SUPERNODE™

LONG RANGE SUPERCONDUCTING TRANSMISSION TO ENABLE RENEWABLE ENERGY

8TH ANNUAL IVSUPRA EVENT

BERLIN, 4TH APRIL 2022

AGENDA

- Robert O'Connor – Chief Commercial Officer
- Eoin Hodge – Chief Technology Officer

1. COMPANY OVERVIEW
2. WHY SUPERCONDUCTIVITY?
3. WHY A SUPERGRID?
4. WHAT IS SUPERNODE DOING?
5. RECENT SUPPORTING WORK

COMPANY OVERVIEW

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.

WHO ARE WE?

EDDIE O'CONNOR
Founder, Chairman and Owner

PAT COX
Director

(Former President of EU Parliament)

KJELL INGE RØKKE
Director

(Owner of Aker ASA)

KARL-PETTER LØKEN
Director

(Investment Director, Aker Horizons)

JOHN FITZGERALD
CEO

(Ex director of Grid Dev and Interconnection EirGrid)

AKER HORIZONS

(50% ownership)

OUR CORE ASSUMPTIONS

GLOBAL DECARBONISATION BY 2050

ELECTRIFICATION IS THE KEY VECTOR FOR DECARBONISATION

DECARBONISATION REQUIRES THE **ADOPTION OF INTEGRATED INFRASTRUCTURE** DEVELOPMENT PLANS GLOBALLY

100KM+ MARINE CONNECTIONS WILL BE COMMERCIALLY AVAILABLE BY 2030

EUROPE NEEDS A SUPERGRID

- Europe needs to connect **2,000 GW** of renewable resources **by 2050**
- Superconducting transmission technology can be utilised for **offshore** and **terrestrial** applications

WHY IS NEW TRANSMISSION TECHNOLOGY NEEDED IN EUROPE?

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

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

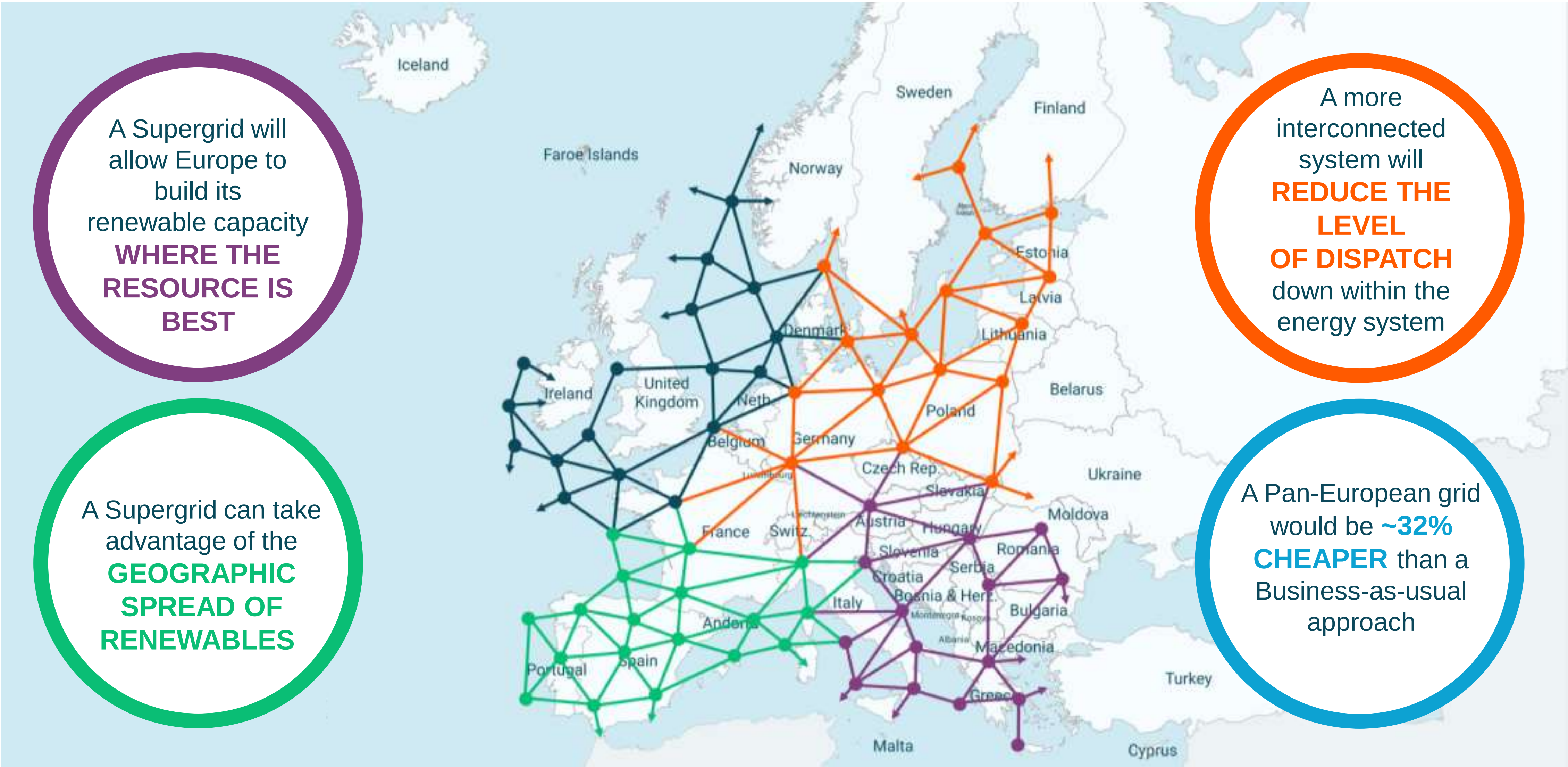
More than **800 GW** of new solar power will be required

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

THE NEED FOR A SUPERGRID



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

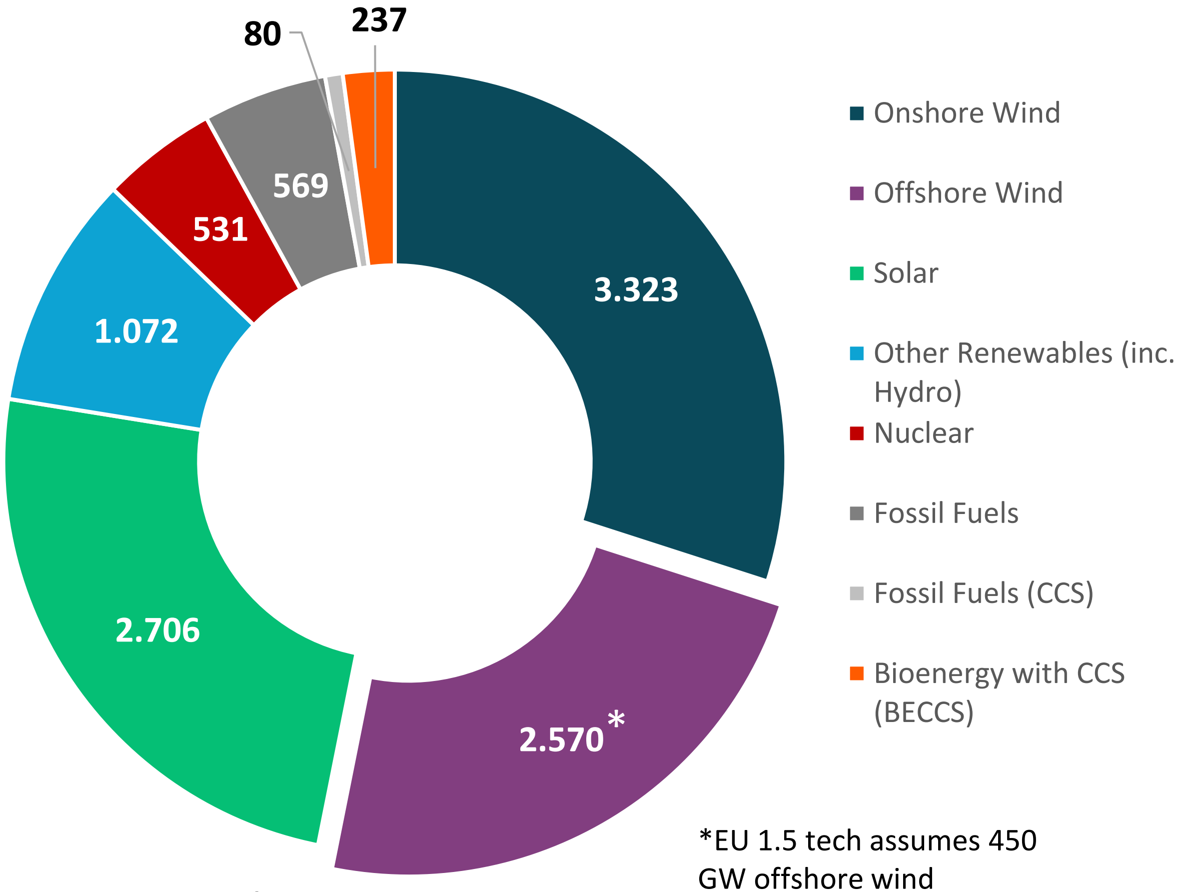
A Supergrid can take advantage of the **GEOGRAPHIC SPREAD OF RENEWABLES**

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

THE GROWTH OF OFFSHORE WIND

EU-28 Electricity Production 2050 1.5TECH Scenario (TWh)



*EU 1.5 tech assumes 450 GW offshore wind

Source: EU 1.5 Tech

OFFSHORE WIND	2030 (GW)	2050 (GW)
Europe	127	640
Asia	109	760
North America	29	360
Latin America	2	120
Pacific	3	80
Africa & ME	0	40
Total	**270**	**2,000**

Source: GWEC

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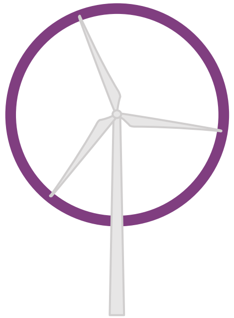
OFFSHORE WIND TRENDS

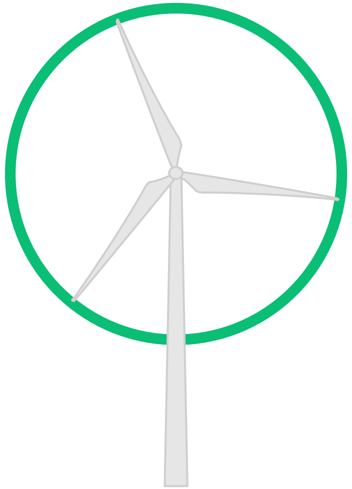
WIND TURBINE ADVANCEMENTS

187m



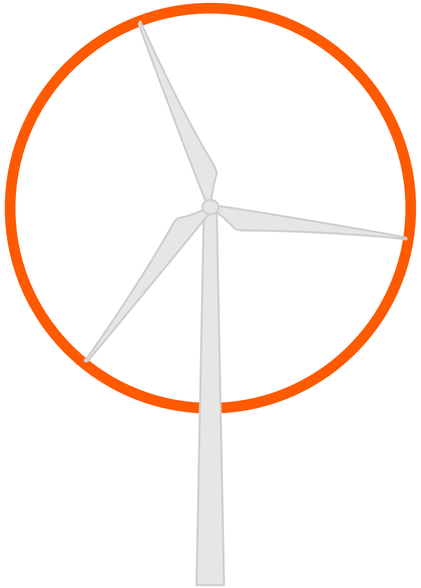
2016
8 MW

220m



2021
15 MW

385m



2027
27 MW

PLATFORM SIZE AND COST

2019
BorWin3
900 MW
18,000 tonnes

2023
DolWin6
900 MW
11,000 tonnes

2029
BalWin1
2,000 MW
20,000 tonnes

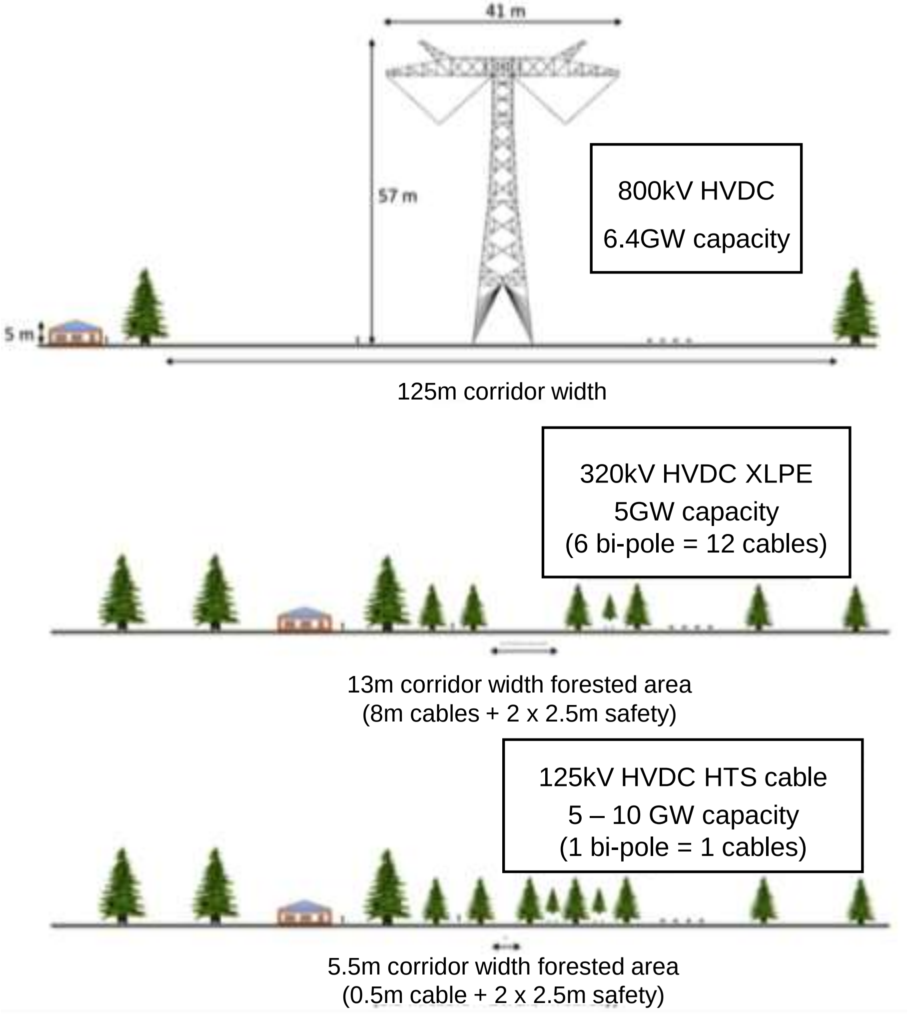
WHY SUPERCONDUCTIVITY?

