INTESA SANPAOLO
INNOVATION CENTER

INDUSTRY TRENDS REPORT
ENERGY, ENVIRONMENT AND UTILITIES

ENERGY AND PNRR:

THE GREEN REVOLUTION

FROST & SULLIVAN

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EXECUTIVE SUMMARY

In April 2021 the Italian government launched the **National Recovery and Resilience Plan** (*Piano Nazionale di Ripresa e Resilienza*, PNRR) which forms part of the European Union's Next Generation EU (NGEU) package of €750 billion post-pandemic investment. The Plan is developed around three main axes – digitisation and innovation, ecological transition and social inclusion – and aims to repair some of the economic and social damage caused by the Covid-19 crisis while at the same time supporting the country with negotiating climate change and narrowing territorial, generational and gender gaps.

The **Energy, Environment and Utilities** sector is one of the chief beneficiaries of the PNNR and is being shaped by the second of six missions which is focused on enabling a "green revolution" by notably supporting the use of hydrogen in transport and industry.

Globally, about 20% of energy consumption is accounted for by **renewables**. Hydro and nuclear are the largest contributors to the mix but new wind and solar capacity additions are growing rapidly. In Europe, offshore wind remains small but nonetheless provided 25 GW of cumulative installed capacity in 2020 with the gradual shift from fixed to floating support structures promising to un-lock attractive deep water sites. Solar PV, in contrast, is expected to contribute over 465 GW of Europe's cumulative installed capacity by 2030 as new inverter technology, solar trackers and bifacial panels boost efficiency.

Conventional systems' requirement for land and the associated costs that this entails are leading operators to explore the potential of **agri-solar energy**. In addition to shading crops, deploying PV in a farm setting can enable solar thermal desalination. More broadly, the agriculture sector has become a center of activity for emerging waste-to-energy initiatives and creative approaches to developing **biofuels**. Thermochemical waste reforming technologies are the fastest growing with market participants also exploring how nutrient recovery could improve farms' sustainability by replacing traditional fertilizers.

In the longer term, **green hydrogen** brings the promise of a zero carbon energy economy with electrolyzer technology well placed to help facilitate this change. Up-take is driven by its ability to both utilize renewables and plug directly into existing energy infrastructure with emerging solutions including low- and high-temperature alternatives. Polymer Electrolyte Membrane (PEM) electrolysis is commercially available and can be incorporated into fuel cells to serve a wide array of applications. Innovation should enable volume production which will alter the economics and move the needle in terms roll-out.

Source: Frost & Sullivan

Power distributors and retailers are at the forefront of the energy transition and provide a common touch point between renewables and other inputs/outputs. Frost & Sullivan finds that their combined spending on digital solutions will more than treble between 2020 and 2030 resulting in the establishment of a truly **smart grid** in which information – as well as electricity – flows through the infrastructure. Investment is focused on three principal areas with connecting businesses and serving customers dwarfed by optimizing the grid while digital transformation is also shaping non-core areas such as marketing and sales.

The digital grid and greater levels of renewable electrification will only be made possible by the availability of increased and improved alternative **energy storage** systems. In Italy, the government's goal to phase out coal by 2025 will require new capacity additions and here, as elsewhere, there is an opportunity for "solar PV plus storage" projects which are increasingly demonstrating comparable costs to gas power plants. Moving forwards, redox flow battery technologies are emerging as attractive candidates to meet power grid storage requirements while the residential sector is also growing strongly.

This **Industry Trends Report** examines many of the principal areas within the Energy, Environment and Utilities sector which are being shaped by the National Recovery and Resilience Plan. It provides an overview of some of the key market dynamics and participants which are playing a role in changing the way in which power is generated, transmitted and distributed as the industry looks to play its part in a green revolution.

Source: Frost & Sullivan

RENEWABLES

Globally, about 20% of energy consumption (and almost 30% of electricity production) is accounted for by renewables. Hydro and nuclear are the largest contributors to the mix with 43% and 28% respectively but new wind and solar capacity additions grew by 90% and 23% in 2020, the last year for which data is available, according to figures from the International Energy Agency.

Renewable capacity is expected to increase over 8% in 2022 compared with last year, pushing through the 300 GW mark for the first time.

Despite the phase out of incentives, China is the undisputed leader of renewable growth, accounting for over 40% of the clean energy mix. The US is in second place with projects benefitting from multi-year federal tax incentives. India, meanwhile, has overtaken the European Union as the third largest global powerhouse with operators enjoying lower technology prices and improved grid integration.

In Europe, offshore wind remains small but nonetheless provided 25 GW of cumulative installed capacity in 2020 with new additions planned

The continent leads the adoption compared to other regions. In 2020, 1,502 MW was commissioned in the Netherlands, followed by the United Kingdom (714 MW), Belgium (706 MW), Germany (315 MW), Portugal (25 MW) and Denmark (9.5 MW).

