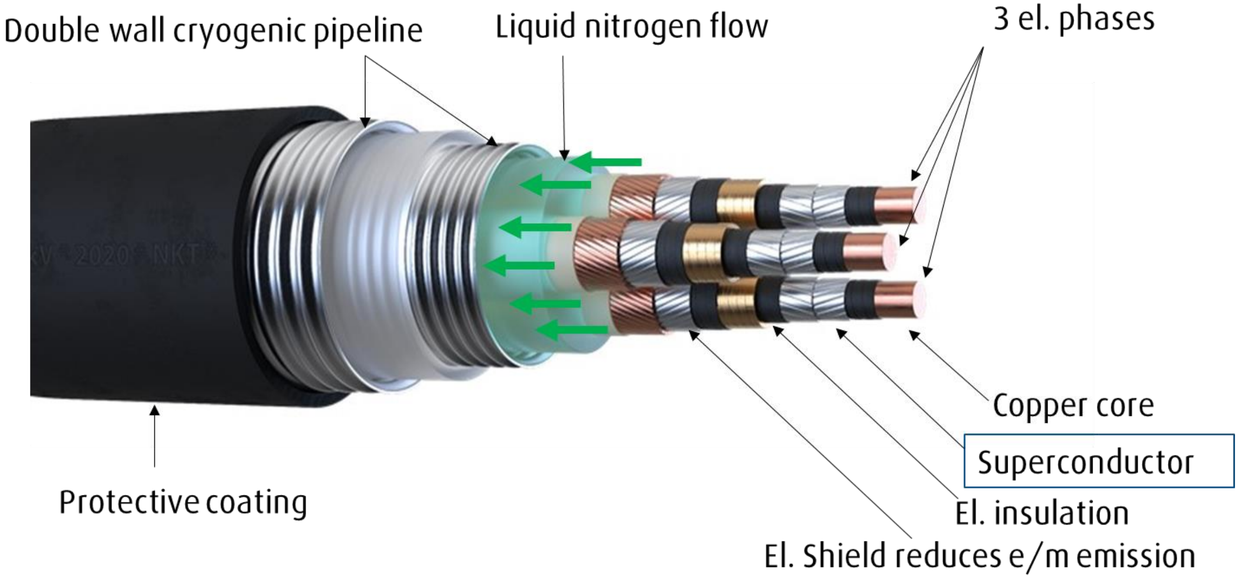
Werkstatt Kabel 2020

Development of a distributed cooling system (Concept)



Werkstatt Kabel 2020

SWM SuperLink
Solution



2020 Projekt Start → 2021 Development → 2022 Type Test → 2023 Field Demo/PQ → Commercially Available

Summary

The SWM SuperLink Project is the corner stone of the worlds longest installation of HTS cable systems

The HTS solution

- Is an economically sound and technically smart solution for some of the biggest challenges in modern city grids
- Minimal environmental footprint and smaller and fewer construction sites
- New flexibility in growing networks
- Increases the energy efficiency in urban distribution grids
- Minimizes the impact on citizens during the construction phase

Werkstatt Kabel 2020

Purpose

We connect a greener world


CURRENT
Enabling Network Technology throughout Europe
NORELA CONSTANTINESCU
Head of Section Innovation
ENTSO-E

Superconductivity – a potential game changer

High Temperature Superconductivity in cables

Advantages:

- High Power carrying capacity
- Easier and shorter installation time
- Low impact on the environment