TRANSMISSION TECHNOLOGY - CHINA

THE CHINESE ULTRA-HVDC GRID

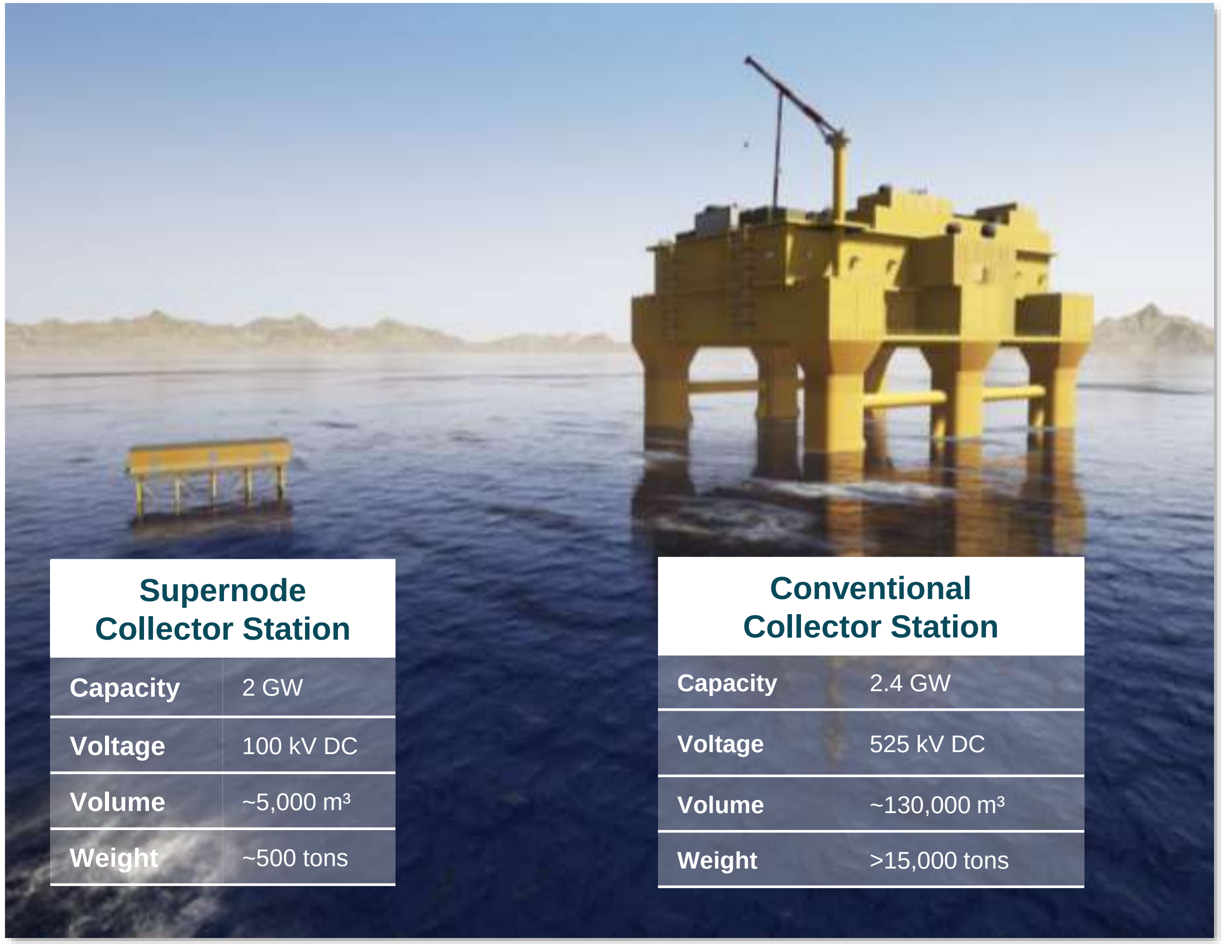
- China has constructed huge HVDC overhead power lines that transmit massive amounts of power around the country like a motorway, while the AC system below carries local traffic.
- The largest line has a capacity of 12GW and is 3,324km in length or 40,000 GW.km.
- Europe’s Supergrid must be predominantly built underground and in a marine setting as it faces different geographic and political constraints.
- New innovative cable and grid technologies will be needed in Europe, such as High Temperature Superconductors.

TERRESTRIAL APPLICATIONS



- Smaller Right of Ways
  - Less consents/permitting required
- Significantly less infrastructure required
  - One superconductor cable can replace up to 12 copper cables
  - Lower voltage so less need for large substations
  - Reduced impact on environment during construction
- No excess heat
  - Cables can be buried deep underground
  - Cables can be installed close together
  - No heat leakage into surrounding soil
- Low electromagnetic field (EMF)
  - Copper cables can't be buried too close together
  - Public fears over EMFs
  - Can't install copper cables in metal dense areas i.e. bridges

OFFSHORE GRID APPLICATIONS



Supernode Collector Station	
Capacity	2 GW
Voltage	100 kV DC
Volume	~5,000 m³
Weight	~500 tons

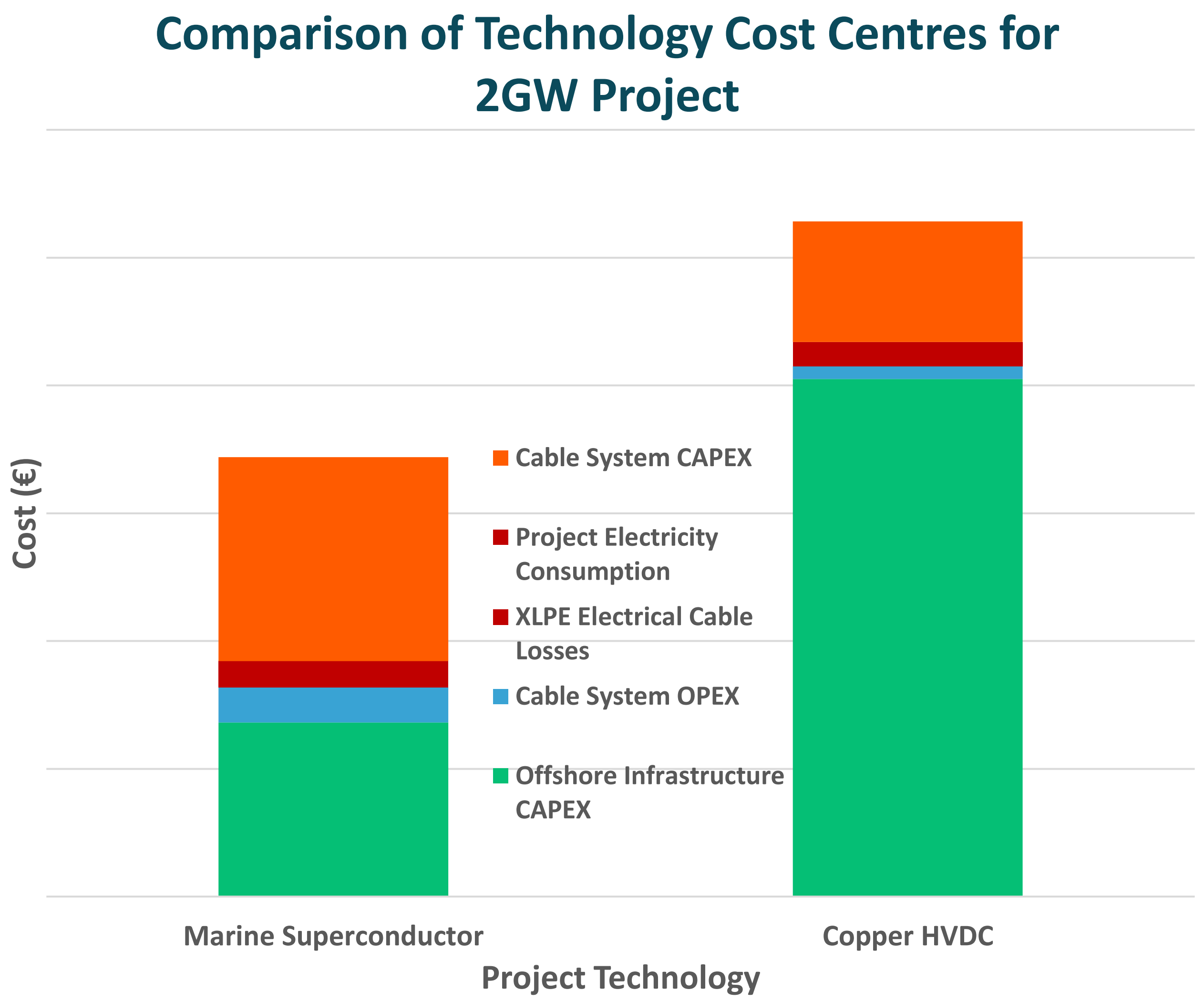
Conventional Collector Station	
Capacity	2.4 GW
Voltage	525 kV DC
Volume	~130,000 m³
Weight	>15,000 tons

- Current cable technology needs to increase voltage to increase power capacity:
  - this has led to the increase in size of offshore platforms
- Superconductors can operate at much lower voltage:
  - thus requiring smaller and more cost-efficient collector stations compared to conventional HVDC alternatives
  - Smaller stations cause less environmental impact during installation
- 70-80% cheaper platforms and electrical equipment at MVDC voltage levels

COST SAVINGS OF OFFSHORE APPLICATIONS

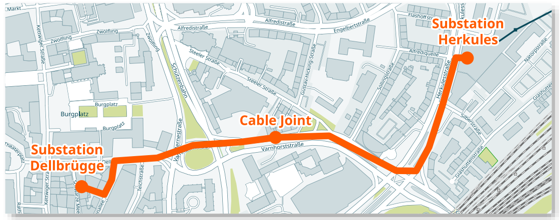
- The offshore platform required for a superconductor based connection is much smaller and thus much cheaper compared to conventional technologies.
- Superconductor cables themselves are more efficient than conventional cables due to having zero electrical losses.

The cables do use a small amount of power to cool the materials to maintain a state of superconductivity.

