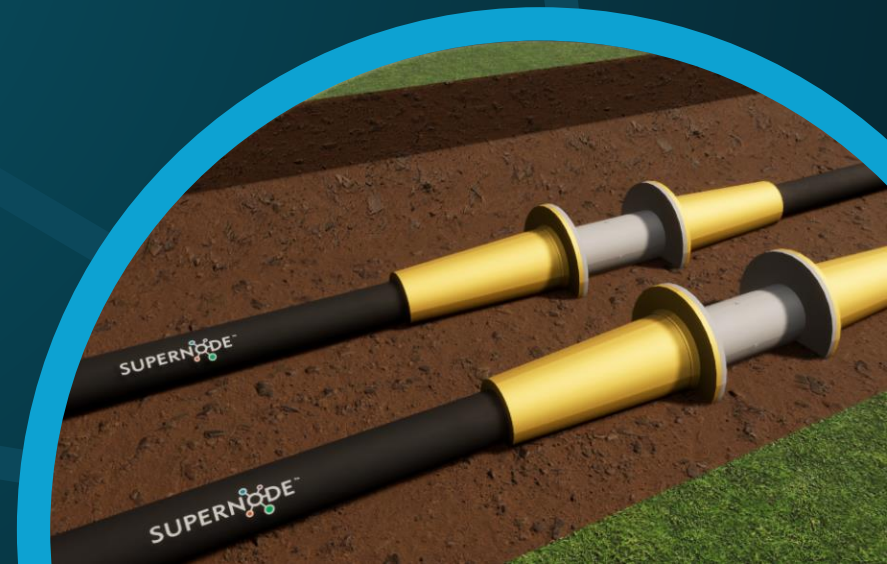


SUPERNODE™

CERN

KT SEMINAR



CONTENTS

1. INTRODUCTION: JOHN FITZGERALD / SUPERNODE
2. PROBLEM STATEMENT
3. PROPOSED SOLUTION
4. HOW CERN HELP OVERCOME CHALLENGES
5. WHAT WILL SUCCESS MEAN



OUR VISION AND MISSION

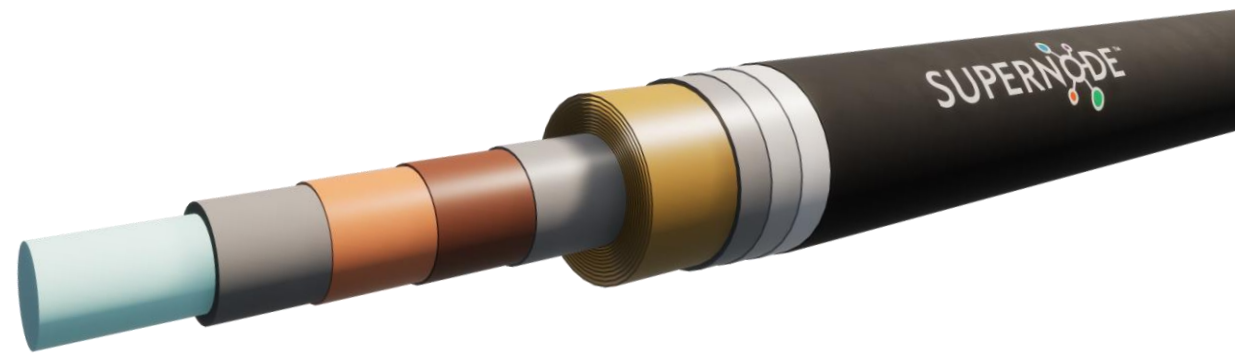
OUR VISION

PEOPLE SHOULD HAVE ACCESS TO SECURE
AFFORDABLE AND RENEWABLE ENERGY



TO DEVELOP AND MARKET INNOVATIVE TRANSMISSION
TECHNOLOGY BASED ON SUPERCONDUCTORS

OUR MISSION



WHO ARE WE?



EDDIE O'CONNOR
Founder, Chairman and
Owner



KJELL INGE RØKKE
Director

(Owner
of Aker ASA)



PAT COX
Director

(Former President of
EU Parliament)



JOHN FITZGERALD
CEO

(Ex director of Grid Dev
and Interconnection
EirGrid)



Henrik O. Madsen
Director

(Former President & CEO of
DNV)

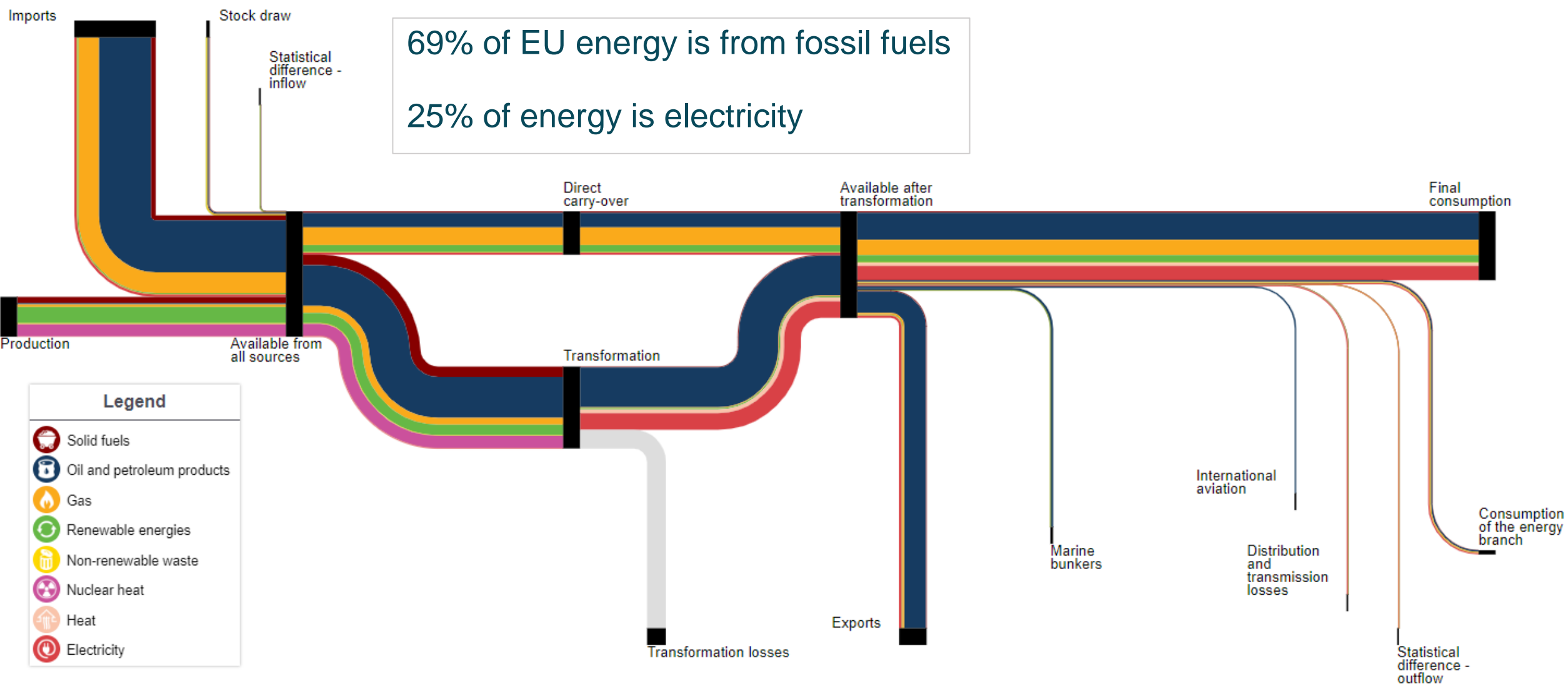


AKER HORIZONS

(50% ownership)

CURRENT STATUS

69% of EU energy is from fossil fuels
25% of energy is electricity



- Legend**
- Solid fuels
 - Oil and petroleum products
 - Gas
 - Renewable energies
 - Non-renewable waste
 - Nuclear heat
 - Heat
 - Electricity



ELECTRICITY GRIDS



- 50Hz/60Hz AC synchronous systems - developed over the past 100yrs.
- Highly reliable meshed transmission systems with N-1 contingency planning for the loss of any circuit /infeed.
- Limited interconnection between countries and very limited connectivity between synchronous systems.
- Fossils fuels move globally and there is very limited international trade in electricity.

CURRENT GRID / ENERGY SYSTEM CANNOT OPERATE WITHOUT CARBON

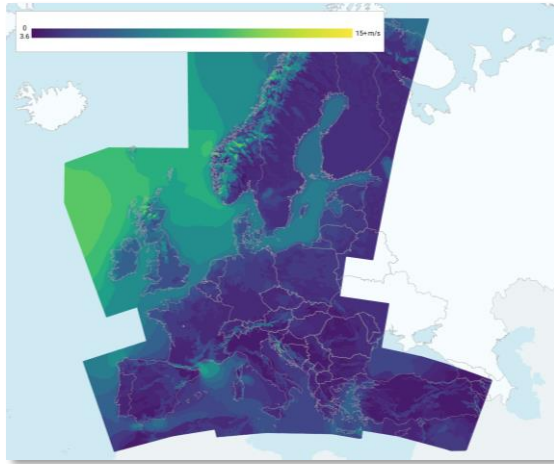


- There are little or no offshore grids.
- Fossil fuel supply lines (ships & pipelines) need to stop.
- DC transmission is better for long distance than AC.

