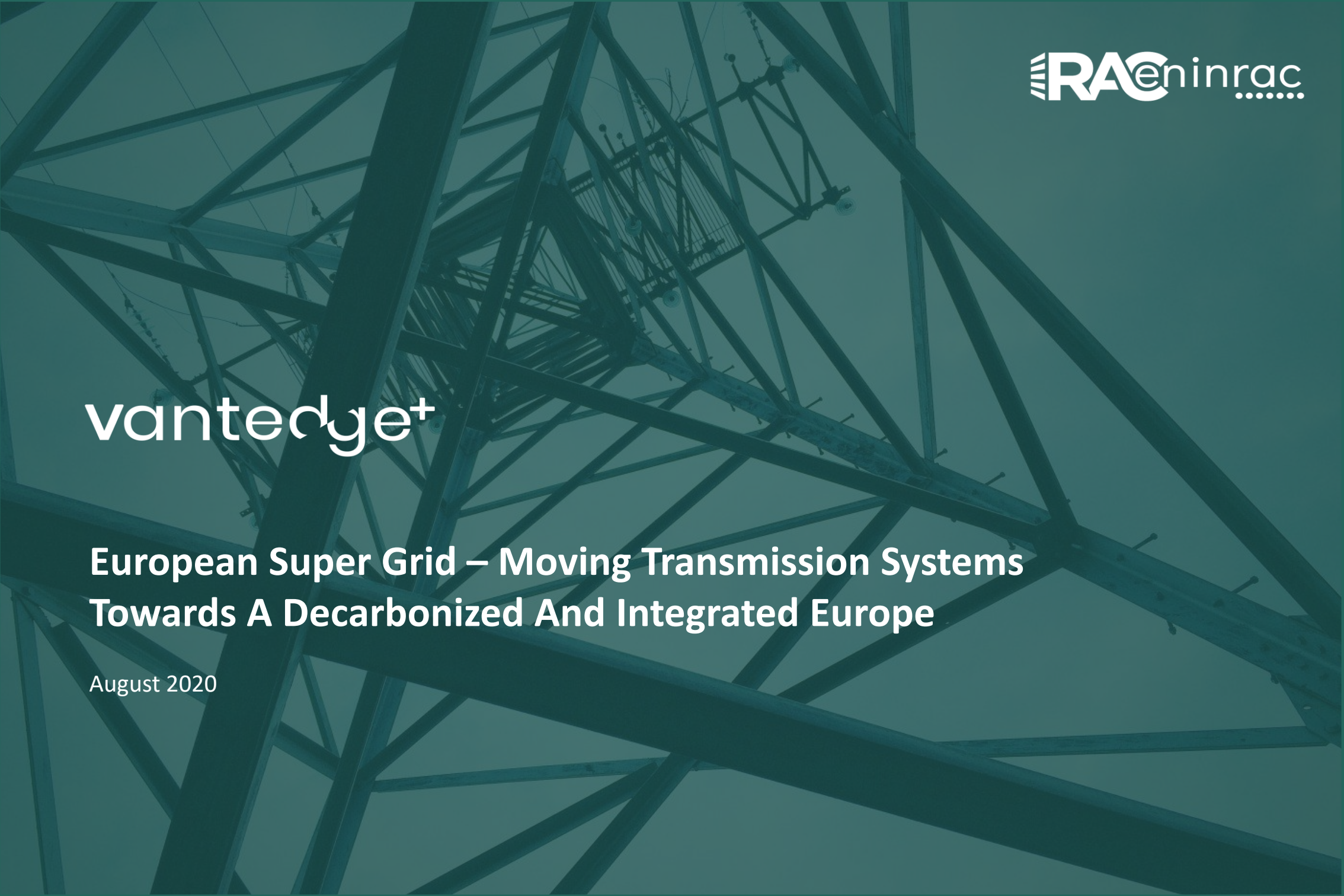


European Super Grid – Moving Transmission Systems Towards A Decarbonized And Integrated Europe

August 2020

European Union heading towards building Super grid

The electricity generated at power plants needs to be supplied to the distribution utilities for which a robust transmission network is very essential. The transmission network in Europe works as a single grid with all major countries connected to each other delivering electric power at high voltages ranging from 220 kV to 1,000 kV. A well connected and upgraded transmission network is very essential as some countries in Europe are trying to phase out thermal & nuclear plants and completely adopt renewable energy for electricity generation. Germany's energy regulator has given a nod to one such project in which high voltage line will send wind power from North sea to southwest consumers in Germany which will help phase out nuclear plant till 2022 and good connectivity will help supplying clean electricity to consumers.