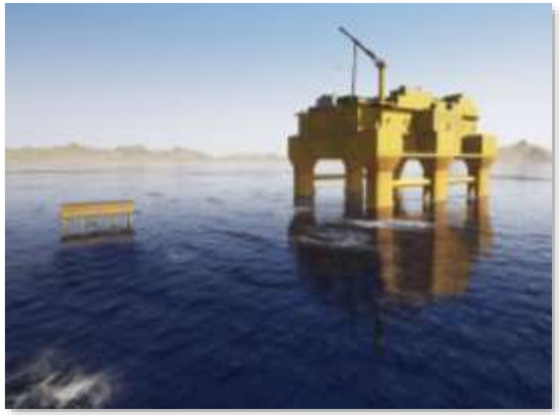


APPLICATIONS

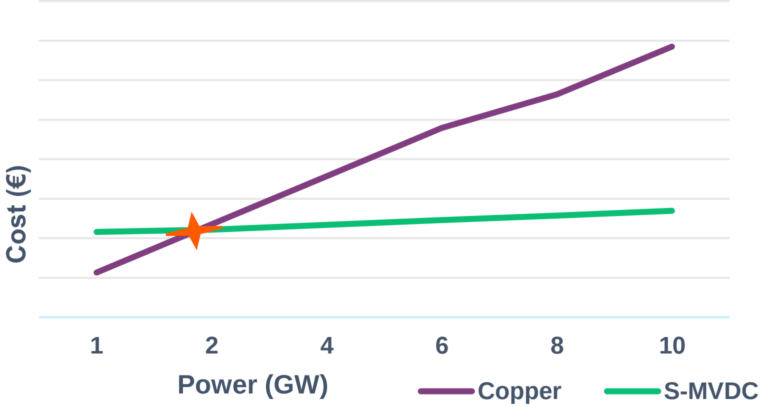
1. URBAN CONGESTION



2. DIRECT CONNECTIONS OF LARGE-SCALE RENEWABLES



3. GRID REINFORCEMENT AT SCALE

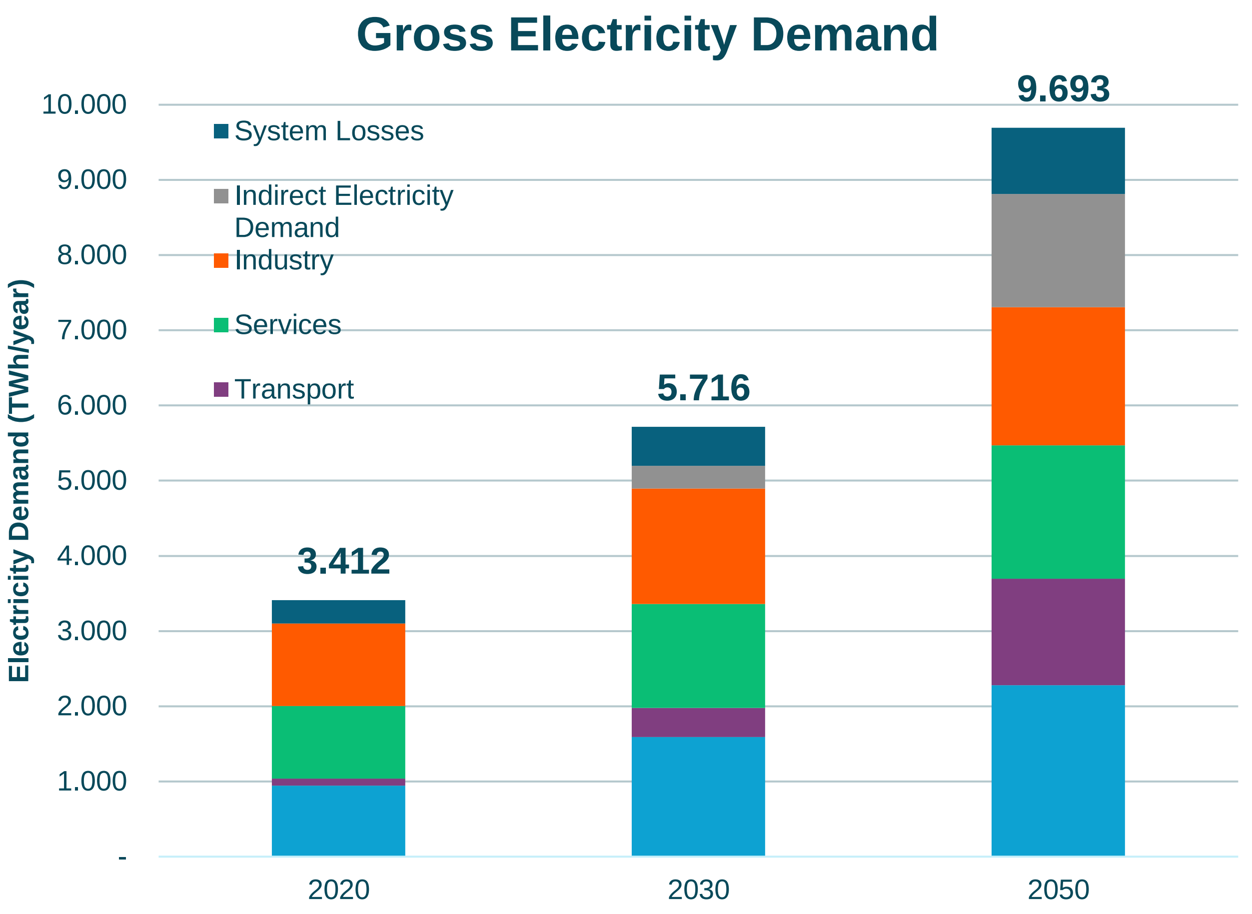


WHY A SUPERGRID?

GROWTH IN ELECTRICAL DEMAND, METCALFE'S LAW
AND METEOROLOGICAL BASED ENERGY SYSTEMS

WHY IS NEW TRANSMISSION TECHNOLOGY NEEDED?

- Electrical Energy Demand in 2050 will **triple compared to 2020**.
  - Decarbonisation
  - Electric vehicles
  - Heat pumps
  - Data centres
- **+900GW** of Wind Power required.
- **+800GW** of Solar Power required.
- For every € invested in offshore renewable generation to 2050, €2 will need to be invested in **offshore grids**, according to the European Commission.



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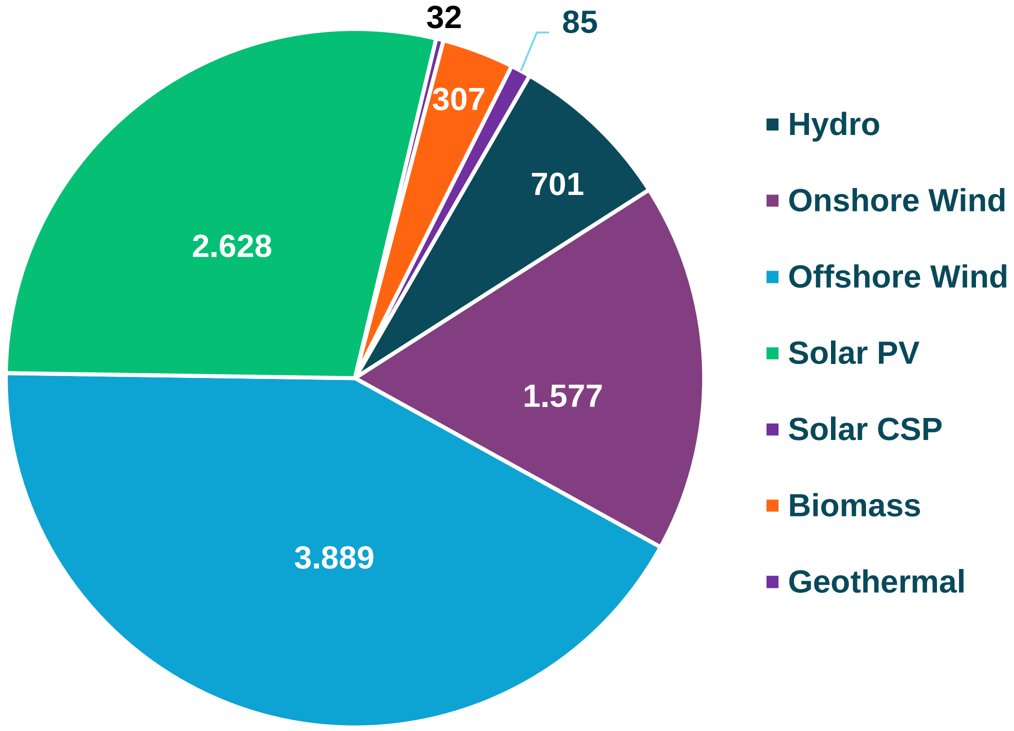
HOW RENEWABLES CAN MEET THIS DEMAND - FUTURE NEED

- The required total renewable capacities are:
  - Hydro: 200 GW **(+50 GW)**
  - Offshore Wind: 740 GW **(+724 GW)**
  - Onshore Wind: 450 GW **(+297 GW)**
  - Solar: 1,000 GW **(+868 GW)**

2050 Renewable Energy Generation (TWh)



This unprecedented increase in renewable capacity requires a proportionate upgrade in transmission infrastructure

*Increase from 2021 levels

EU 1.5TECH: WHERE SUPERNODE DIFFERS

- 1.5TECH is the leading energy scenario from the EU Commission to achieve net zero GHG emissions by 2050 and stay below the 1.5-degree Paris Agreement target.

	EU 1.5TECH			SuperNode Energy Scenario		
Technology	**Installed Capacity (GW)**	**Capacity Factor**	**Generation Capacity (TWh)**	**Installed Capacity (GW)**	**Capacity Factor**	**Generation Capacity (TWh)**
Onshore Wind	759	**50%**	3,323	450	**40%**	1,577
Offshore Wind	**451**	**65%**	2,570	**740**	**60%**	3,889
Solar	1,030	30%	2,706	1,012	30%	2,660
Other Renewables (inc. Hydro)	245	50%	1,072	15	65%	85
Hydro	-	40%	-	200	40%	701
Nuclear	121	50%	531	110	50%	482
Fossil Fuels	118	55%	569	-	5%	-
Fossil Fuels (CCS)	17	55%	80	-	5%	-
Bioenergy with CCS (BECCS)	49	55%	237	100	35%	307
Total	**2,790**		**11,090**	**2,627**		**9,700**

EU 1.5TECH: WHERE SUPERNODE DIFFERS

ENERGY EFFICIENCY

- Larger role to play in energy demand than previously thought.
- The main efficiency gains will be made in buildings and transportation.

GENERATION TECHNOLOGY

- Offshore wind to lead wind installations.
- Floating wind is a game-changing technology for deeper waters.

CAPACITY FACTORS

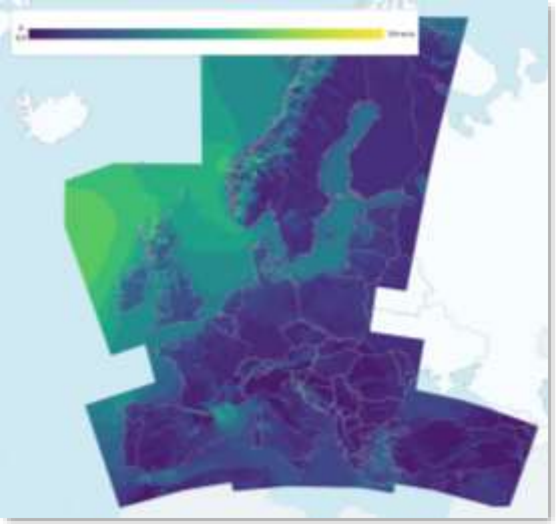
- Capacity factors for some technologies grossly exaggerated in 15TECH.
- Installed generation mix must be developed accordingly.

HYDROGEN

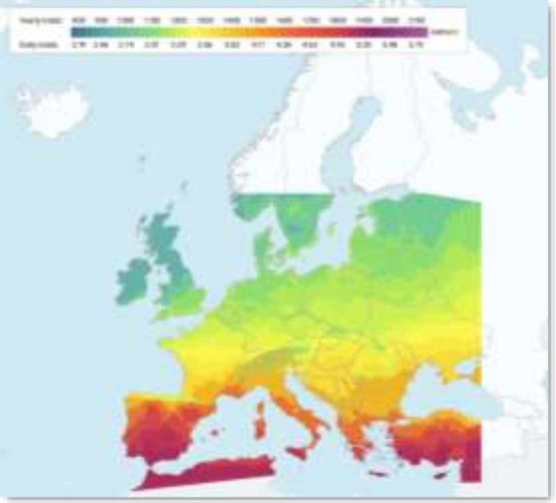
- Has a lesser but still important role to play