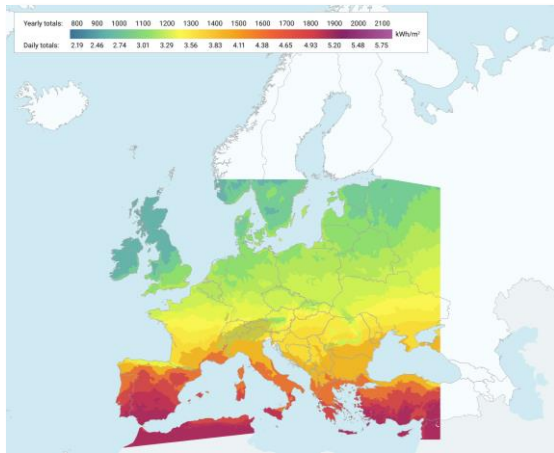
ELECTRIFICATION POWERED BY RENEWABLES IS THE MOST EFFICIENT WAY TO DECARBONISE

EUROPE'S GEOGRAPHY

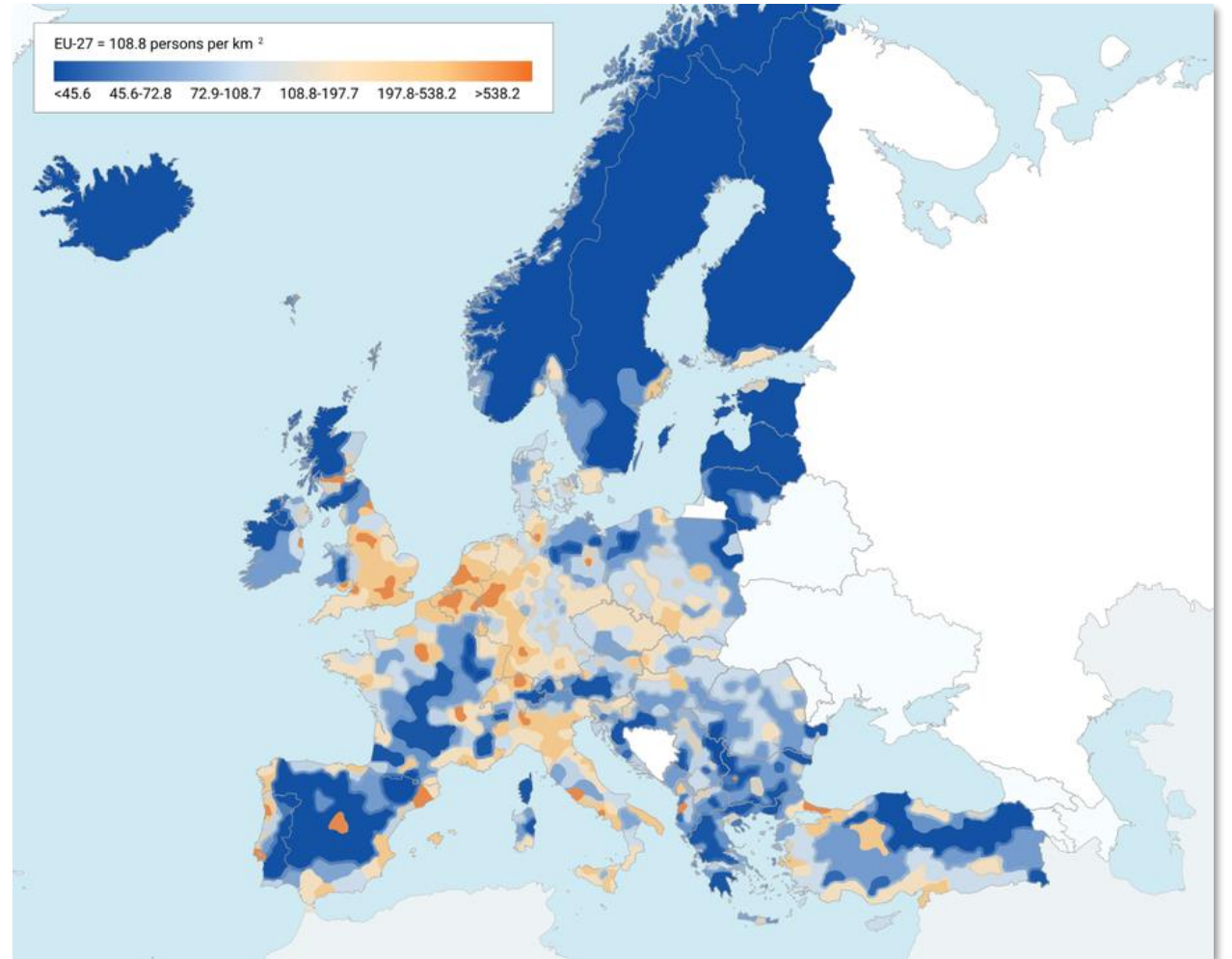
Wind speed



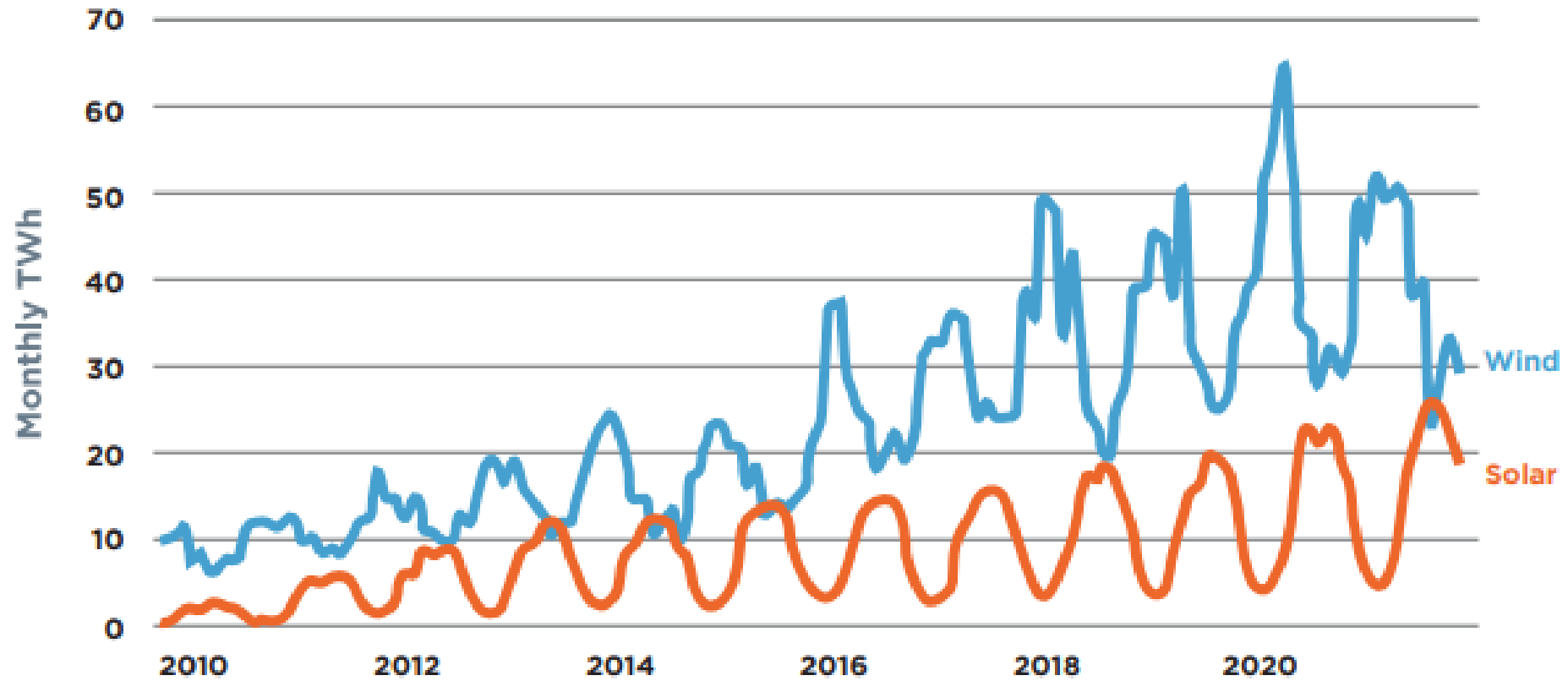
Solar Irradiance



Population density



WIND AND SOLAR GENERATION IN EUROPE



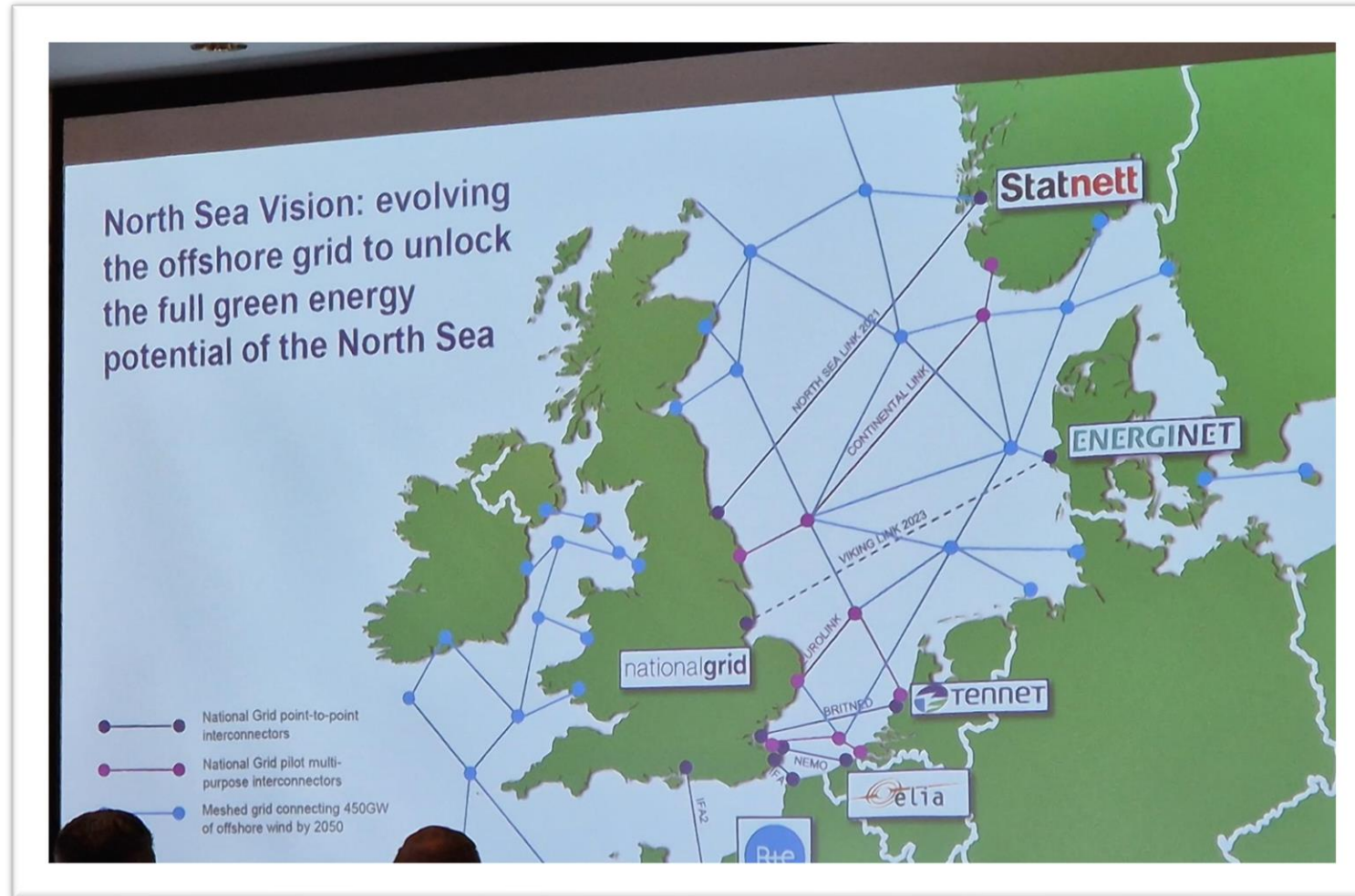
Source: International Energy Agency

O'Connor (2023) Supergrid - Supersolution

A BIGGER OR PAN EUROPEAN GRID IS NEEDED



NORTH SEAS MESHED DC GRID – MOMENTUM BUILDING



450GW Meshed offshore Grid in 2050, National Grid ESO Presentation



OSTEND NORTH SEAS ENERGY SUMMIT

- **April 24th** - 9 countries signed the Ostend Declaration: Belgium, Denmark, Germany, The Netherlands, Ireland, France, Luxembourg, Norway and the UK.