Interest in offshore wind technology has begun to grow in Asia-Pacific. The region is the second largest market with approximately 9.3 GW of installed cumulative capacity. China accounts for the majority of the activity with 2,174 MW of new installations in 2020, followed at some distance by South Korea with 62 MW.

North America is the third-largest market globally with just 42 MW of cumulative installed capacity. Commercial-scale deployment of offshore wind turbines is at a nascent stage. In 2020, new capacity of 12 MW was commissioned in the United States.

Globally, installed capacity of offshore wind energy grew to 34.4 GW by the end of 2020 spread across about 200 operating projects. The United Kingdom leads the way followed by Germany, China, the Netherlands and Belgium.

During 2021, about 23.4 GW of offshore wind capacity was under construction worldwide, with most of the projects located in Asia-Pacific. Global cumulative offshore wind energy deployment by 2026 is forecast to expand rapidly to reach over 145 GW.

Advances in turbines technologies and the deployment of modular substations are enabling higher power ratings and lower costs

Turbine technologies

Innovative drivetrain designs and turbines with increased capacities are delivering more power and reducing the Levelized Cost of Energy (LCOE). There is a growing focus and move towards direct drive and mid-speed drivetrain technologies. Modern turbines are designed with larger hub heights and longer blades which allow higher velocity offshore winds to be exploited. Currently, the size of offshore wind turbines range from 6 MW to 10 MW. Next-generation wind turbines in the 12 MW to 15 MW range will be commercially available in 2023 and 2024.

Modular substations

Electrical network hubs are being deployed that integrate offshore wind farms and onshore power grids by creating a unified, integrated transmission network with shared transmission infrastructure. This approach reduces transmission costs and lowers the impact on the environment and coastal communities due to the reduced need for assets and infrastructure. Available from 2025, future substation islands will comprise energy storage and power-to-X systems which enable the production hydrogen or synthetic fuels

Electric infrastructure

Electrical grid modernization is facilitating the integration of large volumes of offshore wind energy. Technology innovations in electrical interconnections include high-capacity array and high-voltage transmission cables. HVAC alternatives such as low-frequency transmission

Source: Frost & Sullivan

and intermediate reactor stations are also in development. High-Voltage Direct Current (HVDC) technology has lower transmission losses over long distances compared to AC transmission systems with their inherent reactive resistance. HVDC circuit breaker technology is also expected to be commercially available in 2030.

It is however the gradual shift from fixed to floating support structures which promises to un-lock attractive deep water offshore sites and transform the sector

Support structures

Floating foundations are emerging as a technology which is in the demonstration stage but is expected to replace the fixed-bottom foundations that are currently the most common. Floating offshore wind solutions release the potential of sites with depths of over 60m opening up the possibility of harvesting high-potential resources at remote locations far from land. These and other technology advances, such as airborne wind, are anticipated to reduce the associated energy cost and environmental impact and enable emerging economies to deploy offshore.

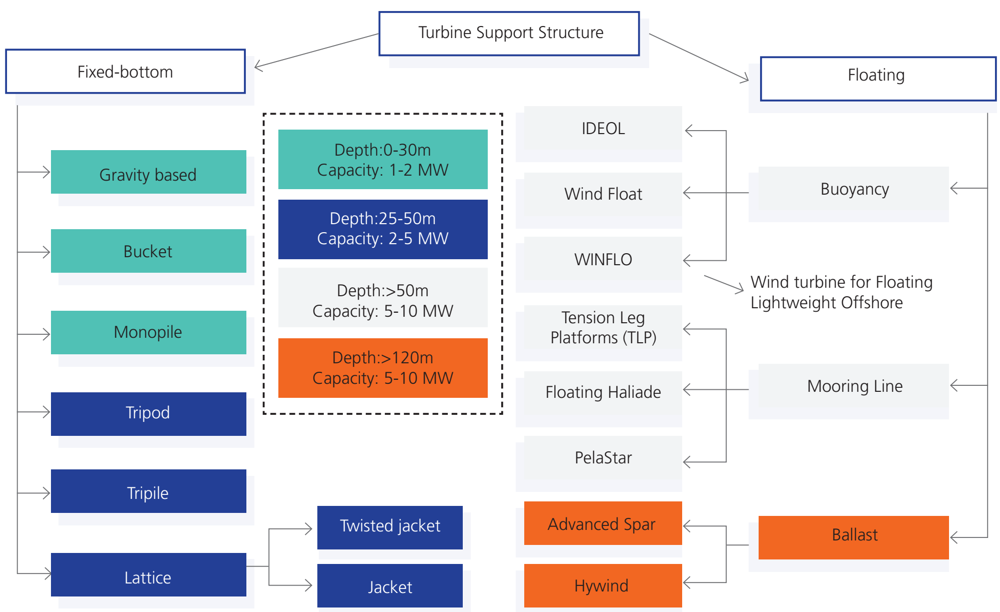
As the industry matures and the installed base ages, demand for wind services will grow with OEMs currently dominating O&M provision

Frost & Sullivan forecasts that the European wind services market will increase from $7.6 billion in 2021 to $14.7 billion, a Compound Average Growth Rate (CAGR) of 7.6%.