ENERGY SYSTEM WITHOUT FOSSIL FUELS

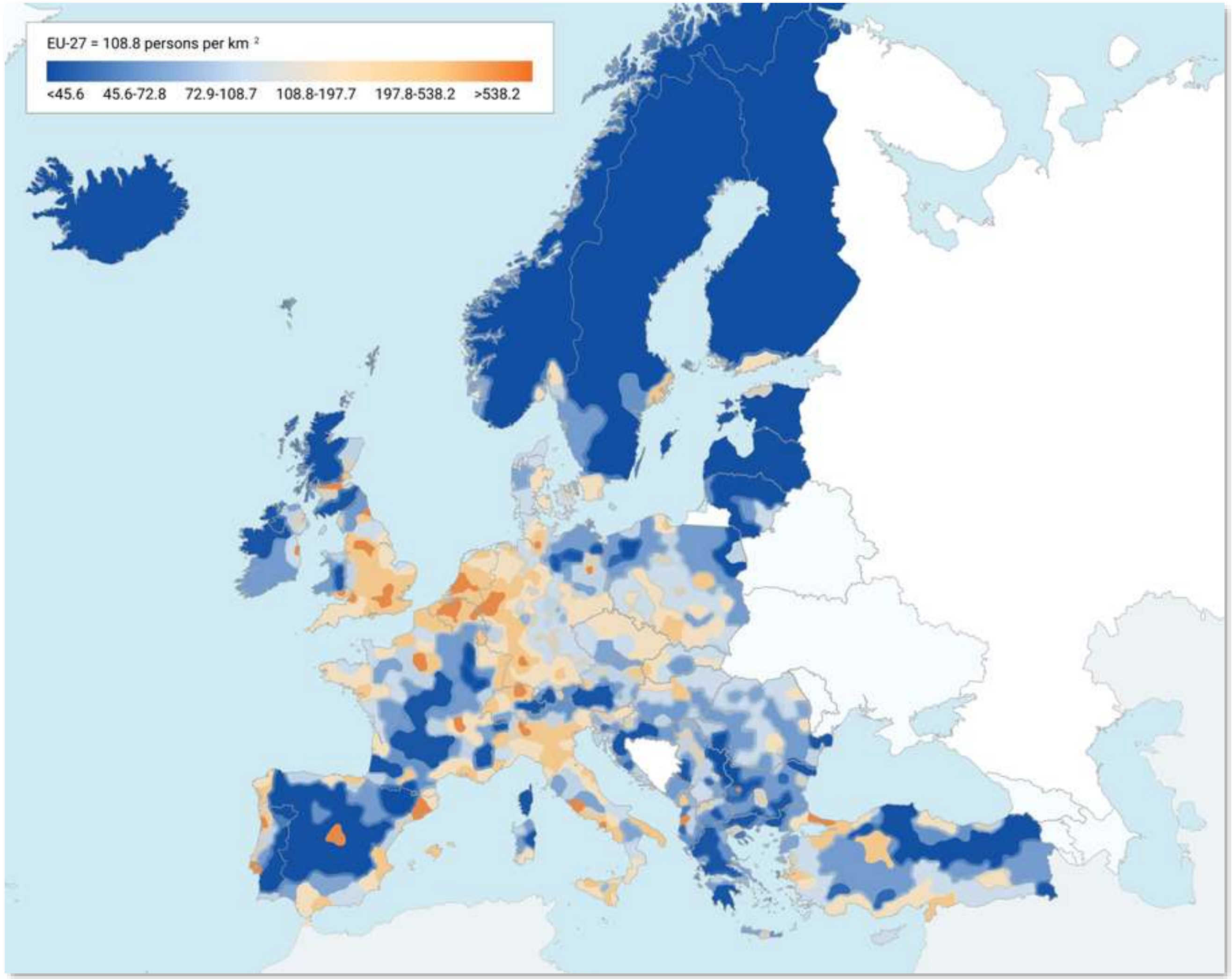
Wind Speed



Solar Irradiance



Population Density



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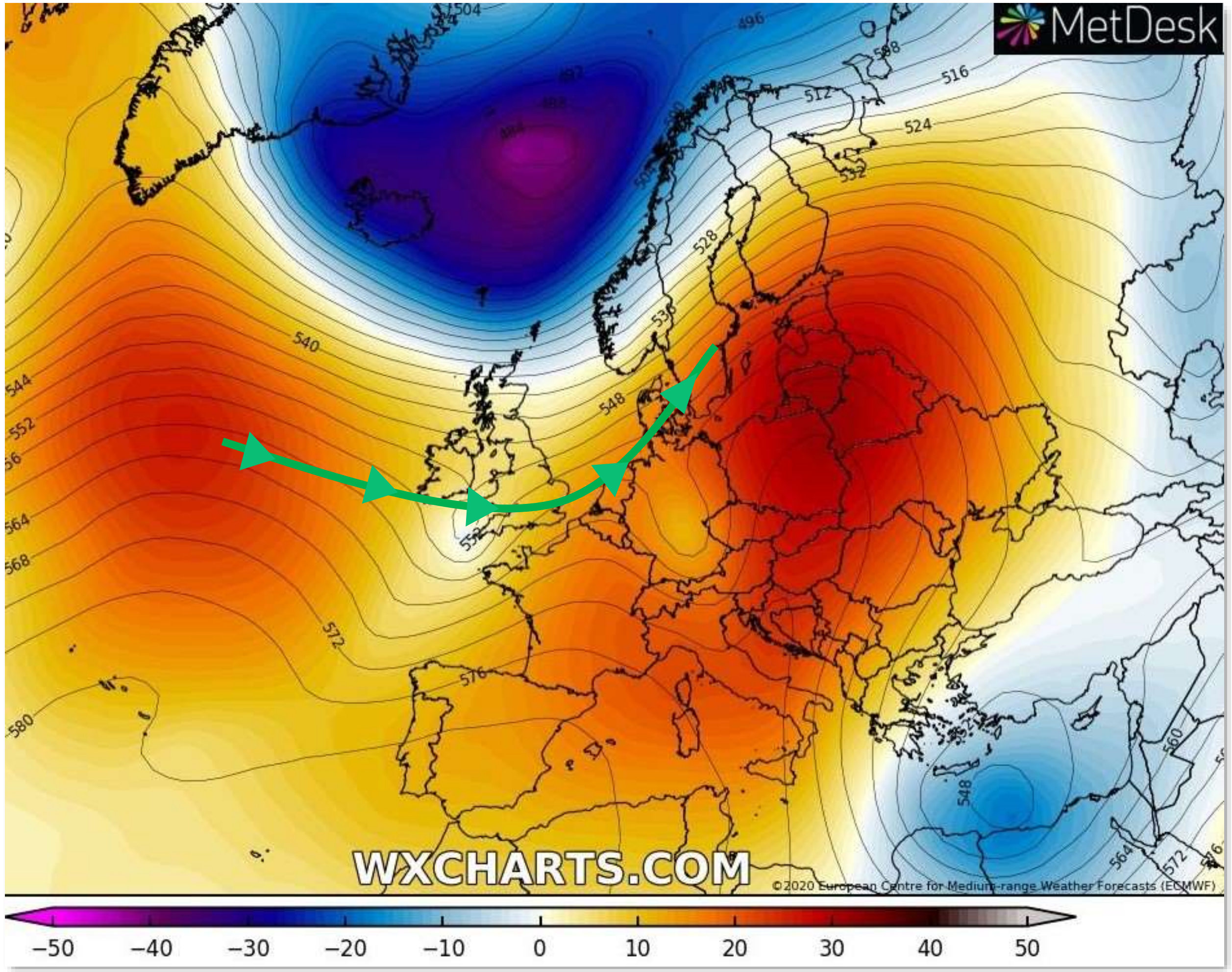
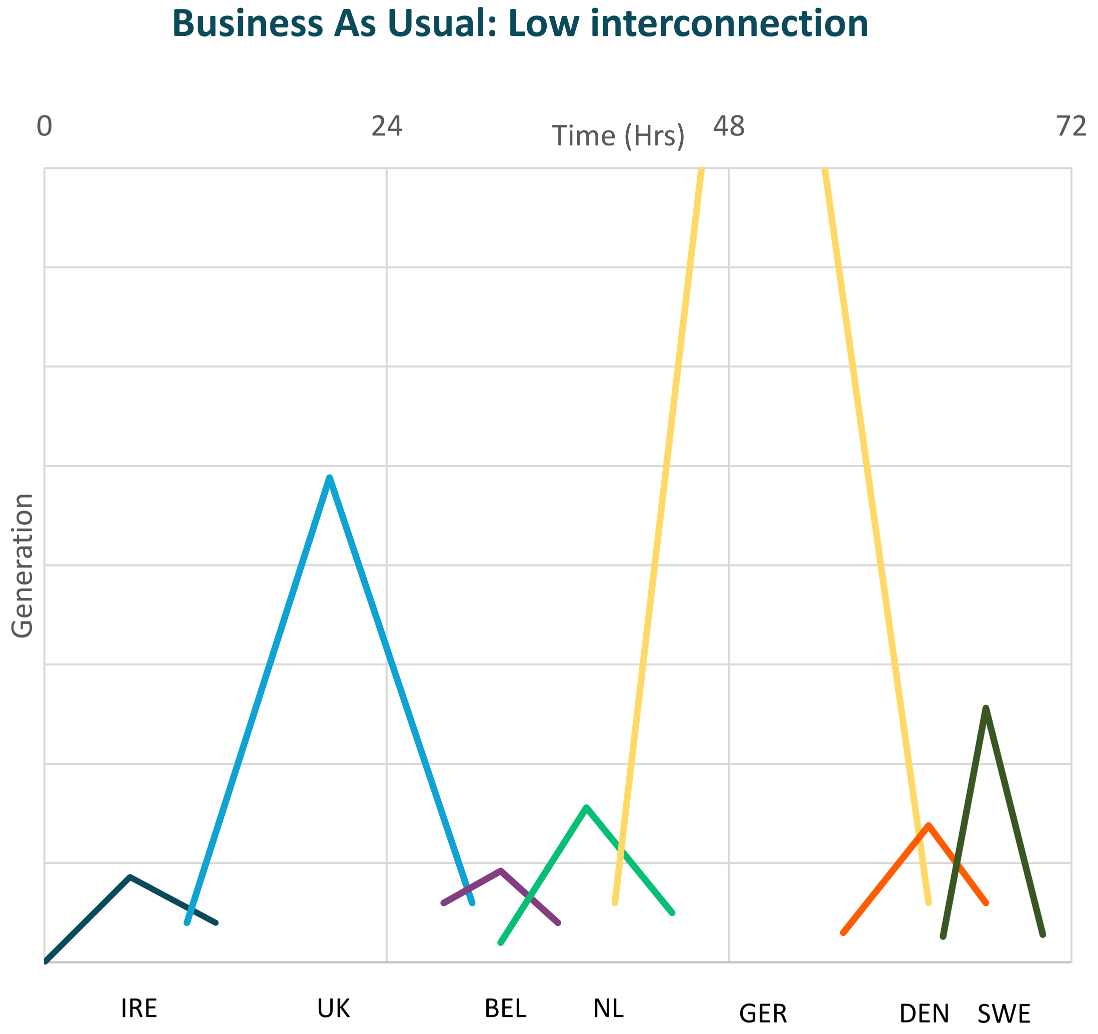
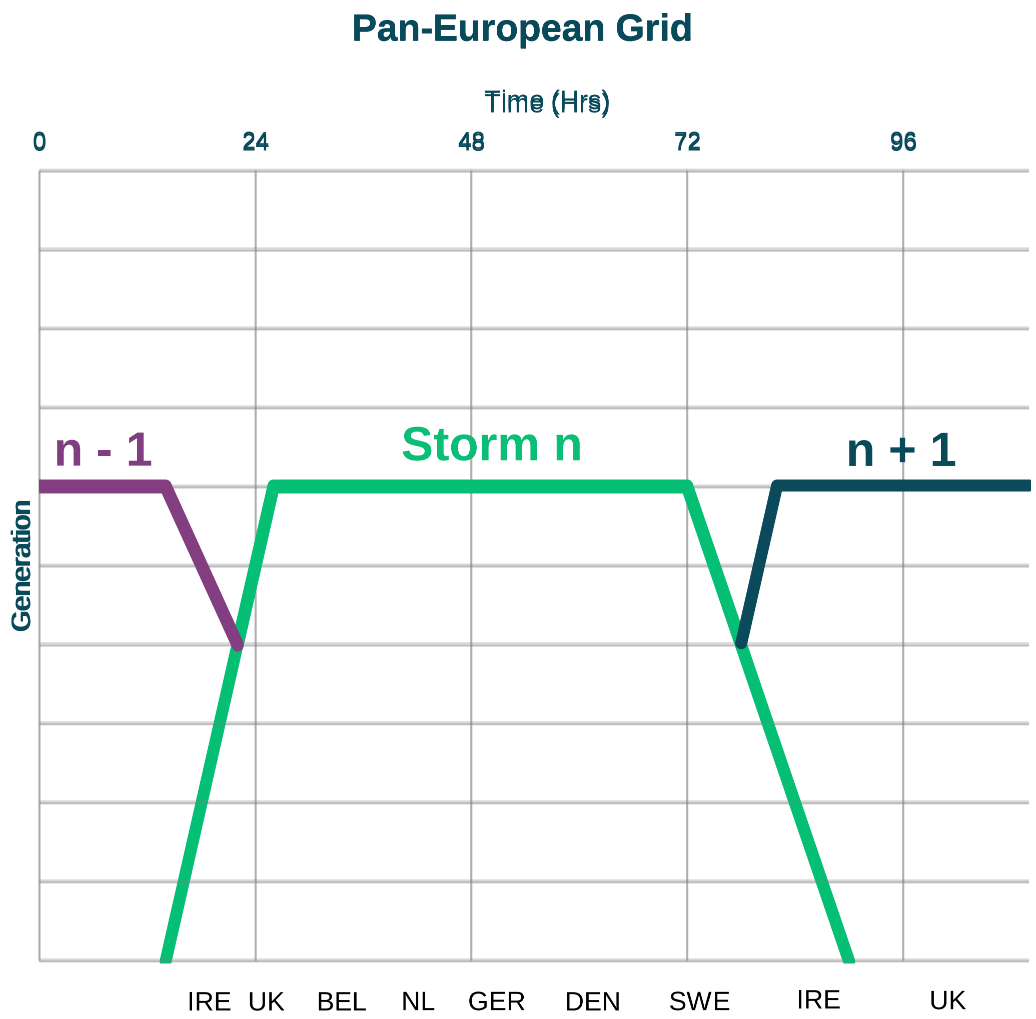
WEATHER SYSTEM PASSING OVER NORTHERN EUROPE

- A weather system rolls in from the Atlantic.
- Its path takes it over Ireland, the UK, Belgium, the Netherlands, Germany, Denmark and Sweden.
- With it, it brings the opportunity to power European homes and businesses with clean wind energy.