- Offshore renewable targets set:
 - 150GW by 2030
 - 300GW by 2050
 - Only 15GW offshore wind today
- Declaration of energy ministers calls for development and realisation of an **'Offshore Meshed Grid'**.



OSTEND DECLARATION ON

THE NORTH SEAS AS EUROPE'S GREEN POWER PLANT

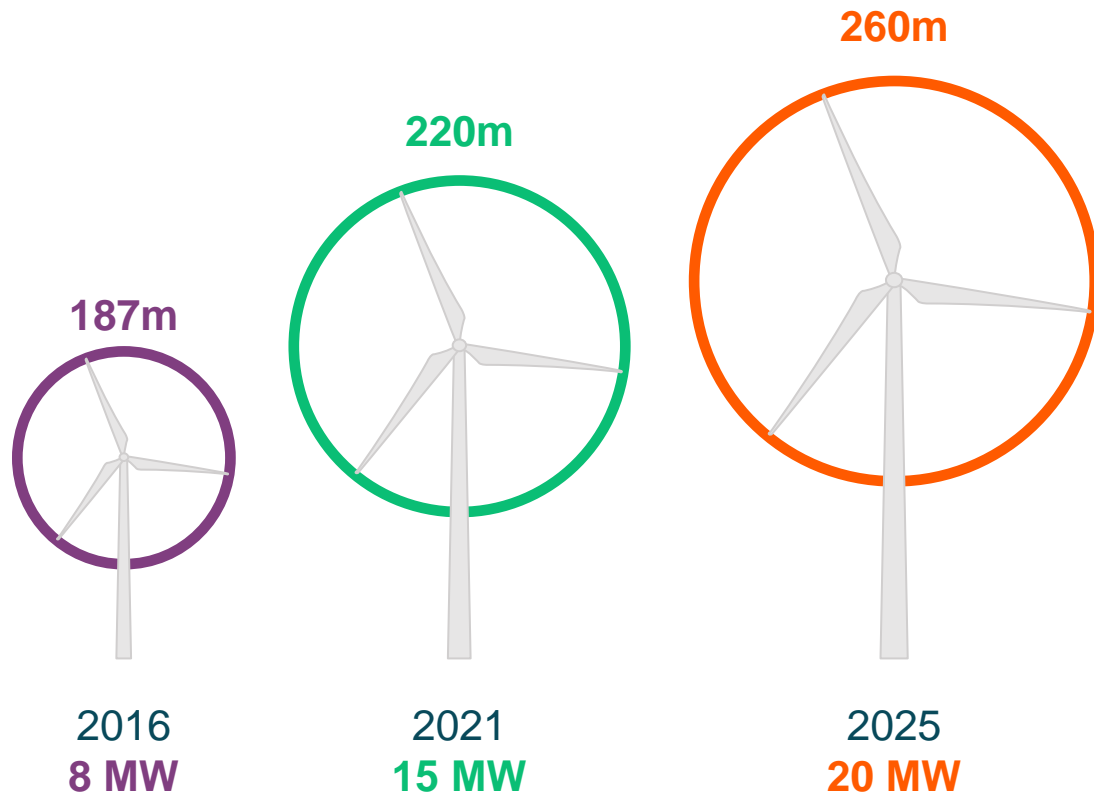
DELIVERING CROSS-BORDER PROJECTS

AND ANCHORING THE RENEWABLE OFFSHORE INDUSTRY IN EUROPE



WE HAVE RENEWABLE TECH TO DO THE JOB

WIND TURBINE ADVANCEMENTS



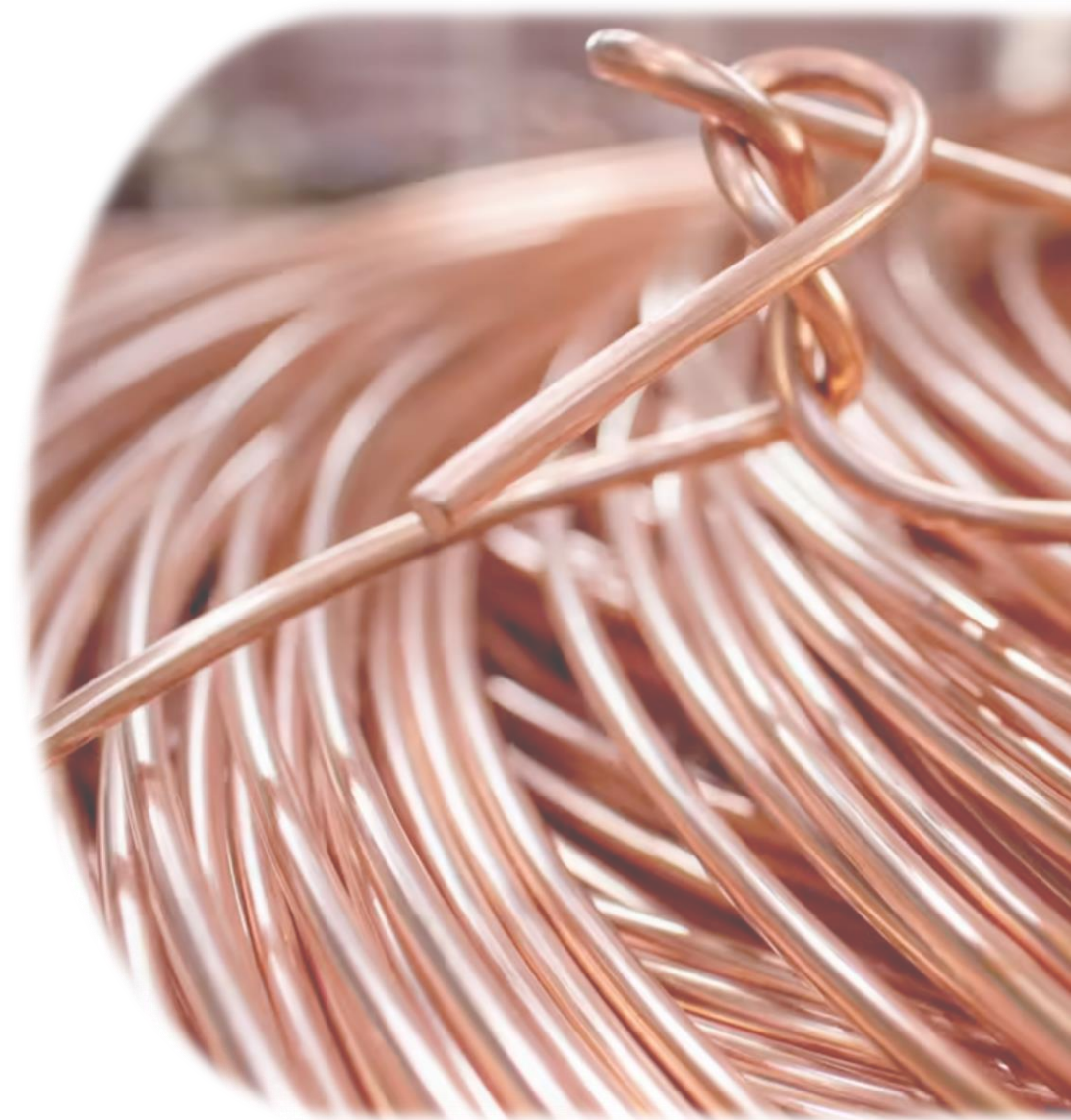
SOLAR PANEL ADVANCEMENTS

- Current efficiencies of ~20%.
- New materials such as **Perovskite** have shown efficiencies in excess of 25%.
- **Bifacial PV** system paired with solar trackers predicted to yield **27% more** than a conventional solar system.