For better connectivity, new inter and intra country transmission networks are being proposed, such initiatives bring business opportunity for many value chain players in the transmission sector. Over USD 15 billion is estimated to be invested in coming decade for the national electricity grid in Italy. United kingdom to see largest fresh investments in power transmission segment as record breaking 5.4 GW wind capacity successfully awarded in 2019. In countries like Estonia, Latvia & Belarus opportunity scale for transmission projects is USD 365.48 Million, Grid upgradation project in Slovakia & Czech Republic brings opportunity of USD 103 Million which are some eye catching projects in Europe. There are few other transmission projects like in Slovenia having opportunity size of USD 54.60 Million and in Bulgaria & Greece catering to opportunity worth USD 32.43 Million.

COVID-19 to have an impact on fresh investments in power transmission in Europe, commissioning of new power transmission lines likely to be affected

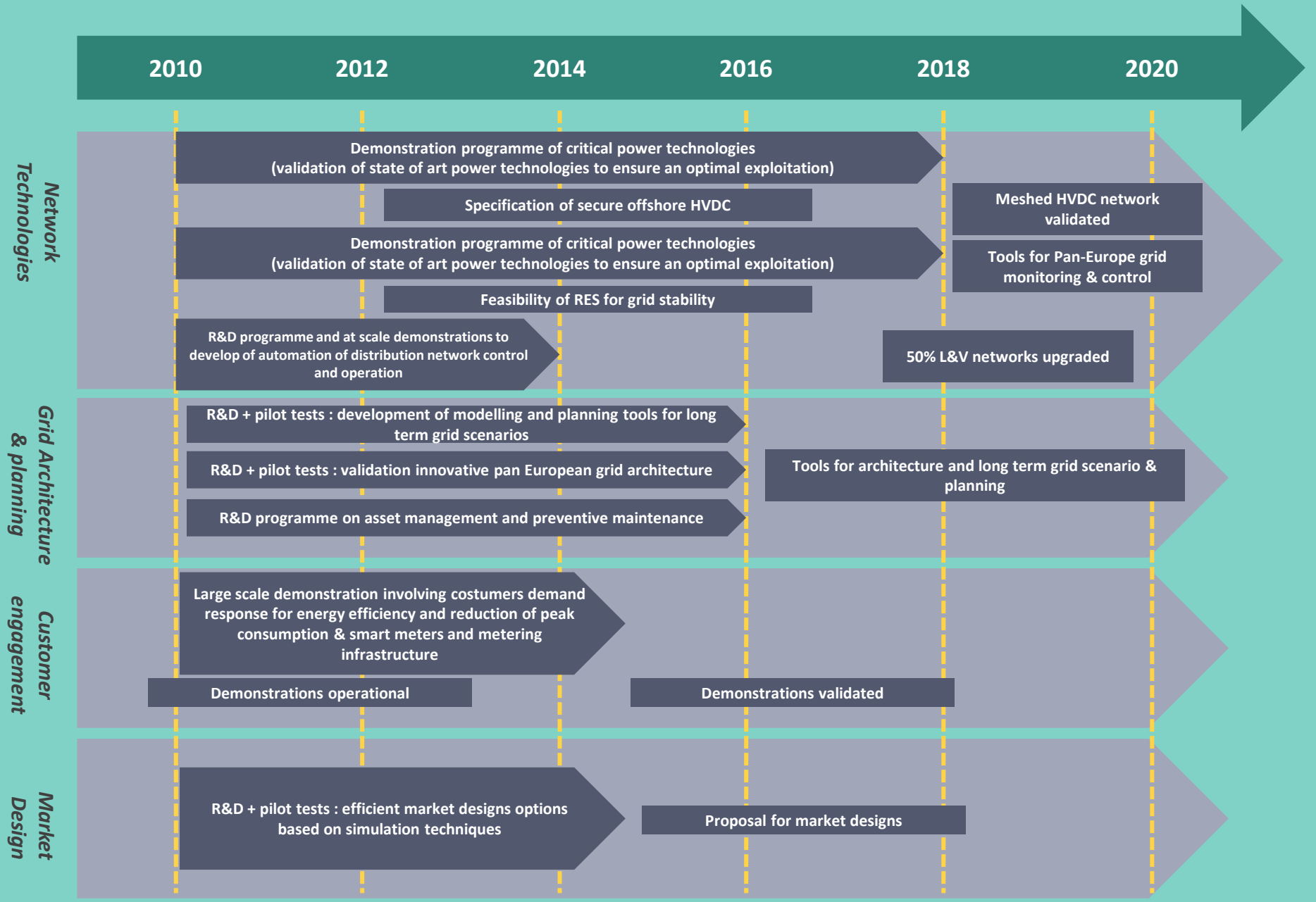
EUROPEAN SUPER GRID – MOVING TRANSMISSION SYSTEMS TOWARDS A DECARBONIZED AND INTEGRATED EUROPE