WEATHER SYSTEM CROSSING EUROPE: TRACKING ENERGY VS TIME





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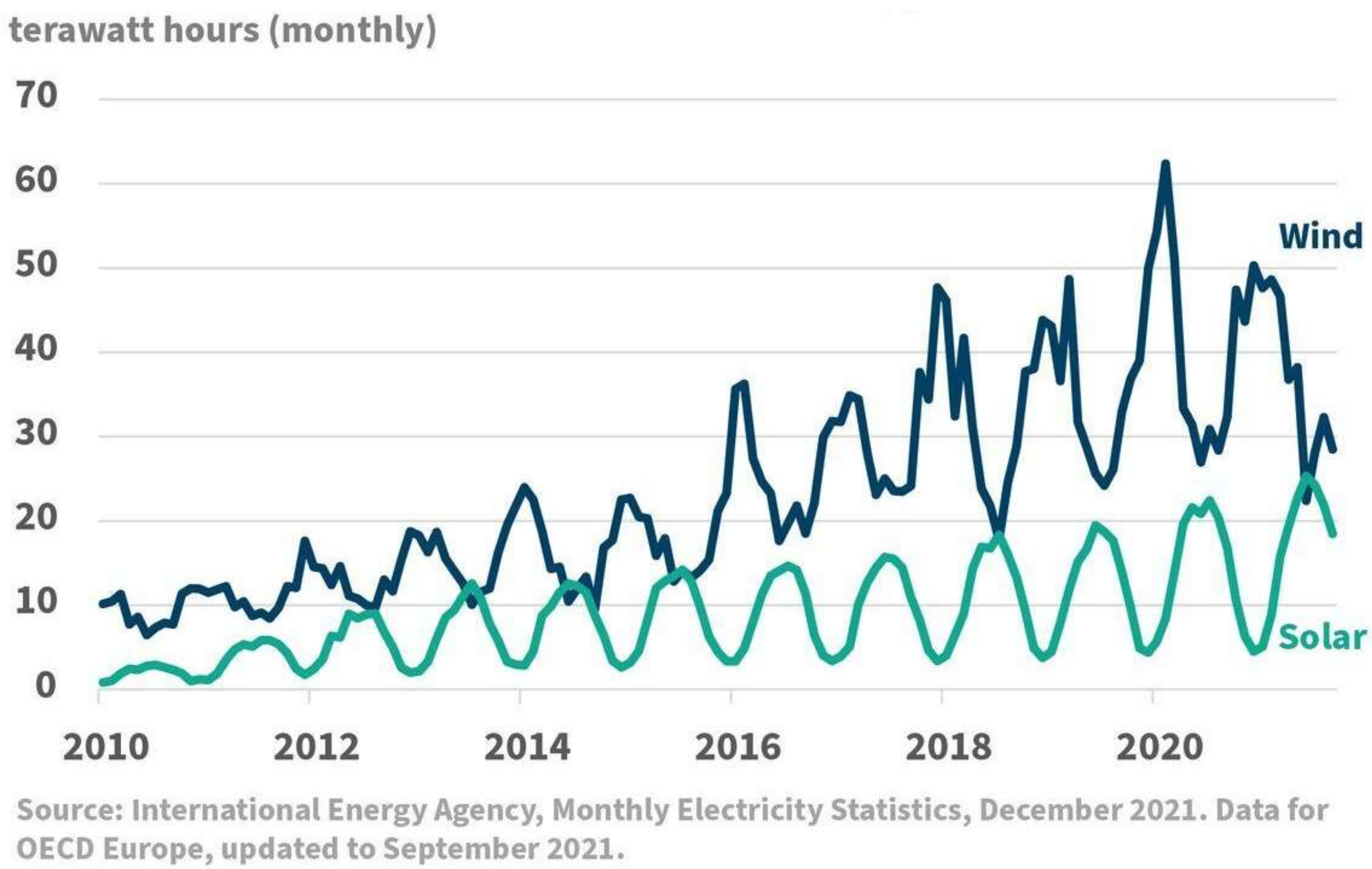
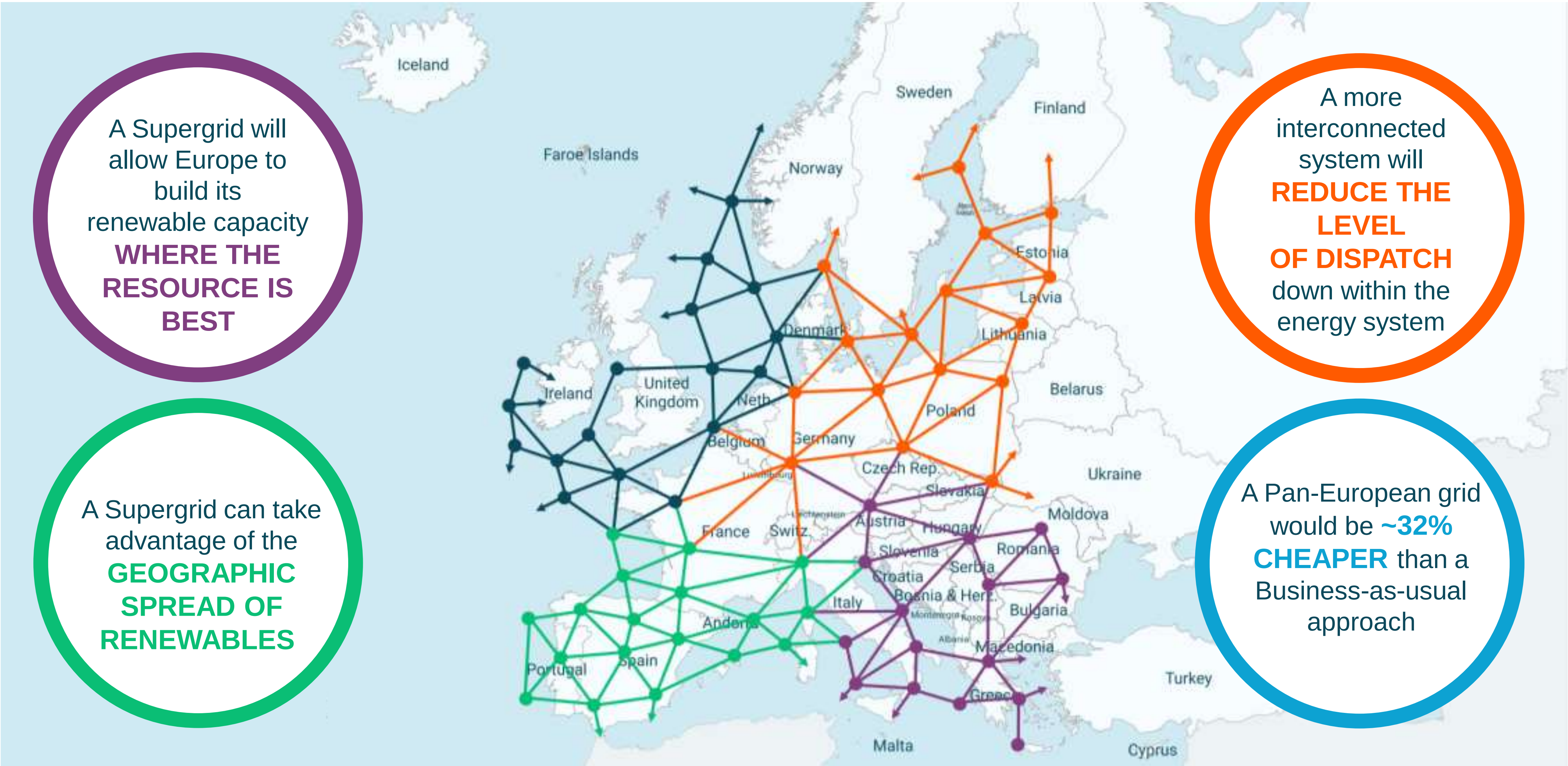
WIND AND SOLAR GENERATION IN EUROPE



THE NEED FOR A SUPERGRID



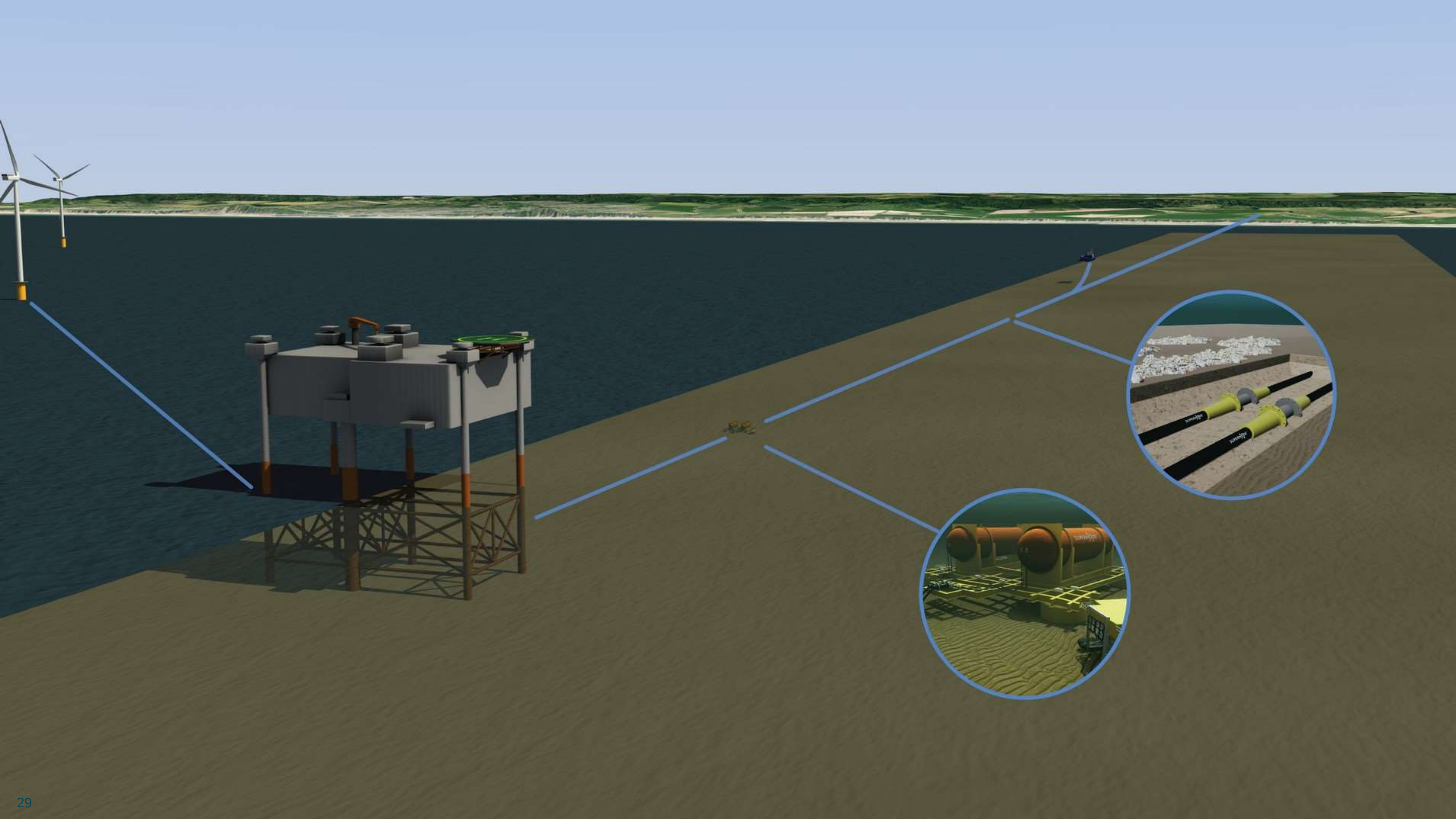
A Supergrid will allow Europe to build its renewable capacity **WHERE THE RESOURCE IS BEST**

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

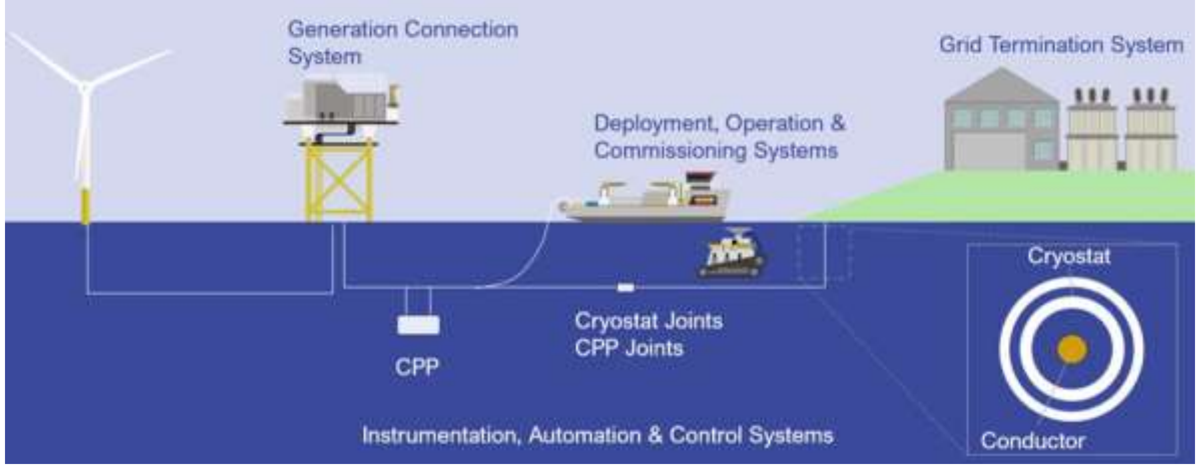
A Pan-European grid would be **~32% CHEAPER** than a Business-as-usual approach

WHAT IS SUPERNODE DOING?