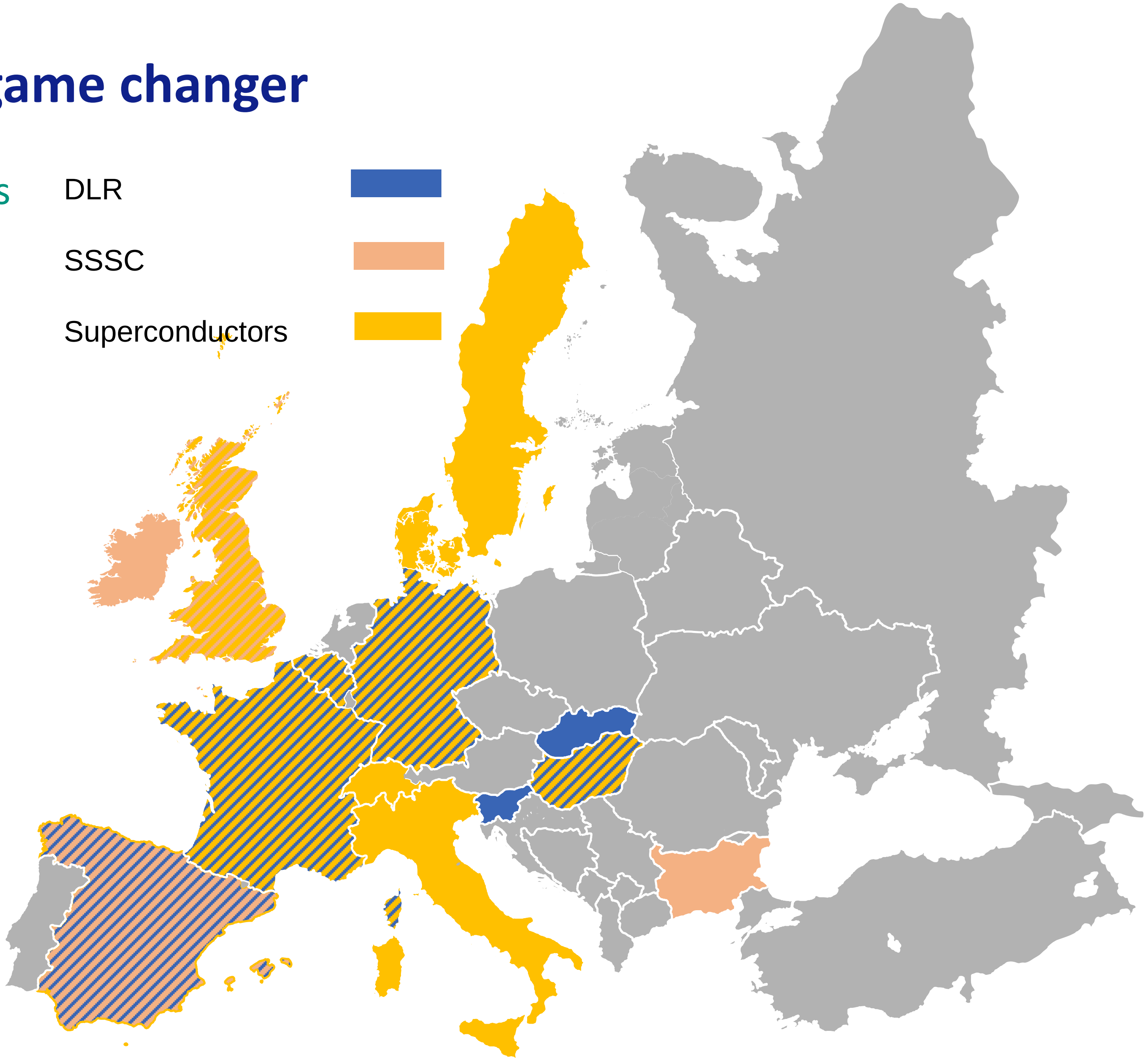
Fields of research:

- Magnetic design and stress analysis on new superconductor material e.g. Bi2 or MgB_2, cable stability analysis against internal flux jumps and external thermal perturbations, electromagnetic field analysis for HVDC superconducting cables, applications in HV and EHV

Technology readiness level:

DC Systems 5-6

AC Systems 7-8



**The map shows selected cases, not the entire coverage*

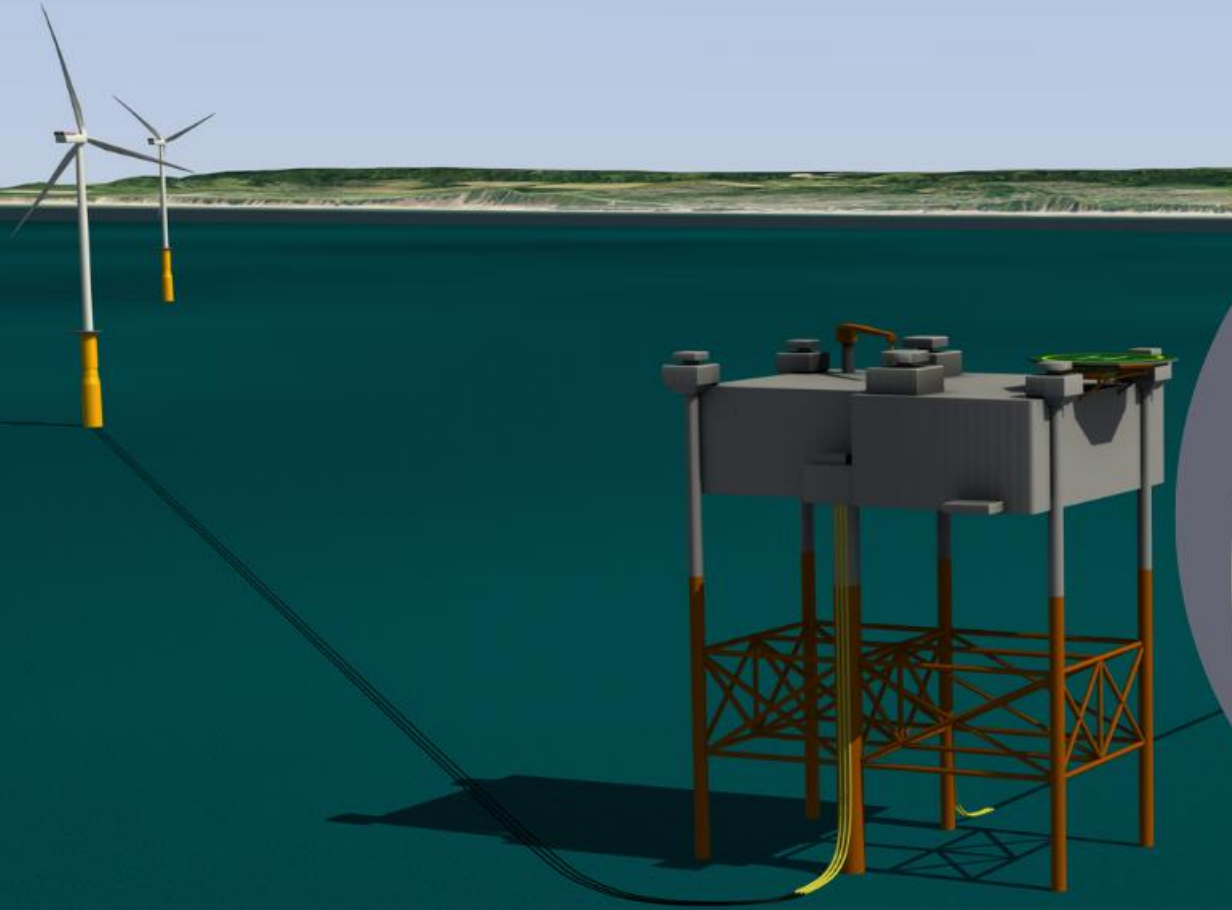
ENTSO-E VISION: A POWER SYSTEM FOR A CARBON NEUTRAL EUROPE

Save the date:
10-12 October 2022

entsoe
VISION

EVENTS

CurrENT
Enabling Network Technology throughout Europe



MARIO DIONISIO

Policy Officer

DG ENER

European Commission

Superconductors for Power Transmission: Beyond the age of copper

Mario Dionisio

European Commission
Directorate General for Energy

Unit B5 - Innovation, Research, Digitalisation, Competitiveness

EU policy context and energy policy instruments (I)

- Paris Agreement – COP 21,…COP 27 in Sharm el-Sheikh, Egypt 06-18 November 2022
- National Energy and Climate Plans
- The European Green Deal
  - Supported by Horizon Europe
- SET-Plan & the different IWGs
- ETIP on Smart Energy Networks
- Bridge Initiative

EU policy context and energy policy instruments (II)

- NextGenerationEU: EU Coronavirus response
- REPowerEU: A plan to rapidly reduce dependence on Russian fossil fuels and fast forward the green transition
  - Saving energy
  - Diversifying supplies and supporting our international partners
  - Accelerating the rollout of renewables
  - Reducing fossil fuel consumption in industry and transport
  - Smart Investment