EXISTING COPPER-BASED TRANSMISSION IS NOT ENOUGH

- **Current copper-based transmission technology** is not designed or sized for a decarbonised Europe based on weather-dependent renewables.
- Copper-based **underground cables can only carry 1 GW** per cable, suffer from electrical losses, and require large amounts of material and space.
- Copper miners now use **ore grades of 0.5%** copper, a quarter the concentration of a century ago.
- “There is going to be a **very significant shortage in copper**. It’s going to be very difficult to meet the aspirations that have been set,” Richard Adkerson, CEO of US mining group Freeport-McMoRan in FT 31/10 2022.



WHAT IS HAPPENING ELSEWHERE



- China has constructed Ultra-HVDC overhead power lines.
- The largest line has a capacity of 12GW and is 3,324km.
- Europe faces different geographic and political constraints.
- New underground and offshore grid technologies will be needed.



HOW DO WE MOVE BEYOND FOSSIL FUELS

KEY ENABLERS

1. **Grids**
2. Storage
3. Consumer behaviour



WHAT PROBLEM DO WE SOLVE?

- Overhead Lines cannot be delivered.
- Conventional underground cables are current limited to c. 2kA per cable (1GW at 525KV).
- Long term copper supply is an issue and order books are full for marine cables in the near term.
- Transmission products that will be the key enabling technology for the renewable energy transition.

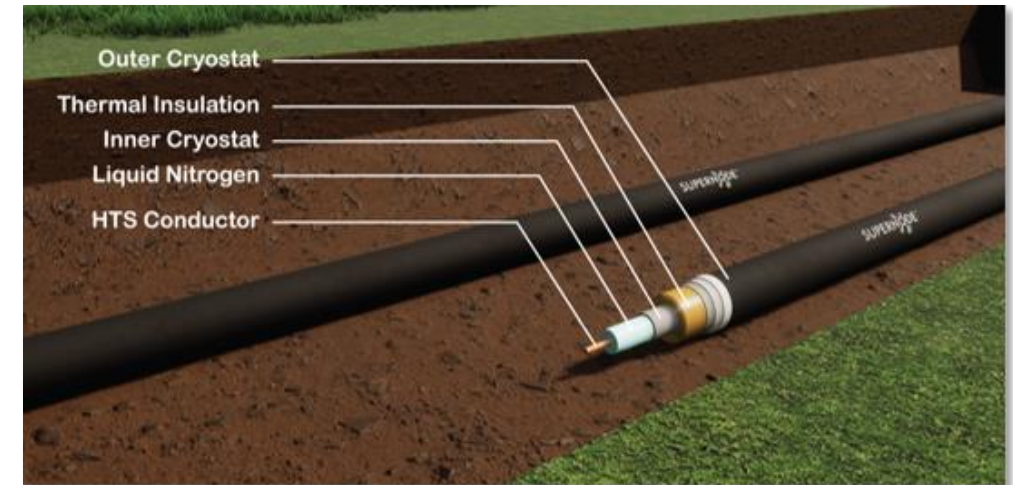
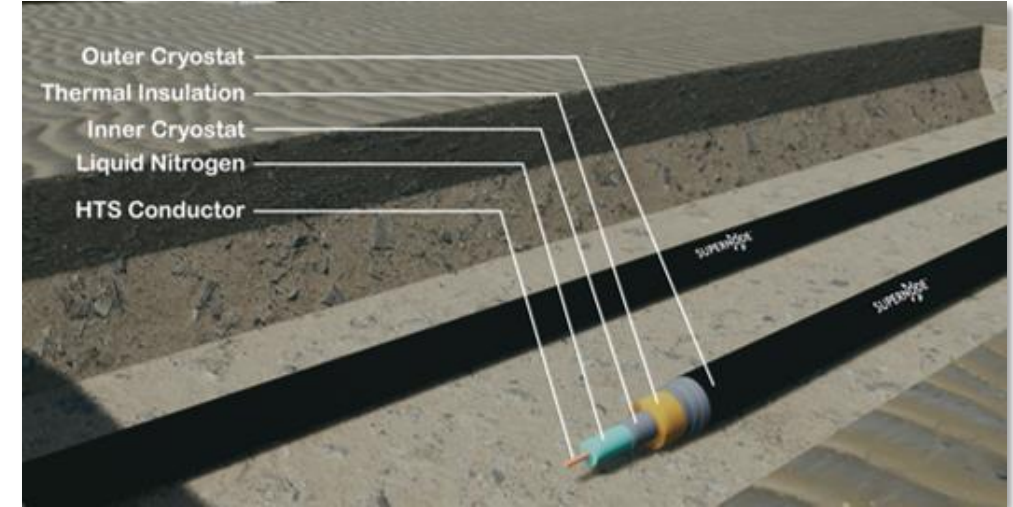


WHAT WE NEED

TRANSMISSION TECHNOLOGY THAT IS:

- Unobstrusive
- High-power
- Scalable
- Long distance
- Marine-enabled

Cable technology based on superconductivity offers a solution



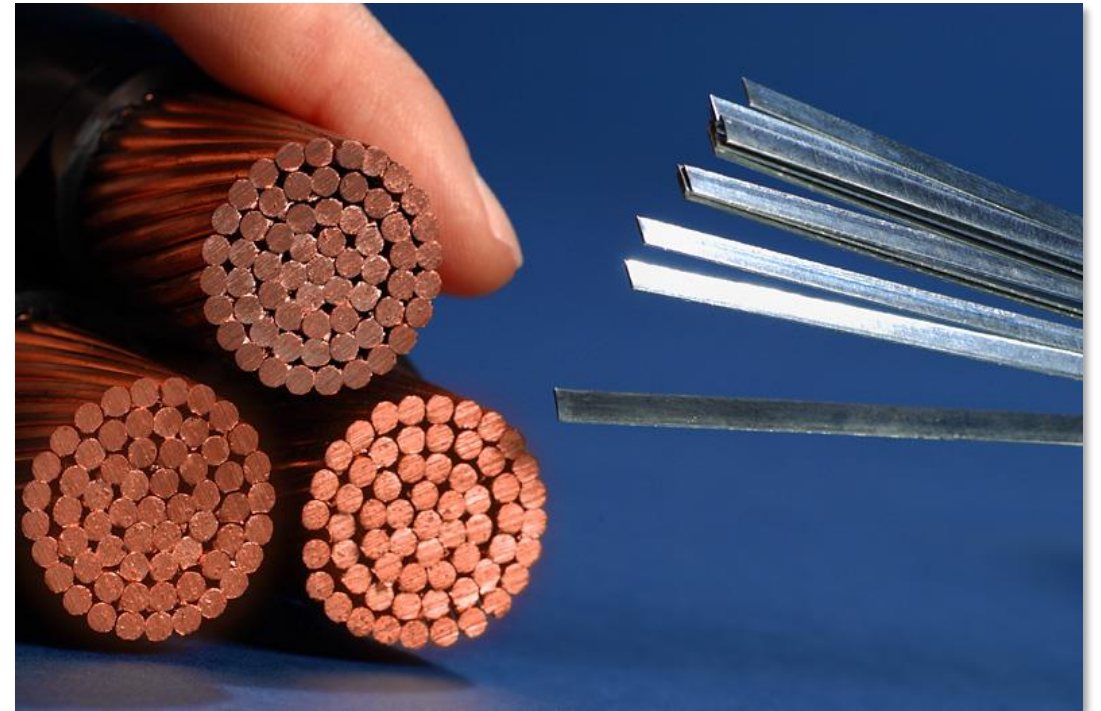
WHAT IS SUPERCONDUCTIVITY?

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

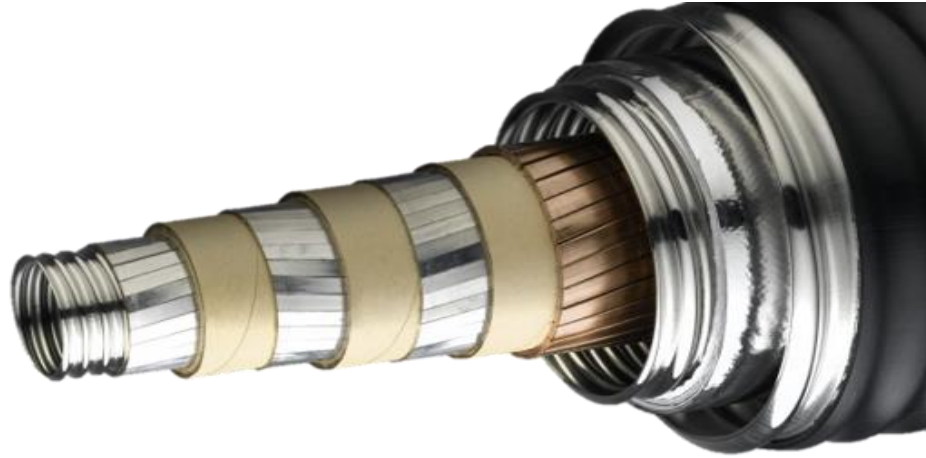
- Zero electrical resistance
- High power density

How to achieve superconductivity:

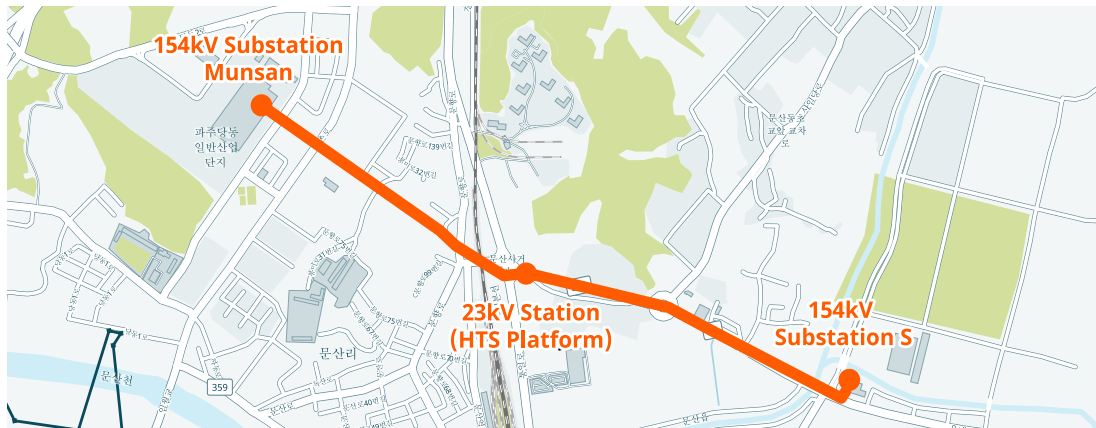
- A material must be cooled to below its '*critical temperature*'.
- High temperature superconductors (HTS) are superconductive around -180°c .



SUPERCONDUCTOR CABLE SYSTEMS IN PRACTICE



Shingal Project, Seoul, S. Korea



Recent Superconductor Projects

2013	 Nexans ELECTRIFY THE FUTURE	Ampacity, Essen	1km, 40MVA, 10kV, AC
2018	 Best Paths TRANSFORMER FOR SUSTAINABILITY	EU Horizon's 'Best Paths' Project	30m, 3.2GW, 320kV, DC
2019	 KEPCO	Shingal, Seoul	1km, 50MVA, 23kV, AC
2021	 amsc	REG, Chicago	62MVA, 12kV, AC
2023	 NKT We connect a greener world	Superlink, Munich	12km, 500MVA, 110kV, AC



THE FOCUS OF OUR SUPERCONDUCTING TECHNOLOGY

- 2GW+ transmission
- Marine and terrestrial deployment
- **Materials and Thermal Management**
- Efficiency, reliability & robustness

Oil & Gas

+

Electricity

=

New Transmission Technology



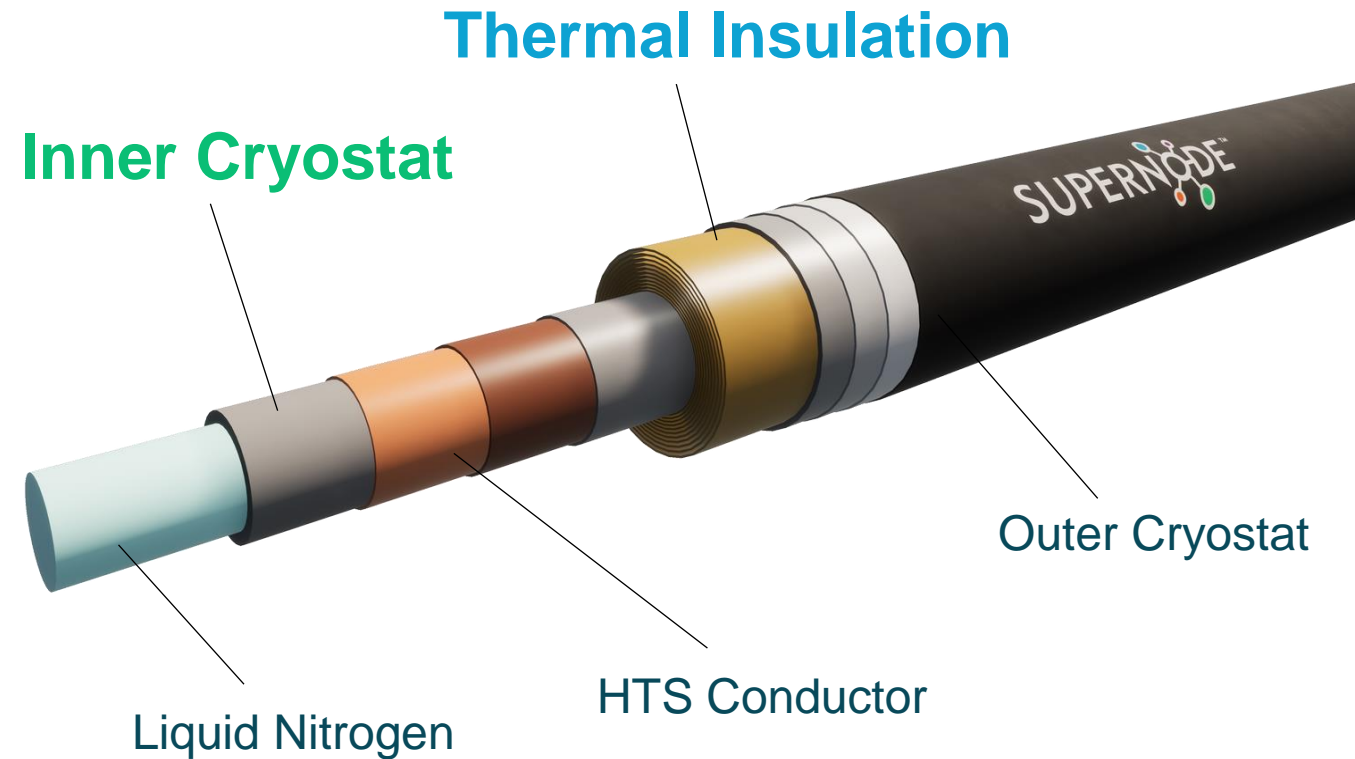
SUPERNODE'S COMPETITIVE ADVANTAGE

PURPOSE DESIGNED CRYOSTAT WILL INCREASE TRANSFER DISTANCE USING:

- Optimal thermal management
- Novel cryostat materials

SUPERNODE CABLE ADVANTAGES:

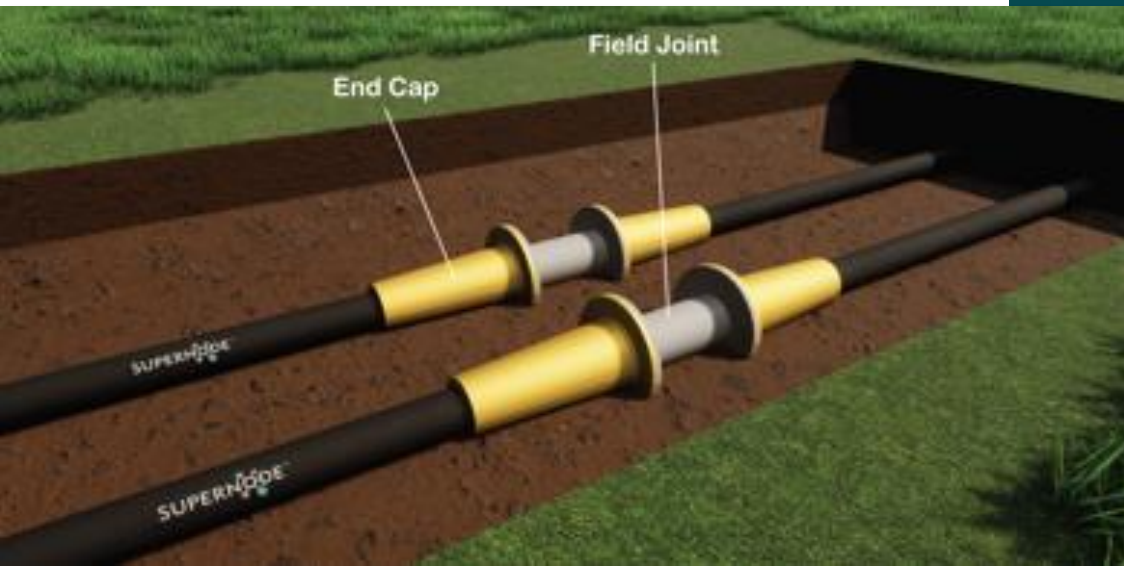
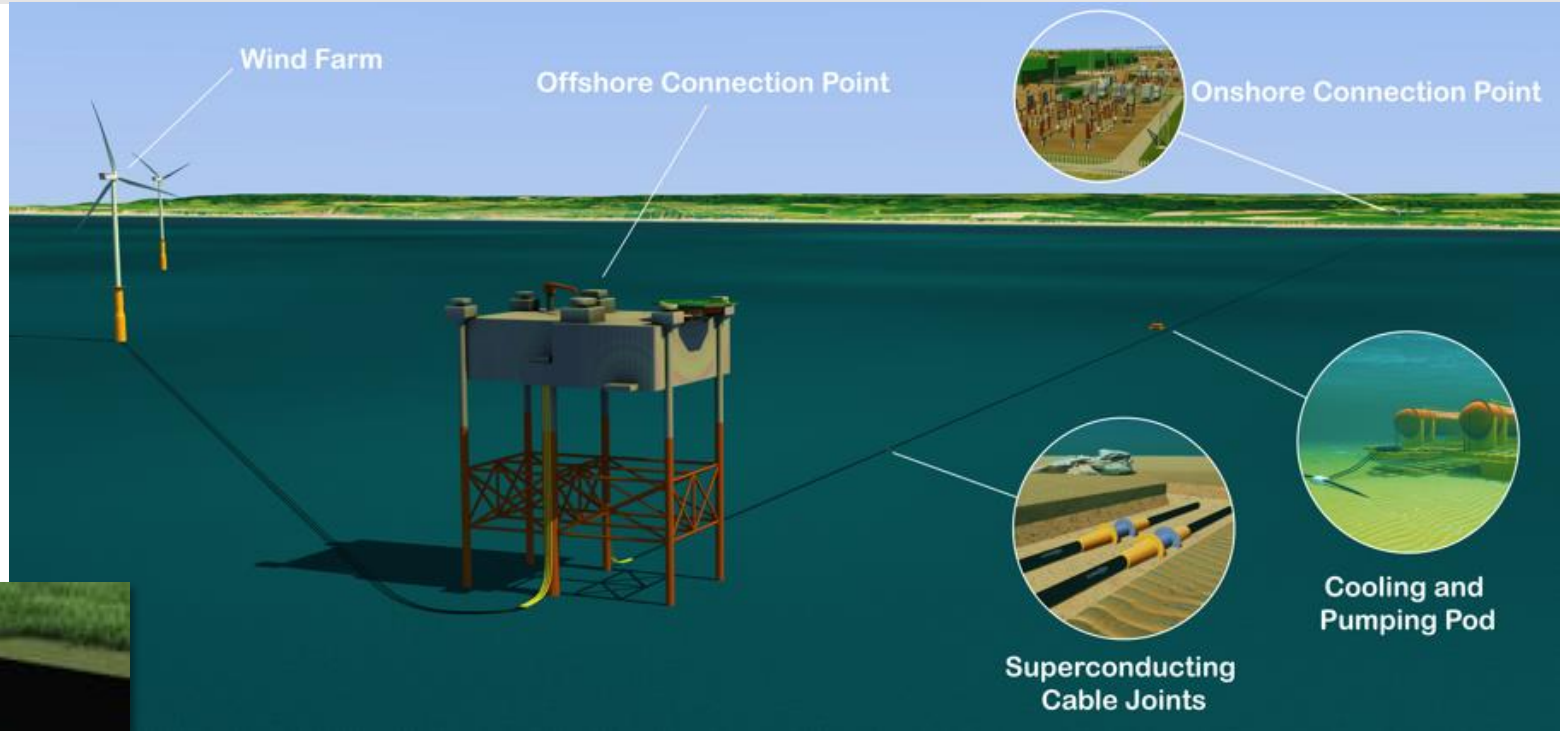
- Lower Price
- Significantly less raw materials
- Smaller footprint
- Less local disruption
- Quicker for asset developers
- Supply chain and regulatory regime diversification
- Cheaper, cleaner electricity for the customer