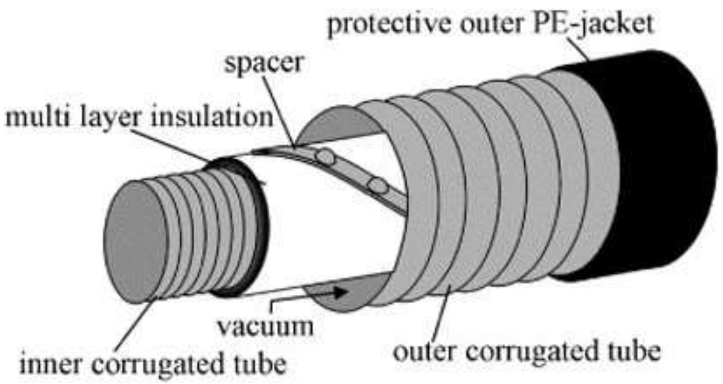
SUPERNODE CABLE DEVELOPMENT

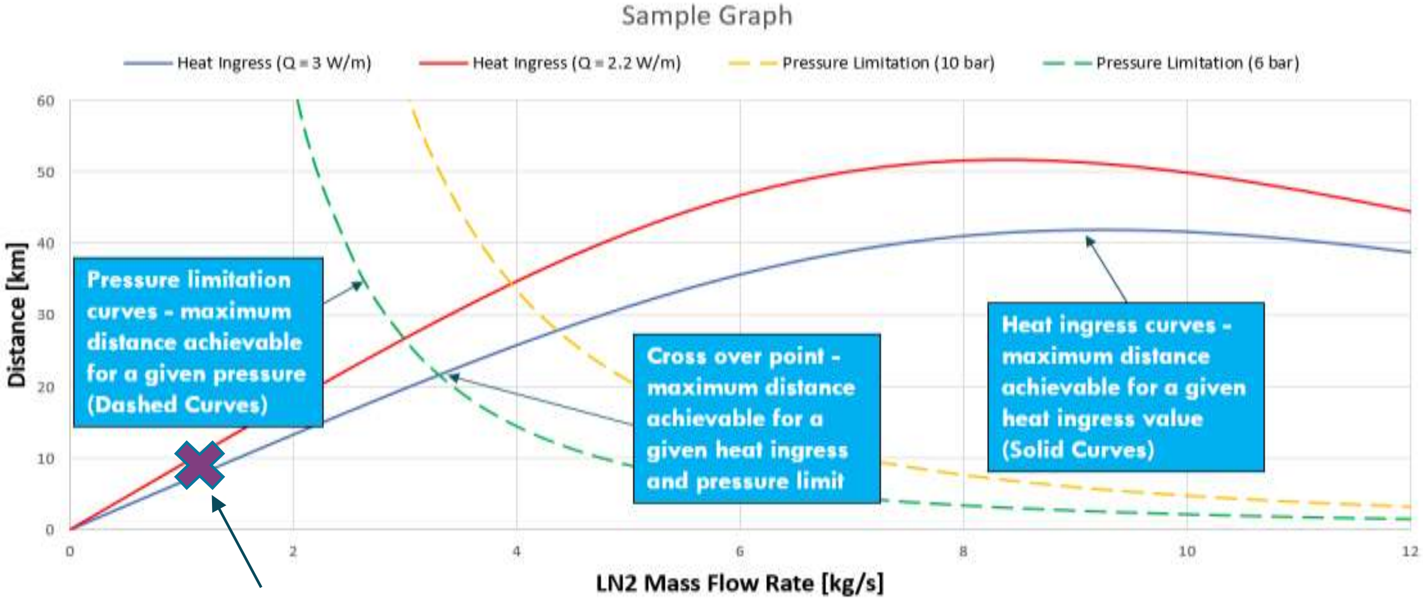
- Marine enabled and terrestrial M/HVDC, 2GW+, long distance transmission,
- Specific focus is on novel materials, thermal management, intermediate cooling and pumping, design for scale production and reliability – several patents applied,
- DNV Statement of Feasibility achieved for offshore transmission cable system in 2020,
- 40 people, 2,000m2 tech centre in Dublin,
- 500m marine demo 2024/25,
- Aker partnership brings decades of marine engineering and manufacturing expertise



DNV·GL STATEMENT OF FEASIBILITY

SUPERNODE CABLE DEVELOPMENT – EXTENDING RANGE & APPLICATION





Technology Challenges:

- Pressure limits
- High frictional heat
- Structural limitations
- Manufacturability challenges
- Hard Vacuum
- Costs

SuperNode Breakthrough Innovations:

- Novel cryostat material developments
- Novel cryogen & thermal management system

Key 2021 Patent applications

SUPERNODE TECHNOLOGY DEVELOPMENT TIMELINE

2019 – Market review & HTS Cable **Technology concept**

2020 – **Benchmark testing** – Gen 01 Cryostat HTS

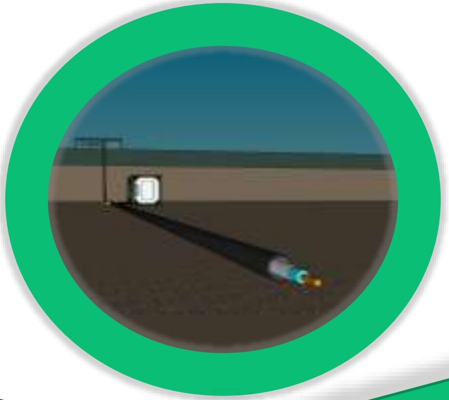
Statement of Feasibility from DNV

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



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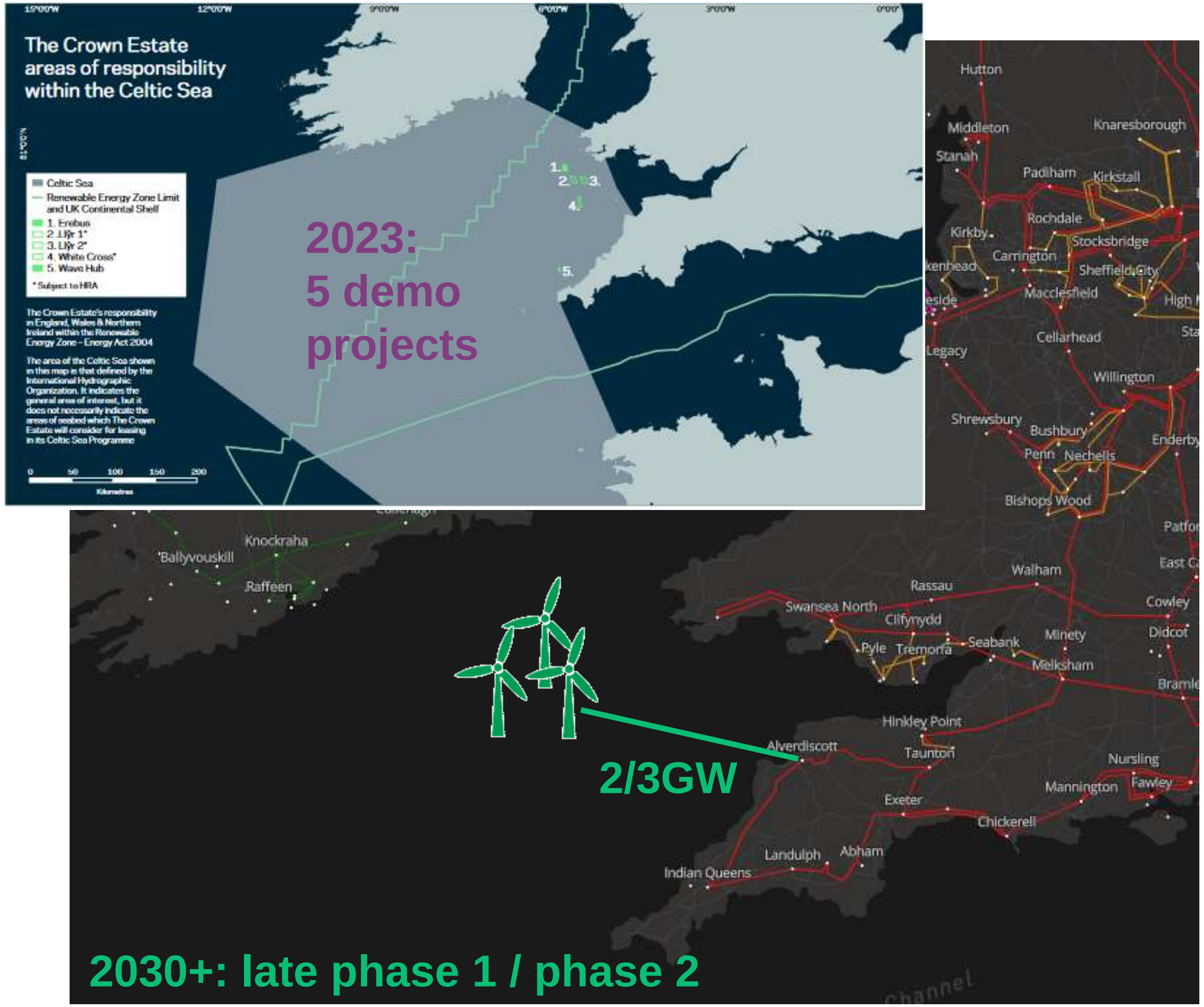
PRO FORMA PROJECT: CELTIC SEA PHASE 2 (2030+)

<u>Context</u>

- 5 demo projects planned for 2023 with total capacity of about 400MW
- 1GW operational floating wind by 2030
- 4GW plan for Phase 1 up to 2035
- Larger opportunity beyond with Phase 2

<u>Policy-Supported Timeline</u>

- 2/3GW, 100km project connecting into Alverdiscott
  - 20 km onshore cable corridor,
  - 80 km offshore HVDC
- EXAMPLE TIMELINE:
  - Framework 2026/27,
  - Facility Running 2028/29,
  - First Delivery 2030/31,
  - Grid connected 2032/33
- 2022/23 We can jointly, with partners, investigate connection optimisation studies and propose superconducting connections as part of future phases



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RECENT PUBLIC AFFAIRS

WHY IS NEW TRANSMISSION TECHNOLOGY NEEDED IN EUROPE?

TSOs to date have been **able to facilitate** increasing levels of renewables

The **core objective of a TSO is security of supply** which disincentivises transformative innovation

The market and supply chain is **not optimised** to connect remote renewables at scale

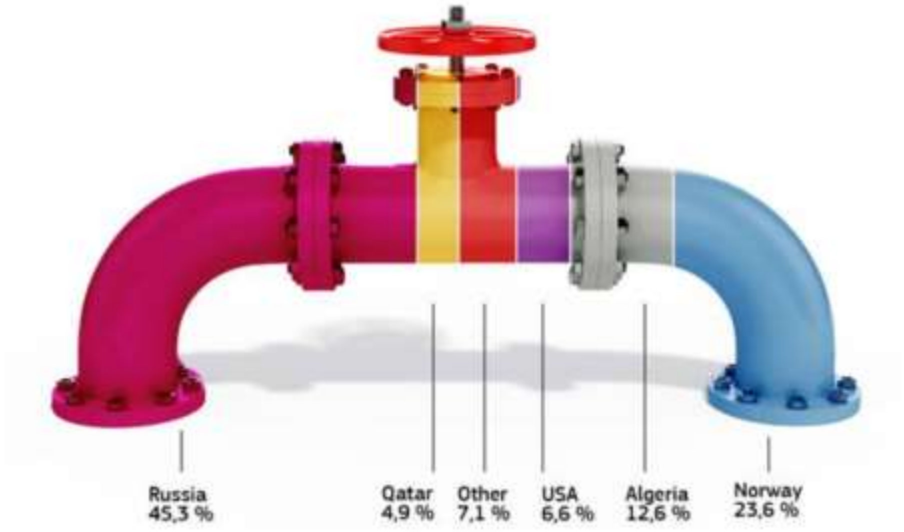
Infrastructure planning **does not consider longterm** time horizons

There is currently **no coordinated offshore grid** to facilitate the large capacities of offshore wind required

CHANGE IN EU ENERGY POLICY FOCUS

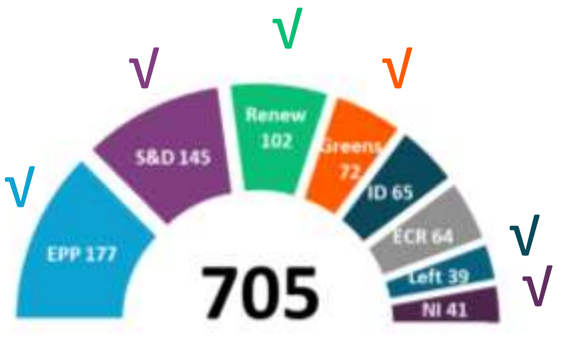
- Change of energy policy focus overnight from climate change to energy autonomy
- Strong political support from European Commission, European Parliament and EU leaders for accelerating renewables.
- 8 March: European Commission issues Communication on Joint European Action
- 10-11 March: EU leaders agree Versailles Declaration
- 24-25 March: EU Council meeting

EU Gas imports



Fit for 55 Package – Renewables Directive & Energy Efficiency Directive

- Revision of the **Renewables Directive (RED).** Some progress on offshore grid planning, but the Fit for 55 package does not meet the need for developing Europe’s electricity grid to accommodate the expected expansion of renewable energy. Watered down language on Sea Basin infrastructure. Draft report from Rapporteur. Strong support for increasing the 2030 renewables target from 32% to 45%, following the war in Ukraine.
- Rapporteur issued his draft report. **Recast Energy Efficiency Directive** (EED): The Commission’s proposal provides a solid legal basis (Art. 3) for applying the ‘Energy Efficiency First Principle’ to energy network operation, planning and investment decisions. Good Commission proposal to clarify and enhance the role of National Energy Regulators in implementing the Energy Efficiency First Principle in the planning, development, investment and operation of gas, and electricity transmission and distribution networks (Art 25).