European Commission

Key EU Initiatives

- EU strategy on offshore renewable energy (60 GW of offshore wind and at least 1 GW of ocean energy by 2030, with a view to reach by 2050 300 GW and 40 GW)
- EU Solar Energy Strategy (over 320 GW of solar photovoltaic by 2025 (more than doubling compared to 2020) and almost 600 GW by 2030)
- EU Strategy on Standardisation - Setting global standards in support of a resilient, green and digital EU single market
- A Chips Act for Europe (to develop a thriving semiconductor ecosystem and resilient supply chain)

Challenges for the power network

- The business as usual grid planning and development can not cope any longer with many aspects of the energy transition (wide offshore development prospected by the ORES, solar strategy, 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

- Big amounts of currents to be conveyed from generation to loads in identified corridors ➔ superconductors

European Commission

...a wide spectrum of technologies

- ➢ IoT
- ➢ HPC
- ➢ 5G
- ➢ DC Technologies
- ➢ AC - DC – hybrid grids
- ➢ Power electronics
- ➢ EV
- ➢ Cybersecurity
- ➢ Blockchain
- ➢ Superconductors

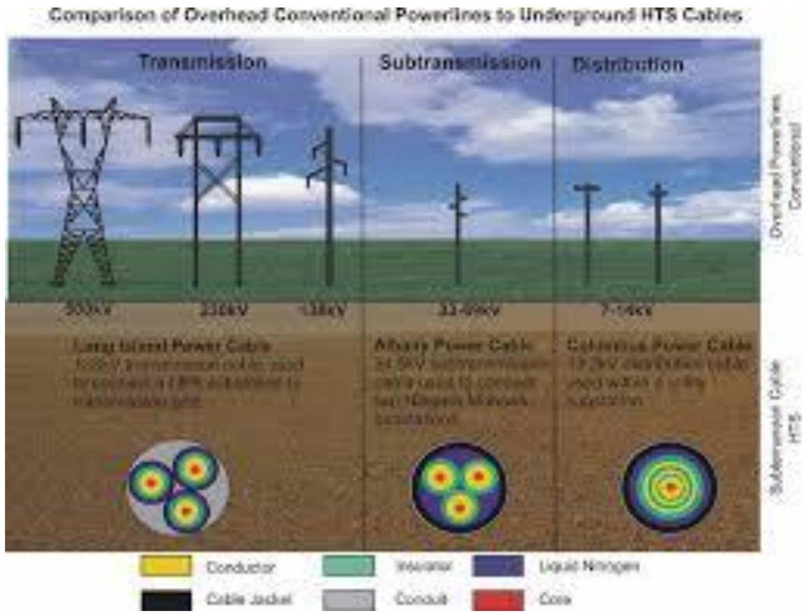
European Commission

Superconductivity

- property of certain materials to conduct direct current (DC) electricity without energy loss
- when they are cooled below a critical temperature (referred to as Tc)
- These materials also expel magnetic fields as they transition to the superconducting state