SUPERNODE'S APPLICATIONS

MARINE MVDC, 2GW+, LONG DISTANCE TRANSMISSION

- Reduced size offshore infrastructure
- E.g Connecting offshore wind farms



TERRESTRIAL MVDC, 2GW+, LONG DISTANCE TRANSMISSION

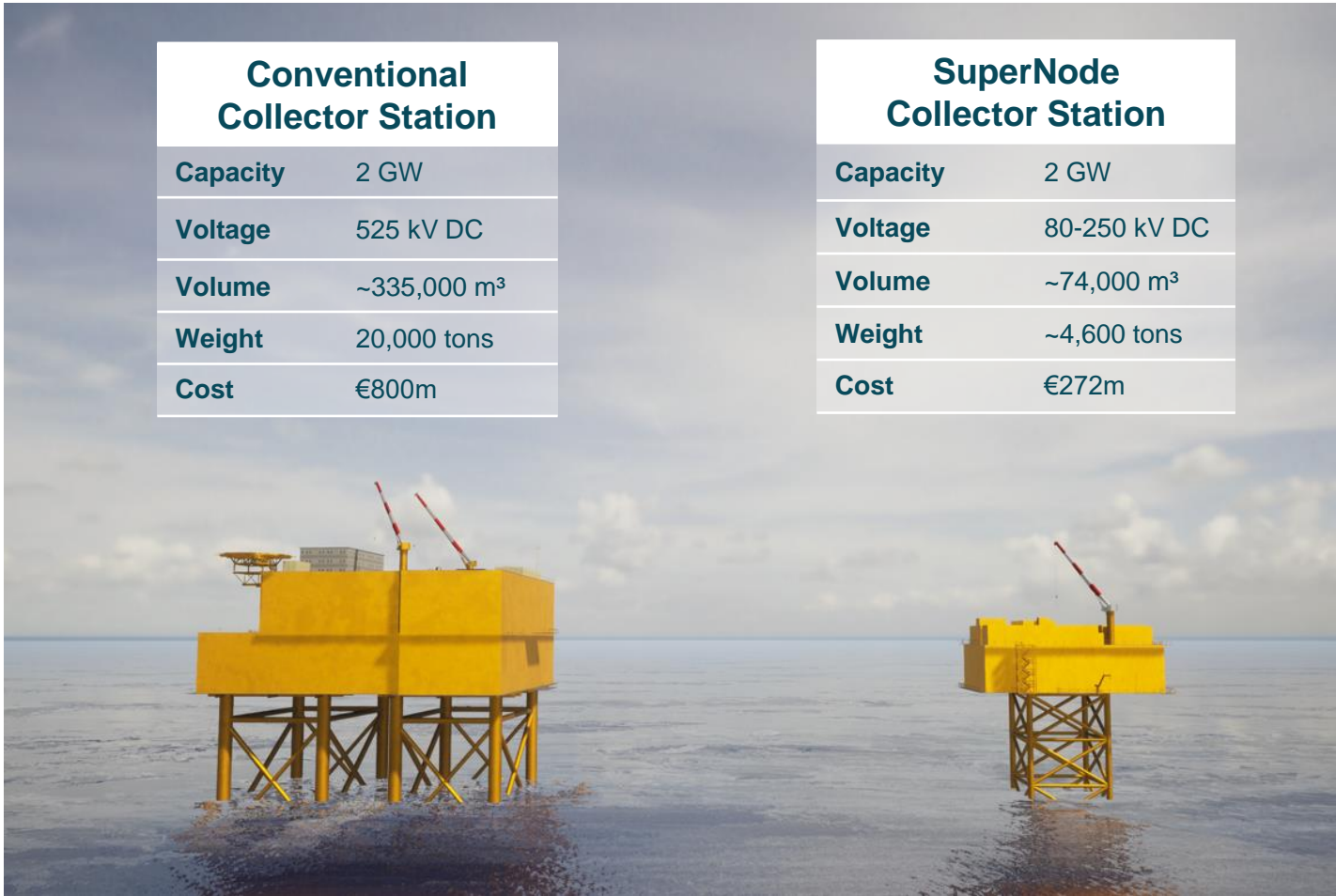
- Compact high-capacity transmission corridor
- E.g. Interconnections between national grids

SUPERNODE OFFSHORE GRID APPLICATIONS

Conventional Collector Station	
Capacity	2 GW
Voltage	525 kV DC
Volume	~335,000 m ³
Weight	20,000 tons
Cost	€800m

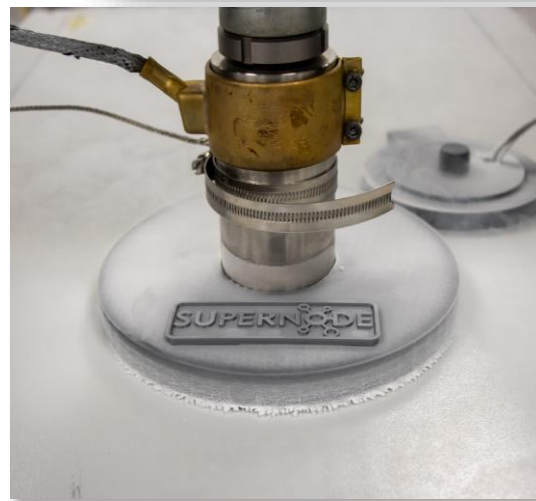
SuperNode Collector Station	
Capacity	2 GW
Voltage	80-250 kV DC
Volume	~74,000 m ³
Weight	~4,600 tons
Cost	€272m

- Increasing voltage with conventional cables leads to increasing platform size
- Superconductors can operate at much lower voltages, needing smaller and more cost effective platforms

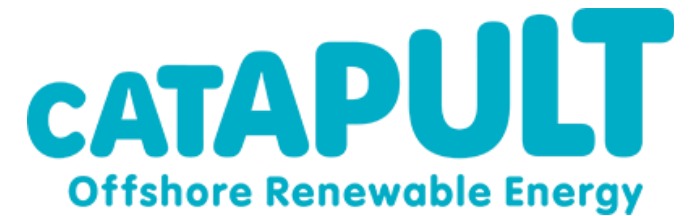
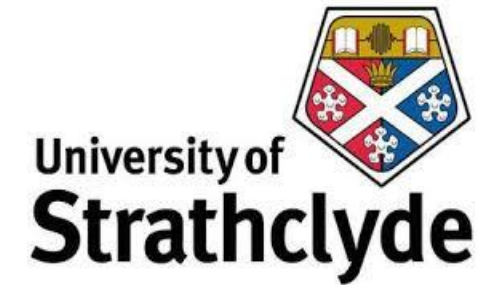


SUPERNODE CRYOGENIC CENTRE FOR SUPERCONDUCTORS

- State of the art facility which encompasses 15k square feet.
- Contains cutting edge equipment to facilitate SuperNode's R&D programme.
- Has the capabilities to assemble our first demo project.