European Parliament votes to accelerate offshore renewables

- The Parliament “stresses the urgency of improving and expanding existing infrastructure” and “calls on the European Commission and the Member States to ensure there is adequate infrastructure in the EU”.

SUPERNODE ENGAGEMENTS

Wind Energy Ireland report on the SuperGrid

- At a webinar on 9 March, Wind Energy Ireland launched its report – Ireland and the SuperGrid, Connecting an Energy Independent Europe. The report is substantially drafted by SuperNode.

Germany Grid Development Plan

- For the first time the German Federal Network Agency (“Bundesnetzagentur”) has included superconductors in its Electricity Network Development Plan for 2035. “This technology [Superconductors] has great potential and grid deployment in the gigawatt range in 2030 is realistic if, for example, corresponding pilot projects are planned in the grid development plan.”

Meeting with Irish Prime Minister:

- Topics: SuperNode; superconducting technology; making transmission a technology of strategic importance; and EU support for accelerating a pan-European offshore grid

CURRENT
Enabling Network Technology throughout Europe

WHAT WE SAY TO THE IRISH POLITICAL AND ENERGY BODIES

- Within the framework of a Strategic Autonomy Review, the European Commission should be invited to come up with proposals to **accelerate the achievement of a pan-European offshore electricity transmission grid** to ensure energy resilience and the supply of large-scale offshore renewable energy;
- A pan-European grid would require a **new, European institutional setup**, including establishing an independent technical body to plan, design and deploy the infrastructure needed to decarbonise Europe’s economies;
- An independent body would avoid the shortcomings of the TEN-E framework and **address the potential conflicts of interest** and national/regional approach;
- **Inter-governmental agreements** should be established with Norway / UK / Northern Africa;
- EU **funding for innovation** should be directed towards commercialisation of breakthrough infrastructure technologies. EU and national innovation funding should not be conditioned on incumbent participation.

ENERGY SYSTEM OPERATION STUDIES

RECENT SUPERNODE STUDIES

OPTIMISING GRID INTEGRATION OF LARGE HTS CONNECTIONS

PUBLICATIONS

SuperNode & University of Strathclyde *IEEE* – Published

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.**

I. Introduction

The issues of global warming and climate change have boosted the requirement for renewable energy. Recently, both the *United Kingdom* and the *European Commission* have set targets for net-zero greenhouse gas emissions by 2050 with requirements for carbon-neutral or even carbon-negative electricity supply. As part of the pathway towards that goal, the UK government aims to have 40 GW of offshore wind farm (OWF) capacity operational by 2030. To achieve this, offshore wind power transmission using modular multilevel converter (MMC) based high-voltage direct current (HVDC) technology will play an important role [1][2]. Up to the time of writing, more than ten MMC-HVDC projects have been commissioned globally to integrate OWFs.

With the increased scale of OWFs, the needs for 5 to 20 GW *Pan-European* transmission corridors and HVDC transmission at higher power rating (e.g. 2GW per connection) are emerging. However, conventional HVDC cables are limited in terms of current levels which in turn, limits their power transfer capability (e.g. 700 MW per cable). For this reason, to develop large-scale offshore DC networks, large numbers of DC cables will be required, which are costly, difficult to install and have a significant environmental footprint, an issue of particular sensitivity for when cables are brought onshore [3]-[5]. To increase power transfer capacity, ultra-high voltage HVDC cables (above 600kV) are being developed, but these ultra-high voltages will increase electrical insulation cost and the footprint of converter stations which will have a major impact on cost, particularly for stations on offshore platforms.

One promising solution proposed to address this challenge is to adopt the second-generation high-temperature super-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 DC cable, where the HTS DC cable resistance was modeled using a pre-defined piece-wise function of time. Similar to [9], reference [11] also showed that the HTS based LCC-HVDC system can effectively limit the fault currents during DC faults, thereby, providing self-protection capability.

Reference [12] simulated replacement of the line commutation converter (LCC) in [9] by a two-level voltage source converter (VSC). The two-level VSCs and HTS DC cables are modeled using a Real-Time Digital Simulator (RTDS). The steady-state analysis results revealed that the harmonic current generated by VSCs causes an AC power loss in the HTS DC power cable. However, no DC fault studies were reported in [12]. Reference [13] studied the control and modeling of a four-terminal VSC-HVDC system based on HTS DC cables, in which the HTS DC cables were modeled using geometry characteristics provided by the *Electric Power Research Institute* (EPRI). However, this model is not generic and cannot be applied to HTS DC cables with other design configurations. Reference [14] undertook an economic evaluation of integration with OWFs. It is shown that a two-stage DC collector grid, which consists of a ±2.5 kV cluster collector network using conventional DC cables and a ±20 kV wind park collector network using HTS DC cables, together with a ±150 kV HTS HVDC transmission system offers reduced losses and is cost-competitive with respect to AC connection systems. In June 2019, it was reported that the *Nexans* company successfully completed qualification tests on a 30m/10kA/320kV HTS cable, which was developed as part of the EU-funded *Best Paths* project [15].

As can be seen from above literature review, most of the existing publications focus on the steady-state, DC fault transient studies and qualification tests of the HTS DC cables

DC Fault Study of a Meshed HVDC Grid using High-Temperature Superconductor DC Cables

***Abstract*—This paper presents the DC fault transient study of an offshore wind power integration system using meshed DC grid and high-temperature superconductor (HTS) DC cables. A representative ± 100kV four-terminal meshed DC grid model is developed. Hybrid DC circuit breakers (CBs) are implemented in the DC grid to deal with the 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.**

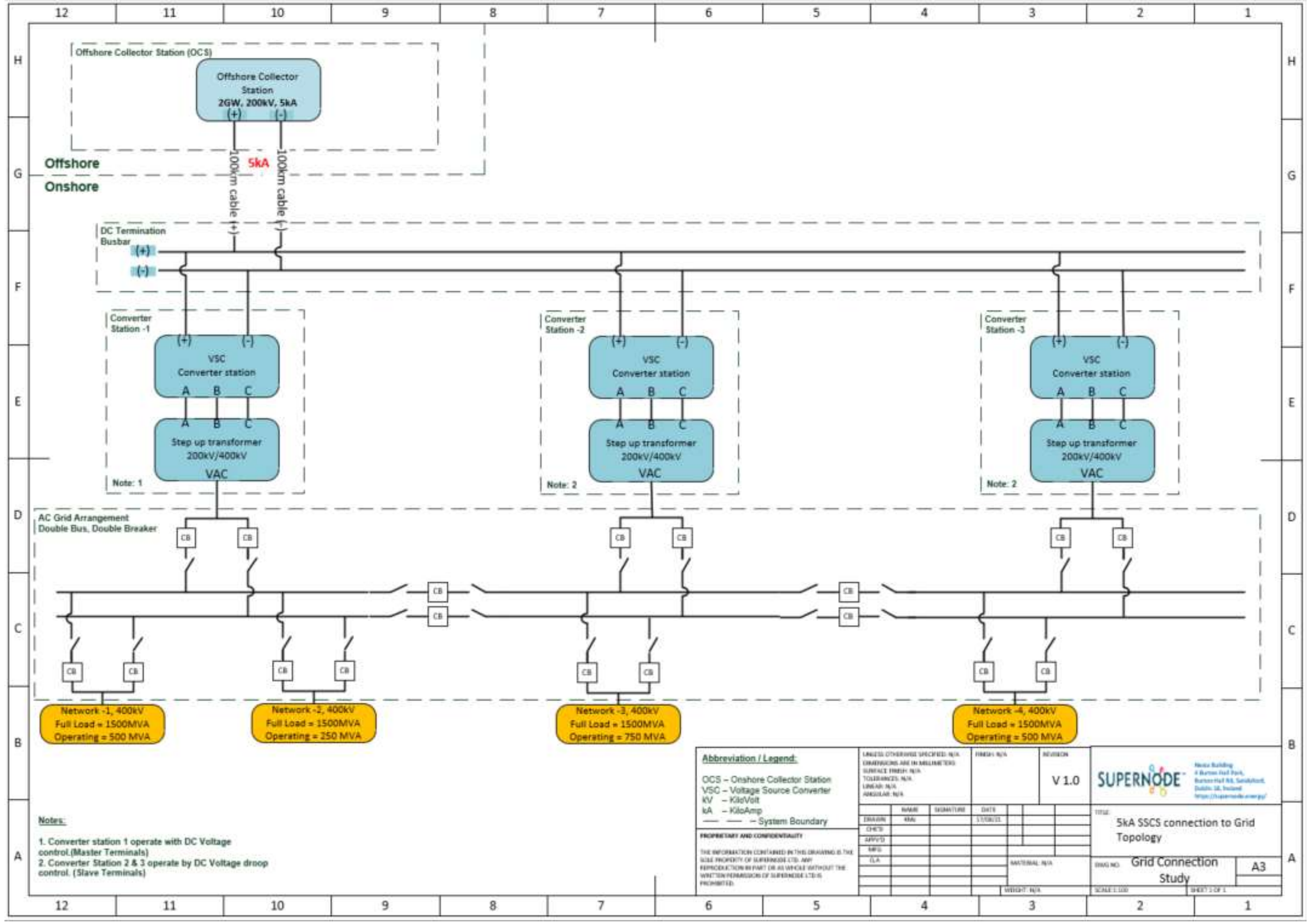
SuperNode & University of Aberdeen - Research paper under peer review by the *Electric Power System Research Journal*

Title :

Analysis of Bidirectional 15MW Current Source DC/DC Converter for Series-Connected Superconducting-Based 1GW/100kV Offshore Wind Farm

SUPERNODE™

GRID INTEGRATION OF HTS CABLE CONNECTION

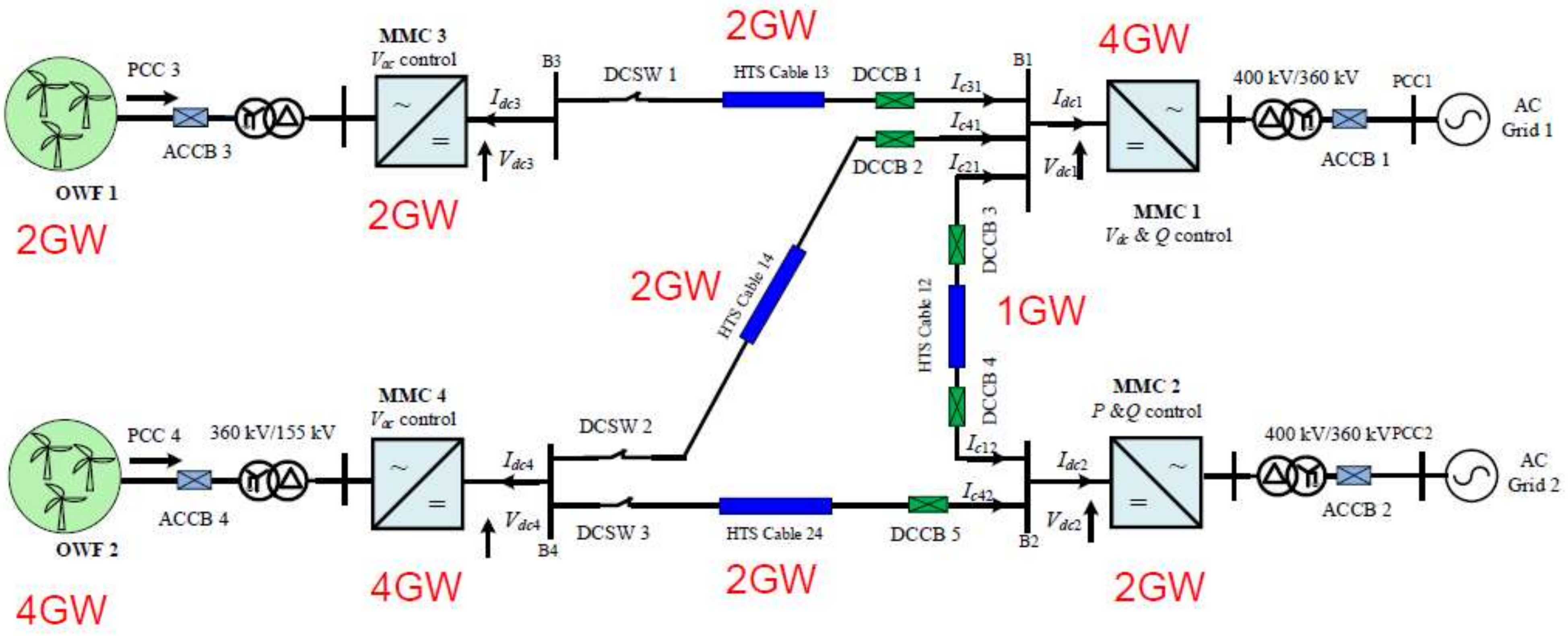


- 2GW, 200kV, 5kA
- Point to point connection with parallel converter stations
- DC voltage droop control strategy
- Multiple converters share the power
- Converters share power depending on head room
- Connection to a traditional AC double bus bar arrangement
- Faults detected & isolated with tripping of AC circuit breakers, healthy converter stations re-energised
- System provides greater flexibility, reliability, reduces transmission infrastructure and total power loss