Over the last three years, investment in new onshore capacity has declined with, as illustrated above, the focus shifting to offshore. Despite this, the onshore segment will continue to dominate the demand for services in the short term since 41.7% of the installed capacity here is more than ten years old and so will require additional maintenance.

Currently, Original Equipment Manufacturers (OEMs) dominate the European wind services market although Independent Service Providers (ISPs) are challenging for the lead.

Wind asset owners and operators typically prefer longer-term service agreements which are attractive for financial investors that are looking for production certainty and reduced risk. Market participants have therefore started choosing the energy availability contracts that ISPs offer with lower annual service costs and more guaranteed savings than OEMs.



Source: Frost & Sullivan

PRINCIPAL ABBREVIATIONS

AaaS	*Anything-as-a-Service*
ADM	*Advanced Distribution Management*
AEM	*Anion Exchange Membrane*
AI	*Artificial Intelligence*
APV	*Agrophotovoltaic*
AR	*Augmented Reality*
B	*Billion*
BES	*Battery Energy Storage*
BTU	*British Thermal Unit*
CAGR	*Compound Average Growth Rate*
CapEx	*Capital Expenditure*
CHP	*Combined Heat and Power*
CMS	*Condition Monitoring System*
CO2	*Carbon Dioxide*
CRM	*Customer Relationship Management*
DERMS	*Distributed Energy Resource Management System*
DR	*Demand Response*
DS-CD	*Direct Solar-thermal Carbon Distillation*
DSO	*Distribution System Operators*
EDS	*Electro Dynamic Screen*
EV	*Electric Vehicle*
FC	*Fuel Cell*
GaN	*Gallium Nitride*
GW	*Gigawatt*
H2	*Hydrogen*
HTL	*Hydrothermal Liquefaction*
HVAC	*Heating Ventilation and Air Conditioning*
HVDC	*High-Voltage Direct Current*
IaaS	*Infrastructure-as-a-Service*
IoT	*Internet of Things*
IPP	*Independent Power Producers*
ISP	*Independent Service Provider*
kW	*Kilowatt*
LCOE	*Levelized Cost of Energy*
M	*Million*
M&A	*Mergers and Acquisitions*

Source: Frost & Sullivan

MaaS	*Metering-as-a-Service*	**SiC**	*Silicon Carbide*
MC	*Molten Carbonate*	**SO**	*Solid Oxide*
ML	*Machine Learning*	**STD**	*Solar Thermal Desalination*
MSW	*Municipal Solid Waste*	**T&D**	*Transmission and Distribution*
MW	*Megawatt*	**TaaS**	*Turbine-as-a-Service*
O&M	*Operations and Maintenance*	**TCO**	*Total Cost of Ownership*
OEM	*Original Equipment Manufacturer*	**Te**	*Tellurium*
OMS	*Outage Management System*	**TiO2**	*Titanium dioxide*
OpEx	*Operating Expenditure*	**TOU**	*Time of Use*
OTT	*Over-The-Top*	**TPY**	*Tons Per Year*
PEM	*Polymer Electrolyte Membrane*	**TRL**	*Technology Readiness Level*
PEMFC	*Polymer Electrolyte Membrane Fuel Cell*	**UK**	*United Kingdom*
PV	*Photovoltaic*	**US**	*United States*
RES	*Renewable Energy Source*	**UV**	*Ultraviolet*
RO	*Reverse Osmosis*	**V**	*Volt*
RoI	*Returns on Investment*	**VPP**	*Virtual Power Plant*
SaaS	*Software-as-a-Service*	**VR**	*Virtual Reality*
SCADA	*Supervisory Control and Data Acquisition*	**W**	*Watt*

Source: Frost & Sullivan

ABOUT INTESA SANPAOLO INNOVATION CENTER:

Intesa Sanpaolo Innovation Center is the company of Intesa Sanpaolo Group dedicated to innovation: it explores and learns new business and research models and acts as a stimulus and engine for the new economy in Italy. The company invests in applied research projects and high potential start-ups, to foster the competitiveness of the Group and its customers and accelerate the development of the circular economy in Italy.

Based in the Turin skyscraper designed by Renzo Piano, with its national and international network of hubs and laboratories, the Innovation Center is an enabler of relations with other stakeholders of the innovation ecosystem - such as tech companies, start-ups, incubators, research centres and universities - and a promoter of new forms of entrepreneurship in accessing venture capital. Intesa Sanpaolo Innovation Center focuses mainly on circular economy, development of the most promising start-ups, venture capital investments of the management company Neva SGR and applied research

For further detail on Intesa Sanpaolo Innovation Center products and services, please contact
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