OUR PARTNERS



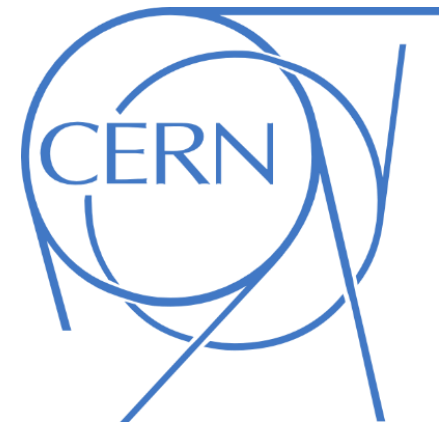
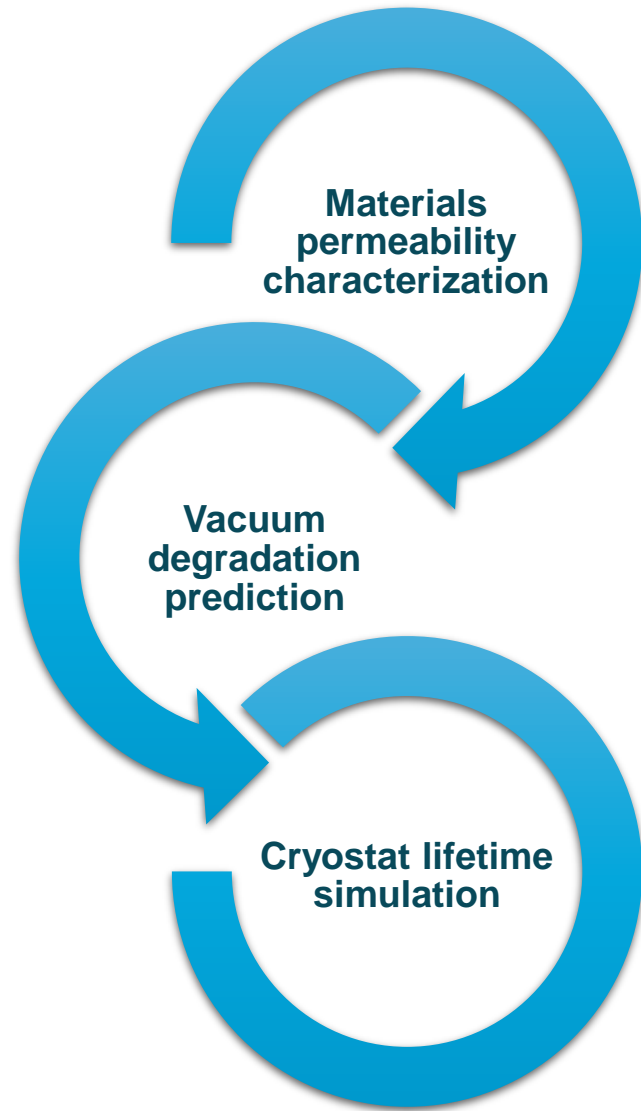
A K E R H O R I Z O N S



UNIQUE CERN COMPETENCIES AND CAPABILITIES

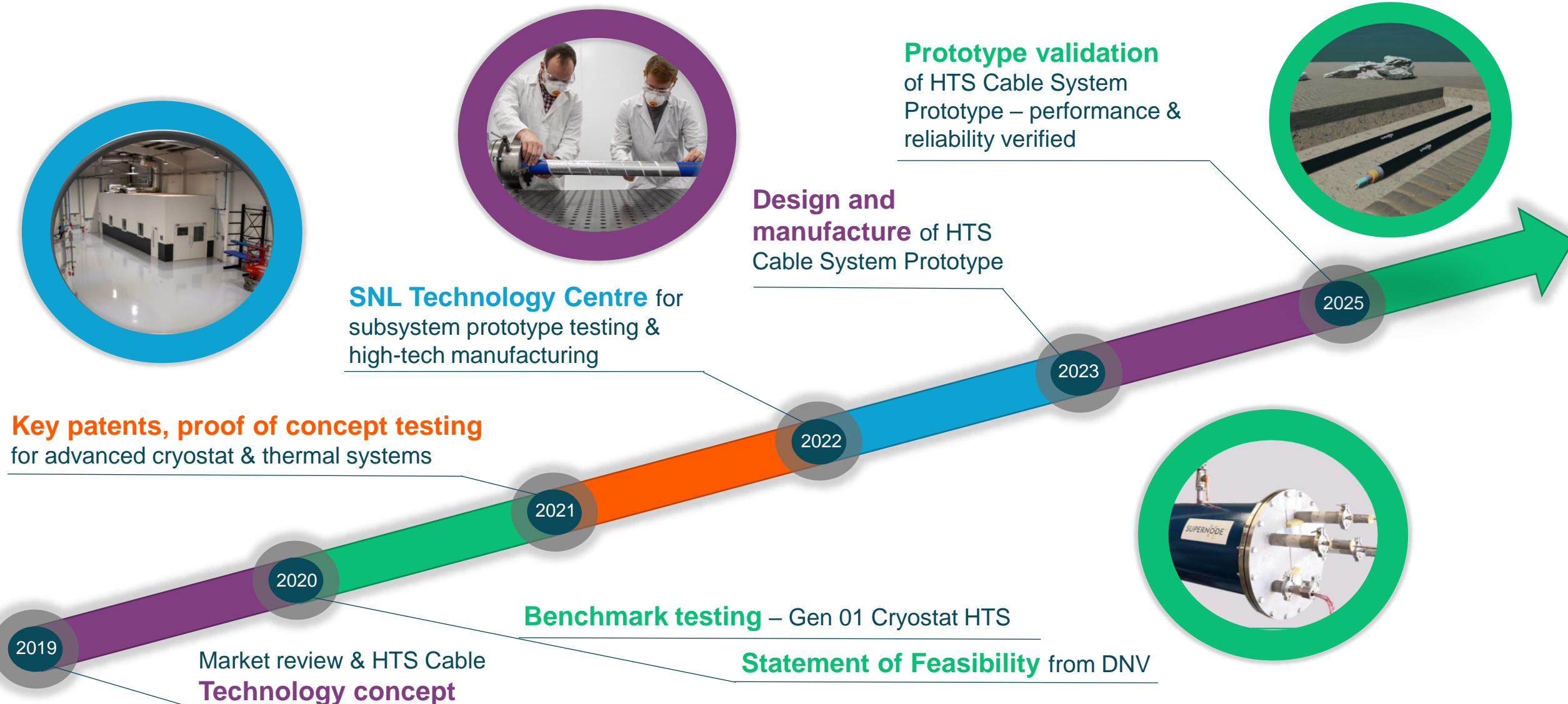


SuperNode Engineer posted in CERN

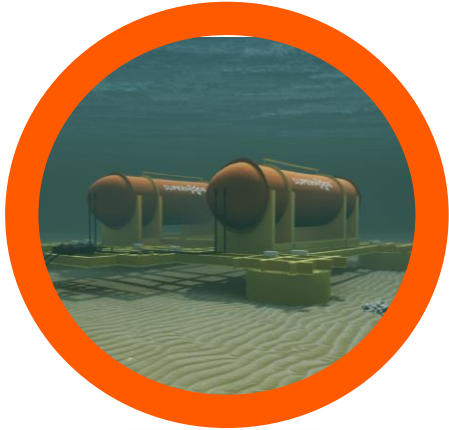


Develop state-of-the-art test rig to be installed in SuperNode headquarters

TECHNOLOGY DEVELOPMENT TIMELINE



TECHNOLOGY DEPLOYMENT TO MARKET



Manufacturing & Commissioning

Commercially Available
Cheapest form of Bulk Power Transfer (GWs)