GRID REINFORCEMENT AT SCALE WILL HAVE THE GREATEST IMPACT

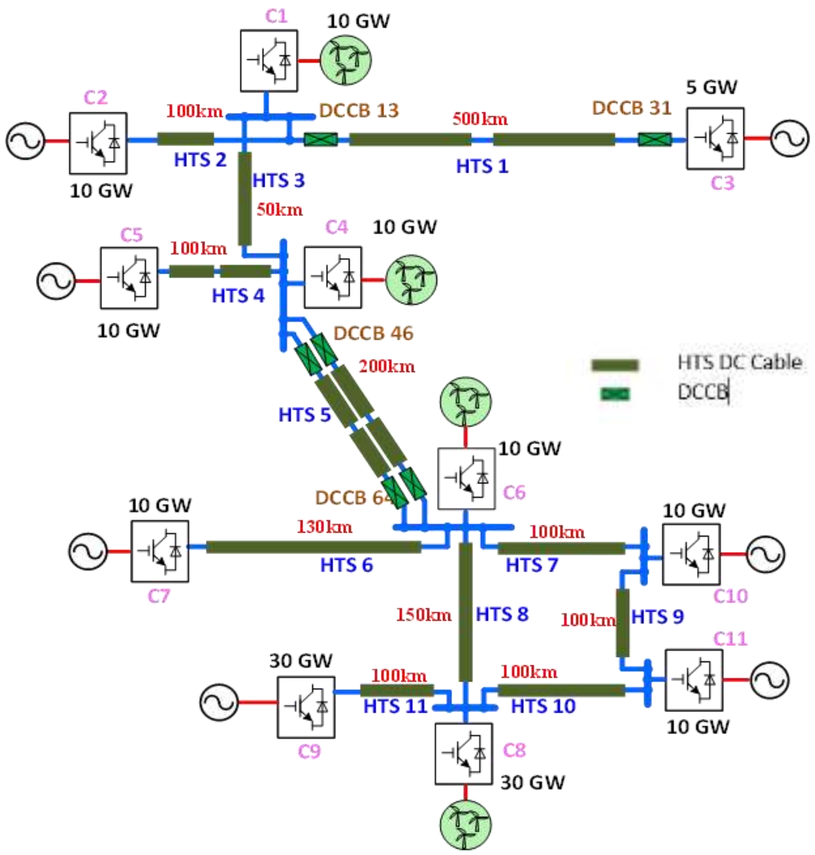
- **Voltage** – Superconductors can transmit higher power capacities at lower voltages, simplifying many aspects of a broader system specification and operation, particularly for **DC Grids**.
- **Higher Current Integration** – Superconducting cables carry higher currents that require management at integration points through the network.
- **System Protection** – Protection studies within SuperNode and academic partners show operational advantages leveraging inherent fault limiting properties of Superconducting cables to facilitate operation of DC protection strategies.
- **Meshed Networks –** Meshed grids comprising Superconducting cables can effectively incorporate transmission redundancy and operational resilience building minimal-cost capacity buffering throughout network lines.

POWER FLOW MODELING AND FAULT PROTECTION STUDY OF PROMOTION 4 NODE DC GRID TOPOLOGY WITH INCREASED CAPACITY HTS SUPERCONDUCTING CABLES



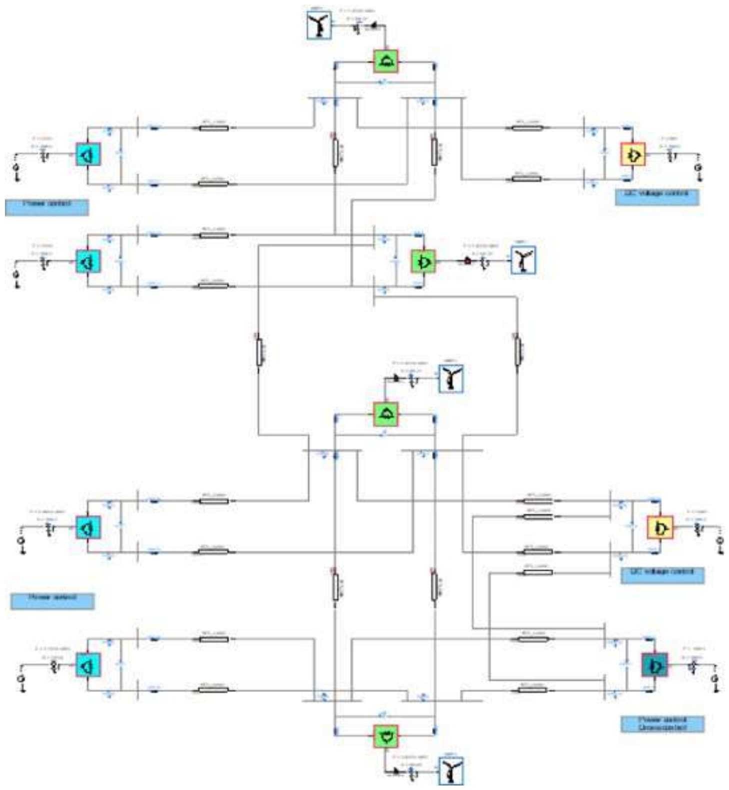
MULTI TERMINAL DC GRID

POWER FLOW MODELING AND FAULT PROTECTION STUDY



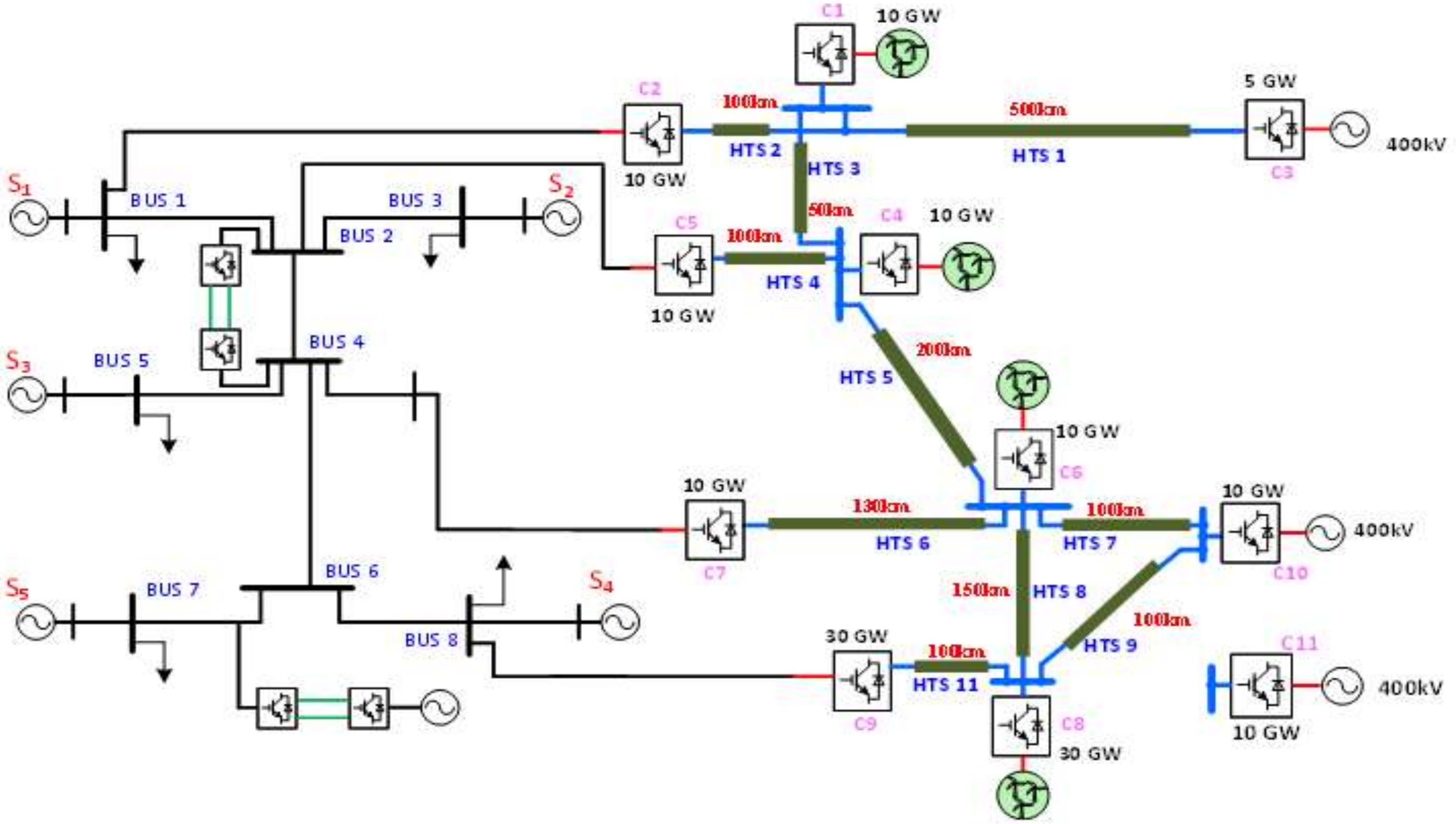
SIMULATION MODEL IN PSCAD

- Evaluated system behavior
- Test performance of control strategy
- Perform DC fault studies



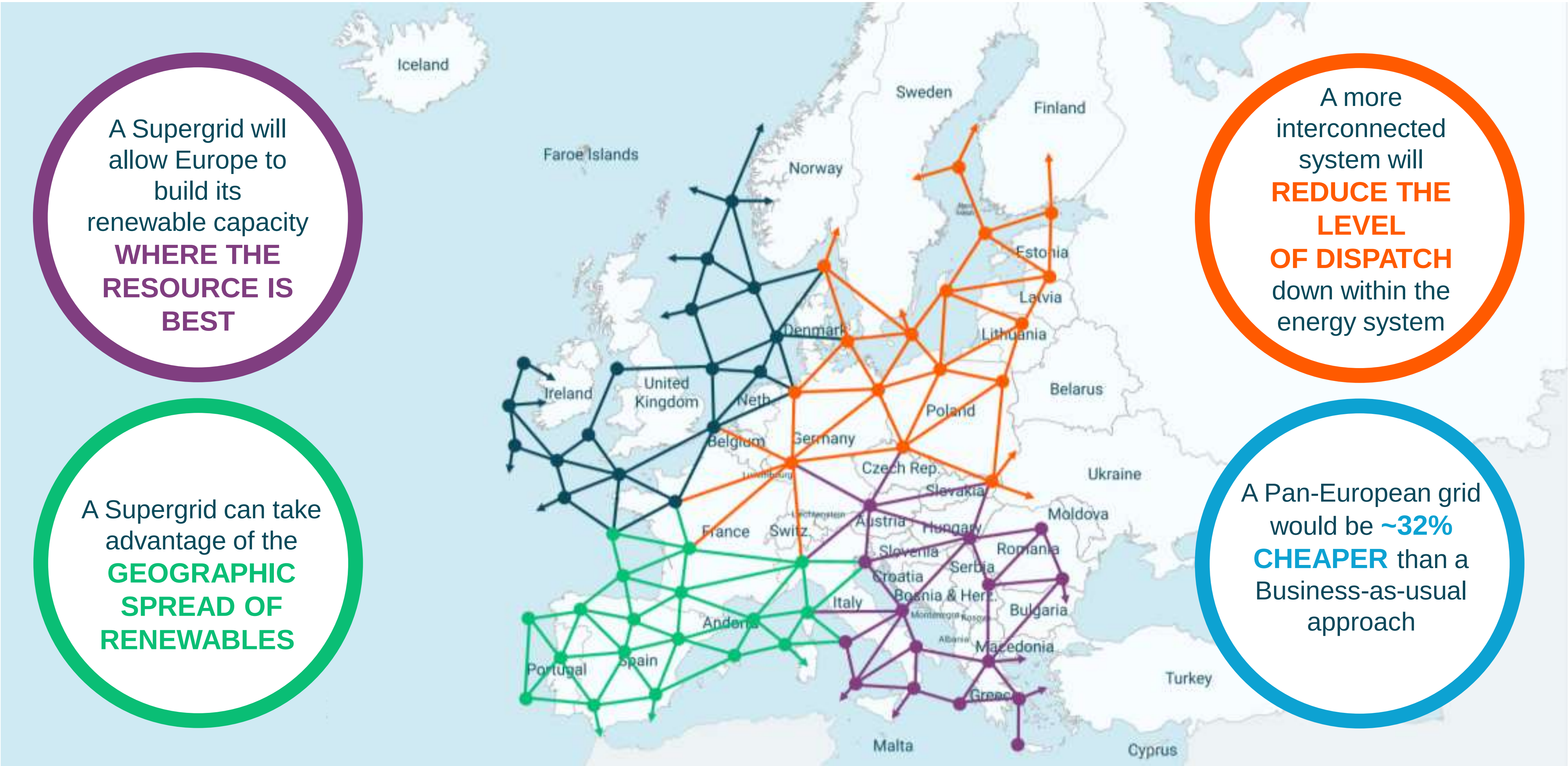
OVERALL ONSHORE-OFFSHORE NETWORK

Step 4: Connect the entire offshore DC grid.



SUPERNODE™

THE NEED FOR A SUPERGRID



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