EUROPEAN GRID

European Grid is a possible future super grid that would ultimately interconnect the various European countries and the regions around Europe's borders at high voltage HVDC network lines – including Kazakhstan, Morocco, Mauritania, Egypt, Scandinavia and Iceland with specific purpose of enabling renewable energy to reliably delivered from these areas, and to utilise only existing hydro power as balancing.

Benefits of Super grid –

- A cross-border energy network would have a number of benefits, including improved energy security, grid decentralisation, and the improved uptake of renewable energy technologies
- The most significant benefit would be the pooling of the entire renewable energy resource of the European continent. This would reduce intermittency by smoothing supply and demand issues, while also providing a huge amount of reserve
- Lower the cost of power in all participating countries by allowing the entire region to share the most efficient power plants
- Pool load variability and power station unreliability, reducing the margin of inefficient spinning reserve and standby that have to be supplied
- Allow for wider use of renewable energy particularly wind energy
- Allow wide sharing of total European hydro power resource which is about 6 weeks of full load European output
- Decrease Europe's dependence of imported fuels



Source: European Commission, Eninrac research

Investment Plans For Power Transmission Asset Development

As per 2030 Climate and Energy Framework the total investment needs (including investments in end-use sectors, generation and grids) in the reference scenario amount to USD 913.9 billion (annual average till 2030) and the decarbonisation scenarios require additional investments ranging from 4.7 % (for a 40 % GHG reduction target and 26.5 % RES) to 7.71 % (for a 40 % GHG reduction target and 30 % RES) compared to the reference. The incremental investment needs to reach the 2030 targets are hence relatively low; the average electricity cost in 2030 would be basically identical in the considered scenarios, i.e. 197.1 USD/MWh in the reference scenario and 200.4 USD/MWh and 199.3 USD/MWh respectively in the two other scenarios versus 146.7 USD/MWh in 2010. The investment needs for grids and generation & boilers only represent between 9 and 12 % of the total investments, while transport is responsible for the major share (about 80 %).

Table 01: Investment needs according to the 2030 Framework Impact Assessment

Scenario	2030 Target	Annual Investment Target			
		Till 2030		Till 2050	
		Grid	Generation & Boilers	Grid	Generation & Boilers
Reference	GHG: -32.4 % vs 1990 RES: 24.4 % in FEC EE: -21 % vs 2030 projected	EUR 37 Billion	EUR 41 Billion	USD 45.92 Billion	USD 66.08 Billion

Table 01 : Investment needs according to the 2030 Framework Impact Assessment, Contd.