Commercial Project Notice to Proceed

Demonstration Project 2

Intermediate cooling with advanced cryostat HTS Cable System

2026

2027

2028

2029

2030

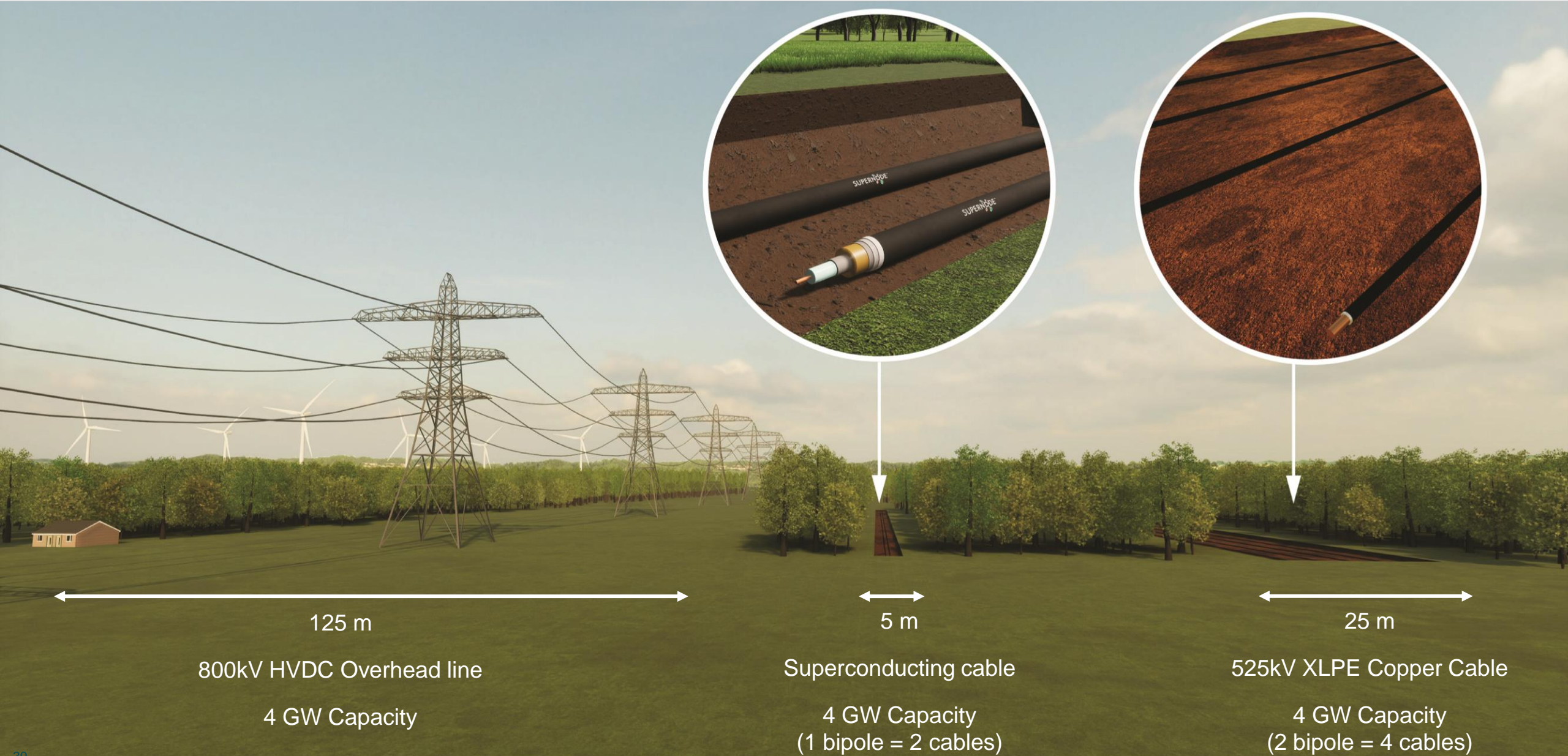
Demonstration Project 1

Advanced cryostat HTS Cable System

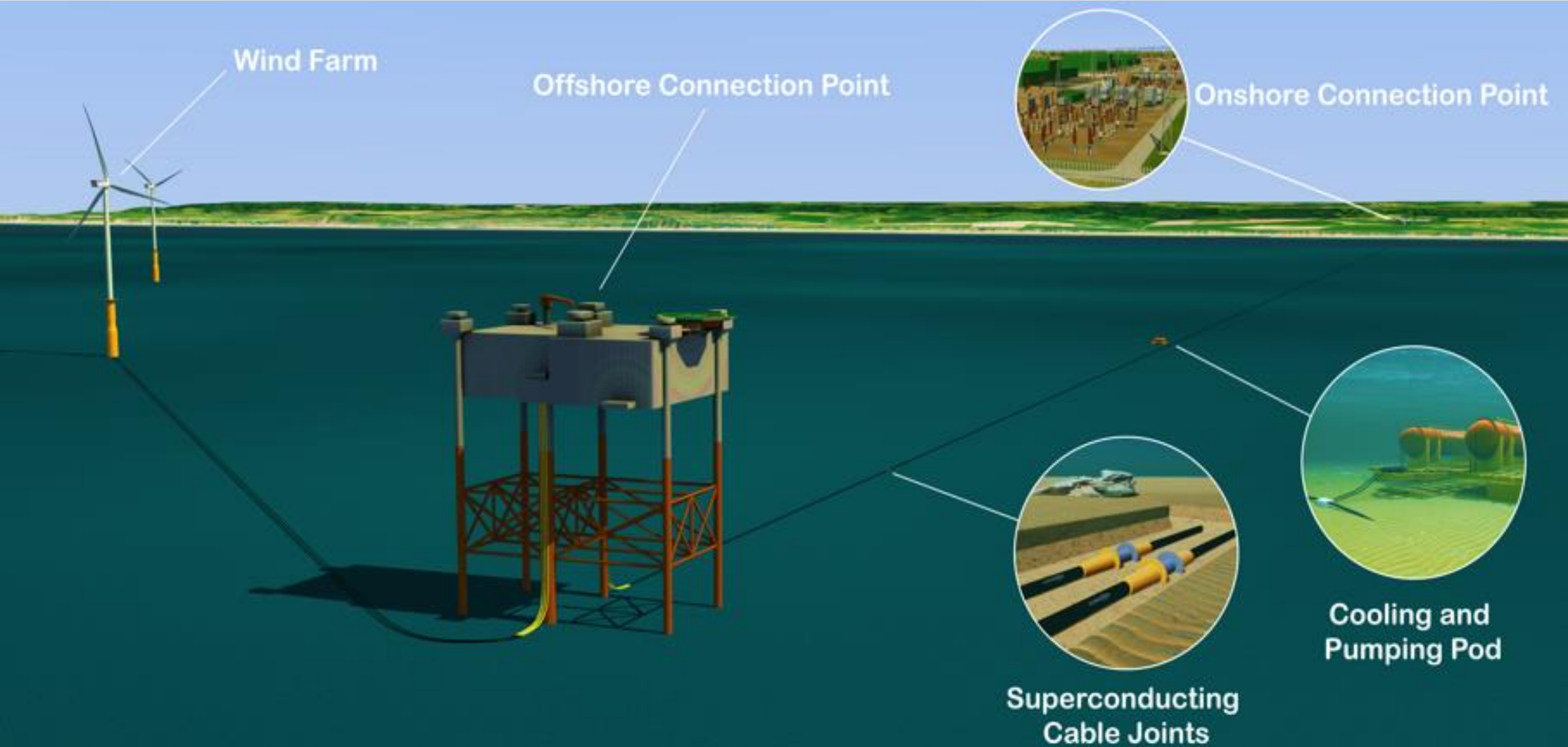
TRL6: Prototype HTS Cable System



ONSHORE SUPERCONDUCTING CABLE SYSTEM



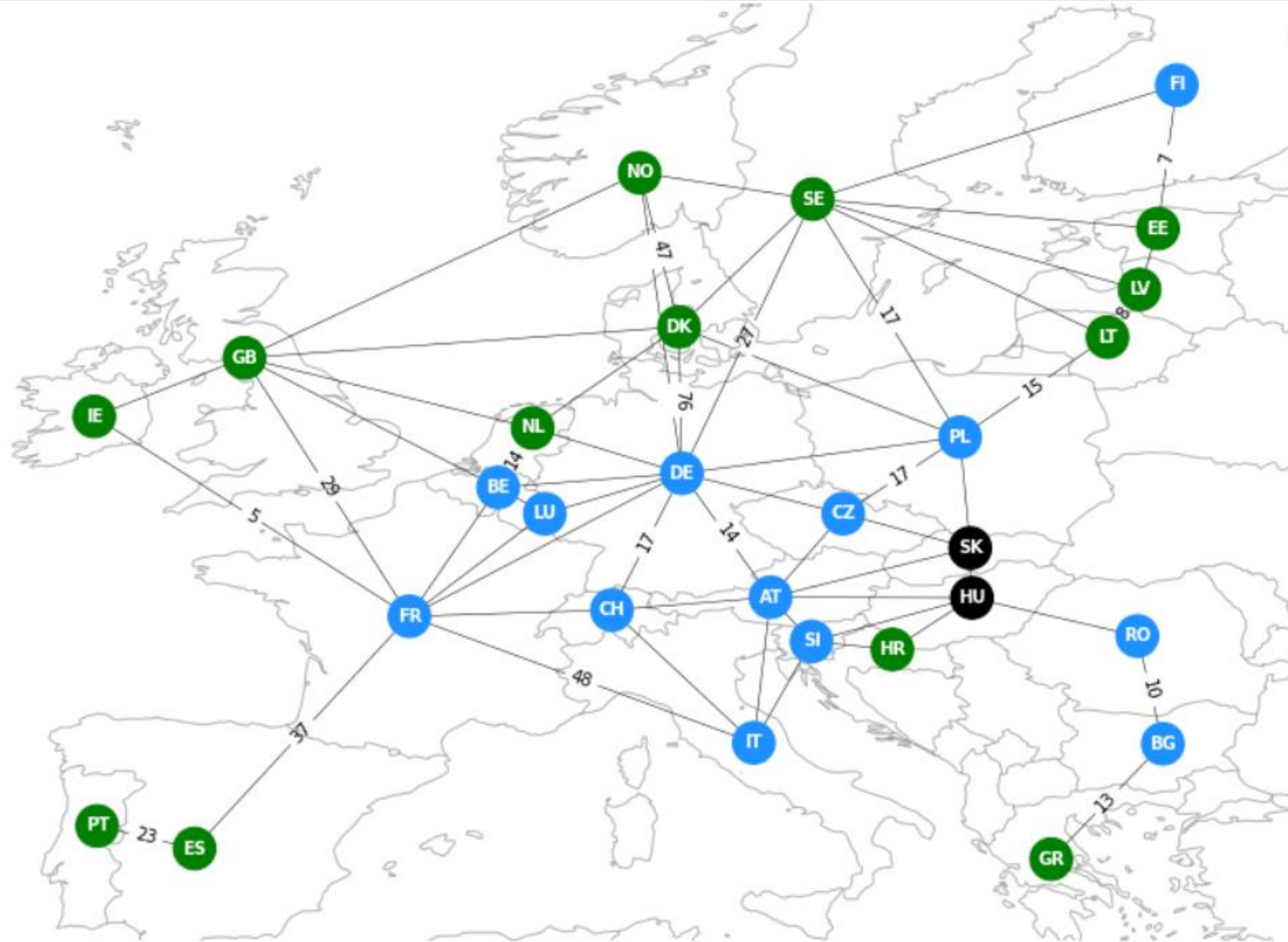
OFFSHORE SUPERCONDUCTING CONNECTION SYSTEM



SUCCESSFUL ENERGY TRANSITION IN EUROPE

An interconnected **pan-European** grid enabled by superconducting cables can provide people with access to energy that is:

- Secure
- Affordable
- Renewable



THANK YOU