European Commission

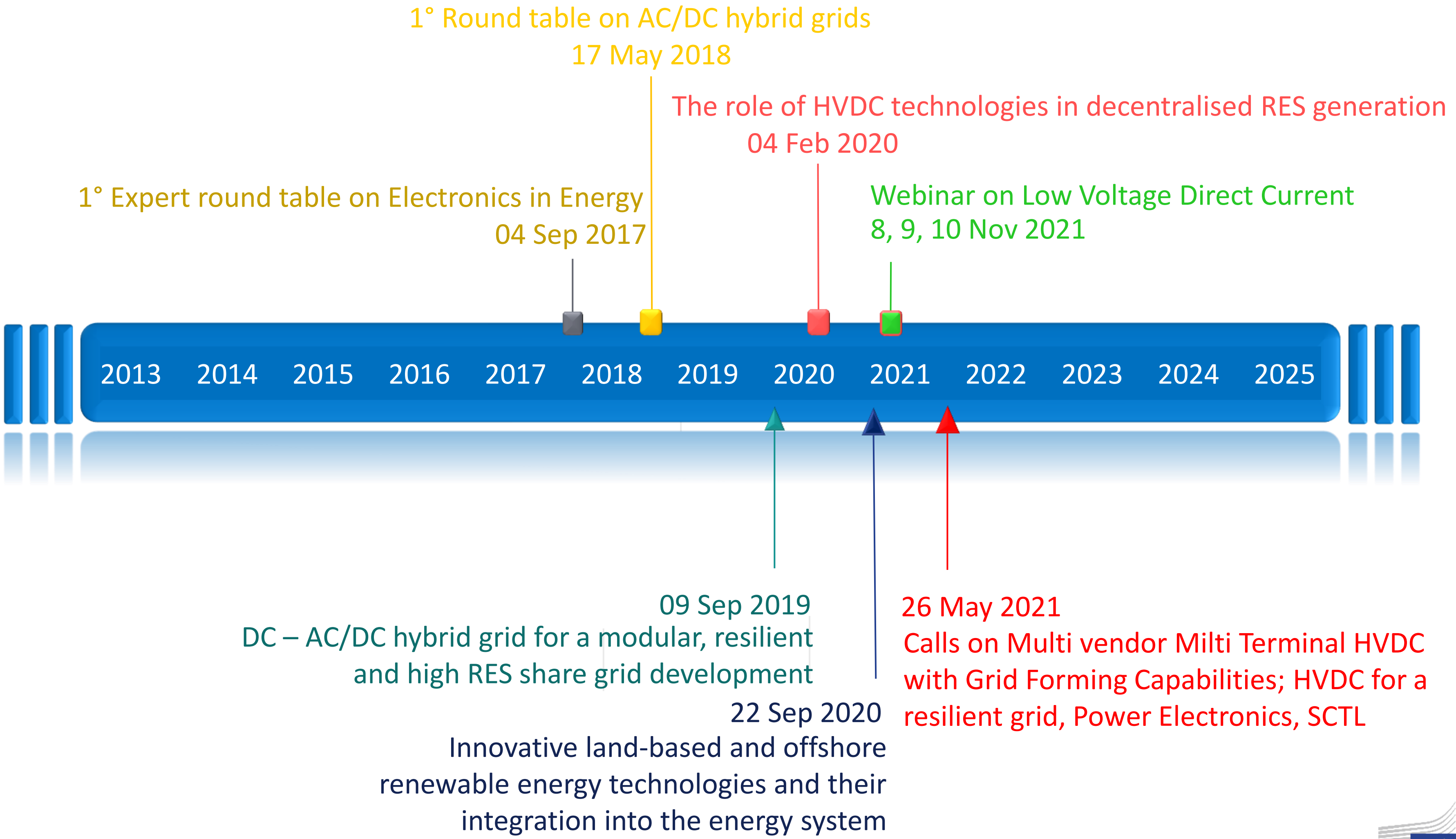
Benefits and challenges



- Lower voltages
- Reduced right of ways
- More R&I and demo needed
- …

European Commission

EC support to innovative technologies



Conclusions

- The end goal is to reduce the global warming of our planet.
- Acceleration of RES deployment to reduce energy dependency
- Ad-hoc EU policy instruments have been put in place to enable the decarbonisation of the energy system and our economy.
- Horizon Europe and other EU funding Instruments support the transformation of the energy system through demonstration projects to prove the technologies and accelerate the energy transition.
- More R&D&I is needed to obtain solutions applicable and competitive for a modern efficient energy system.

Useful links

Directorate General For Energy

Horizon2020 web site

Horizon Europe

AC – DC hybrid round-table

Electronics in energy round-table

The role of HVDC technologies in a highly decentralised RES generation

Funding and tender opportunities

Green Deal call

Low voltage direct current and direct current technologies: potential applications for a clean energy transition

EIRIE (European Interconnection for Research, Innovation and Entrepreneurship)

Thank you!