Scenario	2030 Target	Annual Investment Target			
		Till 2030		Till 2050	
		Grid	Generation & Boilers	Grid	Generation & Boilers
GHG40	GHG: 40 % vs 1990 RES: No pre-set target (26.5 %) EE: No pre-set target (-25.1 % vs 2030 projected)	EUR 41 Billion	EUR 56 Billion	EUR 53 Billion	EUR 85 Billion
GHG40/ EE/RES30	GHG: -40 % vs 1990 RES: 30 % in FEC EE: No pre-set target (-30 % vs 2030 projected)	EUR 40 Billion	EUR 47 Billion	EUR 55 Billion	EUR 72 Billion

Source: Executive summary of the impact assessment for the policy framework for climate and energy in the period from 2020 to 2030 , Eninrac research

Table 02 : Investment needs according to the 2050 Framework Impact Assessment

Scenario	2030 Target	Grid Investment Cost	
		Till 2030	Till 2050
Current Policy Initiatives (CPI)	GHG: -40 % vs 2005 RES: 29 % in final energy consumption (FEC) EE: -11.6 % (2050 vs 2005)	EUR 584 Billion	USD 1357 Billion
High EE	GHG: -80 % vs 1990 RES: 57.3 % in FEC EE: -40.6 %(2050 vs 2005)	EUR 657 Billion	EUR 1518 Billion

Table 03 : Investment needs according to the 2050 Framework Impact Assessment, contd.

Scenario	2030 Target	Grid Investment Cost	
		Till 2030	Till 2050
Diversified supply technologies (DST)	GHG: -80 % vs 1990 RES: 54.6 % in FEC EE: -33.3 % (2050 vs 2005)	EUR 753 Billion	EUR 1712 Billion
High RES	GHG: -80 % vs 1990 RES: 75.2 % in FEC EE: -37.9 % (2050 vs 2005)	EUR 872 Billion	EUR 2195 Billion
Delayed CCS	GHG: -80 % vs 1990 RES: 55.7 % in FEC EE: -32.2 % (2050 vs 2005)	EUR 756 Billion	EUR 1717 Billion
Low nuclear	GHG: -80 % vs 1990 RES: 57.5 % in FEC EE: -37.7 % (2050 vs 2005)	EUR 764 Billion	EUR 1793 Billion

Source: Executive summary of the impact assessment for the policy framework for climate and energy in the period from 2020 to 2030, Eninrac research

NATIONAL AND PAN-EUROPEAN GRID DEVELOPMENT PLANS

I. For North – South Europe Interconnections – Key Developments Planned vis-à-vis transmission connections

Table 3: Key Projects Planned Under the North –South Europe Grid Interconnections

Name of the Project	Net Transfer Capacity (NTC) in MW	Anticipated Commissioning
Celtic Interconnector	700	2026
Greenlink	500	2023
IFA2	1000	2020
Norway-GB NSN	1400	2021
Nautilus (2nd interconnector Belgium-UK)	1400	Earliest 2028
France-Alderney-Britain	1400	2022
Viking DKW-GB	1400	2022
ElecLink	1000	2020
Biscay Gulf + uprates Gatica + Gatica transformer	2200	2025
Navarra – Landes	1500	2027
Aragón – Atlantic Pyrenees	1500	2027
Austria – Italy IT-AT	300	2021
Italy – Switzerland IT-CH	750	2025
Italy – Slovenia SI-IT	1000	2025

Source: ENTSO, Eninrac research

II. For Northern Seas Offshore Grid (NSOG) Interconnections – Key Developments Planned vis-à-vis transmission connections

Table 4 : Key Projects Planned Under the Northern Seas Offshore Grid Interconnections

Name of the Project	Net Transfer Capacity (NTC) in MW	Anticipated Commissioning
Nordlink	1400	2020
Modular offshore grid	1000	2020
North Sea Link	1400	2021
Modular offshore grid phase 2 (120) New onshore corridors Stevin-Avelgem (329) & Avelgem-Center (340)	2000	2026-2028
France-Alderney-Britain	1400	2022
AQUIND Interconnector	2000	2022
Maali	600	2025
Interco Iceland-UK	1000	2030
NeuConnect	1000	2030

Source: ENTSO, Eninrac research

Modernization of the power transmission lines is the key to create a pathway for the effective integration of the renewable capacity - With European market is looking for expanding the renewable capacity into the power generation mix with majority of countries targeting more than 50% of the power generation through renewable resource by 2030, the transmission operators are going for modernisation of power grid for effective integration of the renewable capacity.

> The life of a man consists not in seeing visions and in dreaming dreams, but in active charity and in willing service
>
> **- Henry Wadsworth Longfellow**

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