Mario Dionisio

European Commission
Directorate General for Energy

Unit B5 - Innovation, Research, Digitalisation, Competitiveness
mario.dionisio@ec.Europa.eu

HORIZON-CL5-2021-D3-01-02: Laying down the basis for the demonstration of a Real Time Demonstrator of Multi-Vendor Multi-Terminal HVDC with Grid Forming Capability: Coordinated action

- Type of Action: Coordination and Support Action   Funding Rate: 100%

Opening: 24 June 2021	Deadline: 19 October 2021
Budget: EUR 1 million	**EU contribution per project:** EUR 1 million

- Scope: **Coordination and organisation of a platform involving all stakeholders (HVDC system manufacturers, TSOs, third-party HVDC system integrators, wind turbine manufacturers, offshore wind farm developers)**
    - Compatibility of modelling tools towards interoperability; model sharing between TSOs: legal framework; roles and responsibilities on interoperability issues.
- Expected Outcome: **to support all the preparatory phases among all stakeholders (HVDC systems manufacturers, TSOs, wind turbine manufacturers and windfarm developers) leading to a demonstration project to de-risk the technology to enable the installation in Europe of the first Multi-Vendor Multi-Terminal HVDC system with Grid Forming Capability.**
- Link to the call: Funding & tenders (europa.eu)

HORIZON-CL5-2021-D3-02-08: Electricity system reliability and resilience by design: High-Voltage, Direct Current (HVDC)-based systems and solutions

- Type of Action: **Research and Innovation Action** Funding Rate: **100%**

Opening: 24 June 2021	**Deadline: 05 January 2022**
Budget: EUR 15 million	**EU contribution per project**: EUR 7 – 8 million

- Scope: **addressing at least two of the following topics:** optimal grid architecture concepts using HVDC; real-time monitoring and assessment; reliability model for HVDC; CBA of "firewall" functionality of HVDC; evaluation of the impact on system reliability of an increasing number of HVDC links incorporated in the transmission system; pre-fault monitoring systems; etc.
- Expected Outcome: HVDC for a high share of renewables and increased security of supply; containment of cascading effects following faults or disturbances (also from cyberattack); increased electricity system reliability and resilience throughout the overall interconnection system; impact on system reliability of an increasing number of HVDC links incorporated in the transmission system; systems for fault location on HVDC cables; opening of new business horizons.
- Link to the call: Funding & tenders (europa.eu)

HORIZON-CL5-2021-D3-02-09: Demonstration of superconducting systems and elpipes

- Type of Action: Innovation Action

  Funding Rate: 70%

Opening: 24 June 2021	Deadline: 05 January 2022
Budget: EUR 15 million	**EU contribution per project**: EUR 15 million

- Scope: **demonstration of up to ±100kV, up to 1 GW up to 5 km onshore; demonstration of ±100 kV, up to 1 GW up to 100 km, offshore; demonstration of SCTL based on MgB2, LH_2 cooled, for DC with a length up to 1 km and above onshore; cable design and simulation, CBA; feasibility and applicability of elpipes.**
- Expected Outcome:
  - Superconducting Transmission Lines enabling a higher transmission efficiency and lower operating voltages while still preserving the total capacity;
  - Increased power transfer capability within existing right of ways.
  - Potential use of Elpipes to transfer massive capacities in identified congested corridors
- Link to the call: Funding & tenders (europa.eu)

HORIZON-CL5-2021-D3-02-10: Demonstration of advanced Power Electronics for application in the energy sector

- Type of Action: Innovation Action Funding Rate: 70%

Opening: 24 June 2021	Deadline: 05 January 2022
Budget: EUR 10 million	**EU contribution per project:** EUR 5 million

- Scope: **production, test and validation of WBG-based switching semiconductors such as Silicon Carbide (SiC) for converter station application**
  - Converter board design and production modules assembly; real time testing and validation; simulation, real time testing and validation of the converter; CBA provided by WBG-based compared to Silicon-based switching semiconductor of converters; impact of fast transients; impact of the passive components;
- Expected Outcome:
  - Development of more efficient and smaller size converter stations affecting considerably the grid distribution generally and logistics, cost, etc. and the deployment of the offshore energy grid; reduced size of components and equipment for offshore / onshore applications; reduced cost of WBG-based semiconductors such as Silicon Carbide (SiC).
- Link to the call: Funding & tenders (europa.eu)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Enabling Network Technology throughout Europe
LAYLA SAWYER
Secretary General
currENT Europe

Thank you for your attendance

To keep up to date with our activities:

info@currenteurope.eu

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